PAUL B. KREBS WATER TREATMENT PLANT IMPROVEMENTS

ANNISTON WATER WORKS & SEWER BOARD

PREPARED FOR

ANNISTON WATER WORKS & SEWER BOARD
CITY OF ANNISTON, ALABAMA

VOLUME 1 OF 3
SPECIFICATIONS

For information regarding this project, contact:
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ONE PERIMETER PARK S, SUITE 315 N
BIRMINGHAM, ALABAMA 35243
DUSTIN.HARRIS@JACOBS.COM

Jacobs Project No. D3698100
SRF Project No. FS010239-02

Jacobs

OCTOBER 2024

BID DOCUMENTS

ANNISTON WATER WORKS & SEWER BOARD

CITY OF ANNISTON, ALABAMA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

PAUL B. KREBS WATER TREATMENT PLANT IMPROVEMENTS

****

ISSUED FOR PERMIT

****

JACOBS

Birmingham, Alabama

October 2024

Project No. D3698100 Copy No. _____

ANNISTON WATER WORKS & SEWER BOARD

CITY OF ANNISTON, ALABAMA

PAUL B. KREBS WATER TREATMENT PLANT IMPROVEMENTS

SIGN AND SEAL SHEET

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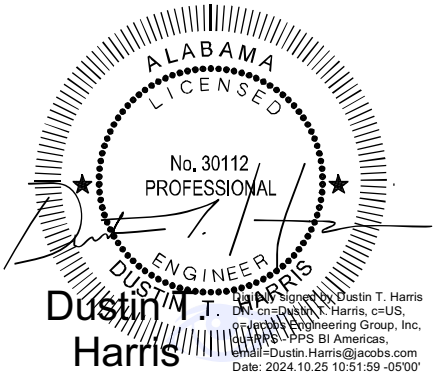

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CITY OF ANNISTON, ALABAMA

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Garrick Donnell Petty, P.E. No. 29827

Garrick D Petty
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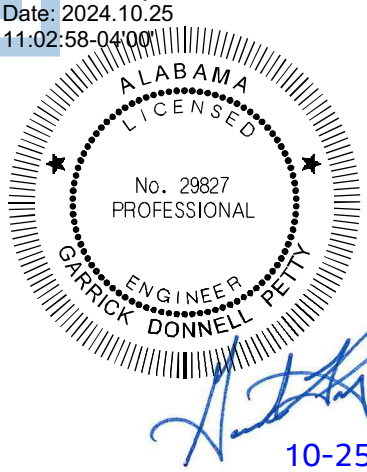

10-25-2024

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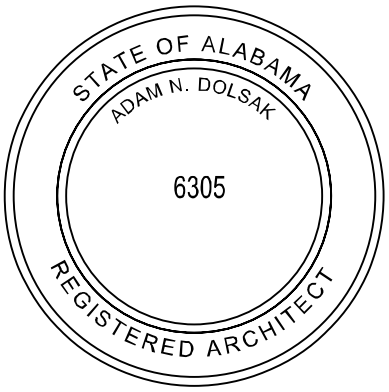

Adam N. Dolsak

Digitally signed by Adam N. Dolsak
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ANNISTON WATER WORKS & SEWER BOARD

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Abel Valiente, P.E. No. 32866

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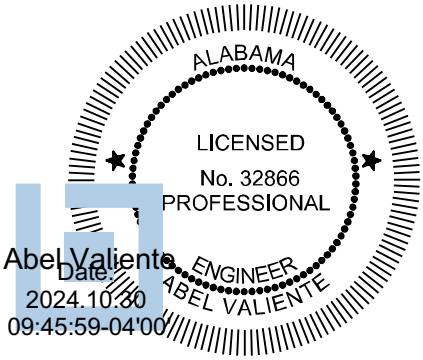

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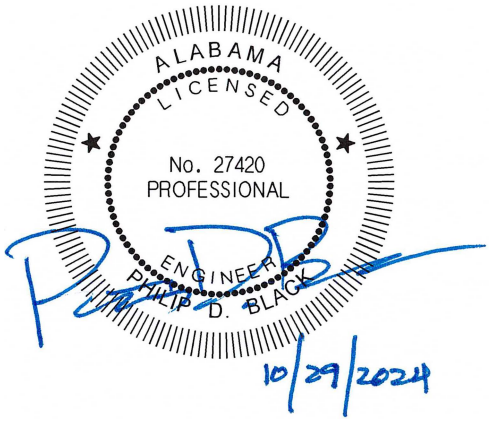

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26 20 00

David Carl Nicholson, P.E. No. 28944

David C. Nicholson
CN=David C. Nicholson, OU=Engineering,
O=Jacobs Engineering Group Inc., L=Dallas,
S=Texas, C=US
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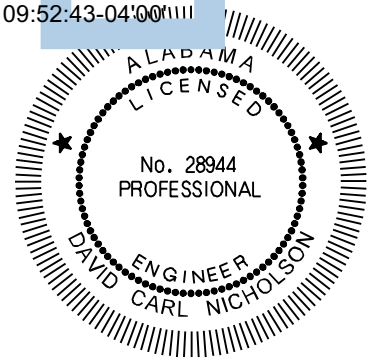

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Lauren Elizabeth Mayes, P.E. No. 51302

Lauren E. Mayes
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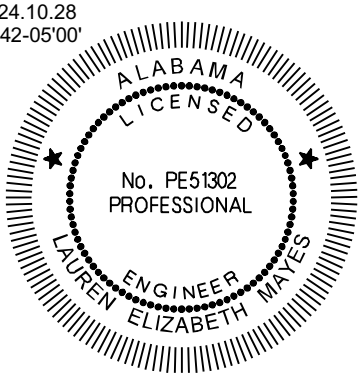

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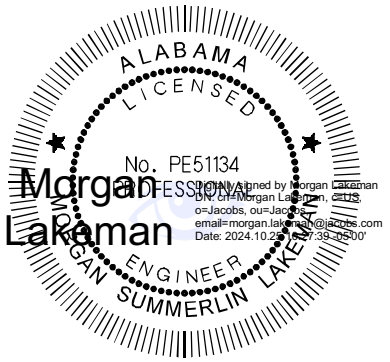

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Christopher Lehman Harris, P.E. No. 32425

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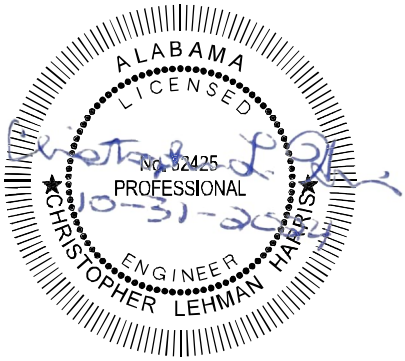

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PART 1

PROCUREMENT REQUIREMENTS

INVITATION TO BID

Sealed Bids for construction of the **PAUL B. KREBS WATER TREATMENT PLANT IMPROVEMENTS** will be received at the office of The Water Works and Sewer Board of Anniston, Alabama, (Owner), 1429 Noble Street, Anniston, AL 36201, **until 10 a.m., local time, on Thursday, February 13, 2025**. Any Bids received after the specified time will not be considered.

Bids will then be publicly opened and read.

The Project contemplated consists, but is not limited, to the following items:

1. Base Bid
    a. Installation of new finished water pump station.
        i. Replace all existing finished water pumps with five new canned vertical turbine pumps.
        ii. Install space and pump cans for two future vertical turbine pumps to serve the distribution system downstream.
        iii. Construct new finished water pump station to house the new vertical turbine pumps south of the existing finish water pump station. The new pump station shall be constructed with individual cans per each pump housing the vertical turbine pumps. This includes the corresponding check valves, isolation valves, air release valves, and instrumentation as required. The pumps and corresponding pipe headers will be located within the building.
        iv. Demolition of the existing maintenance building and modifications to surrounding area as required to allow for construction of the new finished water pump station and electrical building.
        v. Installation of pneumatic surge tank and corresponding compressors, instrumentation, sensors, and appurtenances.
        vi. Installation of all new yard piping for connection of existing clearwell effluent piping to the new finished water pump station and the pump station discharge piping to the connection of the plants high service distribution system piping. Yard piping installation will include tie-ins, flow meters, and valves.

b. Installation of electrical and SCADA upgrades.

    i. Installation of new 277/460V-3-phase power service to replace exiting radial-type distribution power.

    ii. Installation of two new on-site standby generators and paralleling switchgear with isolated/redundant main distribution buses and two separate utility service laterals.

    iii. Update half of the existing main plant process loads currently fed from existing MCC-A to be fed from a new redundant MCC-A2.

    iv. Construct new electrical room within the new finished water pump station to house new electrical gear for the facility including new electrical gear for finished water pump station and generators.

    v. Replace existing lighting with new, energy-efficient LED lighting systems throughout the interior and exterior of the plant.

    vi. Upgrade SCADA with a new RTU in the new finished water pump station.

c. Fluoride Tank Containment Area and Supports

    i. Construction of containment area and tank supports for the new client-provided fluoride tank. This shall include instrumentation, level sensors, loading station, emergency shower and eyewash, and all chemical piping to connect to the existing system.

d. Spring Basin and Containment Wall

    i. Provide waterproofing and repair of the existing Coldwater Spring retaining wall and concrete valley gutters to mitigate surface stormwater short circuiting into the spring.

e. Clearwell/Chlorine Contact Basin Repairs

    i. Repair of collapsed baffle wall. Demolish approximately half of the wall length and reconstruct based on original details. Inspect floor at baffle wall failure location and repair.

    ii. Clean all silt from clearwell floor, inspect for cracks or damage, and repair.

    iii. Repair two concrete pilasters.

iv. Seal cracks in exterior dome roof and coat exterior.

v. Repair cracks in interior clearwell walls.

vi. Provide new exterior and interior coating system.

vii. Repair interior dome roof. Coat and repair exposed wire mesh and rebar. Provide interior coating of surface to prevent future exposure and deterioration.

f. General Site Work

i. New loop road to improve access around the site for maintenance and chemical deliveries.

ii. Demolition of existing entrances and installation of new entrance gate and site fencing.

iii. All stormwater and erosion control measures as required.

iv. Provide site grading and stormwater system improvements per contract documents.

v. Demolition of existing asphalt wearing surface and installation of new wearing surface as indicated in contract documents.

2. Additive Bid Alternative 1: Replace and Repair Existing Air Stripping Towers

a. Portions of each existing Air Stripping Towers (6 Total) to be replaced:

i. 24 vertical feet of 3.5-inch Jaeger Tripack Packing Media (2500 cf).

ii. Two flanged aluminum shell sections above tower packing to be replaced with 304 SS Construction.

iii. 4 screen air outlet screens on the tower shell above the mist eliminator.

iv. Flanged access doors.

v. Polypropylene mesh mist eliminator with support and hold-down. The mist eliminator is 4-inch thick, 138-inch diameter polypropylene mesh.

3. Additive Bid Alternative 2: Installation of new Air Stripping Tower

    a. Installation of new Air Stripping Tower with corresponding blower, valves, piping, instrumentation, sensors and appurtenances.

4. Additive Bid Alternative 3: Replace existing Main DFS control panel with latest generation DFS control panel.

    a. Replace the existing Main DFS control panel in the existing finished water pump station electrical room with a latest generation DFS control panel to include minimum 50 percent more I/O of each signal type. All existing signals will be re-terminated in the new control panel with minimal disruption to plant operations.

The Work will be substantially completed within 840 days and completed in all respects within 900 calendar days from the date when the Contract Times commence to run.

Bidding Documents may be examined in Engineer's office, Jacobs, 1 Perimeter Park South, Suite 315N, Birmingham, Alabama 35243. Electronic Bidding Documents may be viewed and downloaded by registering with QuestCDN online at www.questcdn.com. To view and download digital documents for this project at QuestCDN.com, login or sign up for a free membership within the website's Bidders Tab. Navigate to the digital bidding documents by inputting the Quest Project No. 9449419 on the Project Search page. The digital bidding documents can be viewed for free or downloaded for a non-refundable charge of $22. Any addenda will be posted digitally on the project's website via QuestCDN.com. No partial sets, individual pages, or drawing sheets will be provided.

Each Bid must be submitted on the prescribed Bid Form and accompanied by Bid security as prescribed in the Instructions to Bidders.

The Successful Bidder will be required to furnish the additional bond(s) and insurance prescribed in the Bidding Documents.

The Owner will only accept Proposals from contractors duly licensed by the Alabama State Licensing Board for General Contractors as required by applicable Alabama law, including without limitation Ala. Code § 34-8-1, *et seq.,* Bidders' Alabama General Contractor License Number shall appear on the outside of the envelope containing such bid prior to opening.

For information concerning the proposed Work, contact Dustin Harris, Jacobs, 205-960-3788.

Attendance at a prebid conference will be a mandatory requirement of submitting a Bid for this Project. The mandatory prebid meeting will be held on Wednesday, January 15, 2025, at 10:00 a.m. at the Anniston Water Works and Sewer Board's office located at 1429 Noble St., Anniston, AL 36201.

Owner's right is reserved to reject all Bids or any Bid not conforming to the intent and purpose of the Bidding Documents.

In compliance with the BEASON-HAMMON ALABAMA TAXPAYER AND CITIZEN ACT, the successful bidder will be required to submit proof of Immigration Compliance as the law applies. The following language is required by § 31- 13-9 (k) Code of Alabama 1975 to be placed in all contracts covered by the Act: "By signing this contract, the contracting parties affirm, for the duration of the agreement, that they will not violate federal immigration law or knowingly employ, hire for employment, or continue to employ an unauthorized alien within the state of Alabama. Furthermore, a contracting party found to be in violation of this provision shall be deemed in breach of the agreement and shall be responsible for all damages resulting therefrom."

The Water Works and Sewer Board of the City of Anniston, Alabama

Clif Osborne
Project Manager

INSTRUCTIONS TO BIDDERS

1. DEFINED TERMS

1.1. Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

1.1.1. *Issuing Office*—The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.

2. COPIES OF BIDDING DOCUMENTS

2.1. Complete sets of the Bidding Documents in the number and for the deposit sum, if any, stated in the Invitation to Bid may be obtained from the Issuing Office.

2.2. Complete sets of Bidding Documents shall be used in preparing Bids. Neither Owner nor Engineer assumes responsibility for errors or misinterpretations resulting from use of incomplete sets of Bidding Documents.

3. QUALIFICATIONS OF BIDDERS

3.1. In order to perform public work, Bidder and its Subcontractors, prior to award of Contract or as otherwise required by the jurisdiction, shall hold or obtain such licenses as required by State Statutes, and federal and local Laws and Regulations. No bids will be accepted, except from a qualified contractor duly licensed by the Alabama State Licensing Board for General Contractors.

3.2. To demonstrate Bidder’s qualifications to perform the Work, within 5 days of Owner’s request, Bidder shall submit written evidence such as financial data, previous experience, present commitments, and such other data as may be called for.

3.3. To demonstrate Subcontractor qualifications to perform the Work, Bidder shall, if requested by the Owner, submit written evidence that Subcontractor(s) named in the Bid Form are qualified to perform the Work.

3.4. The bidding contractor, under the same company name, shall have completed at least four (4) projects involving the construction of water or wastewater treatment plants or expansions within the past five (5) years. The Contract amount for at least one of the projects listed is required to be in excess of ten million dollars ($10,000,000) to fulfill the experience requirement. See paragraph 17 of these Instructions to Bidders.

4. LICENSE REQUIREMENTS

4.1. Contractor's license number and the class required shall be inserted in the appropriate place on the Bid Form, before Bid will be considered.

5. EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA, AND SITE

5.1. Subsurface and Physical Conditions:

5.1.1. The Supplementary Conditions identify:

5.1.1.1. Those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site.

5.1.1.2. Those drawings known to Owner of physical conditions relating to existing surface and subsurface structures at the Site (except Underground Facilities).

5.1.2. Copies of reports and drawings referenced will be made available by Owner to any Bidder on request. The "technical data" contained therein upon which Bidder is entitled to rely as provided in Paragraph 5.03 of the General Conditions has been identified and established in Paragraph 5.03 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any "technical data" or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings. Costs associated with making available copies of reports and drawings shall be borne by the Bidder.

5.2. Underground Facilities: Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site is based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner or others.

5.3. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated subsurface or physical conditions appear in Paragraph 5.03 through Paragraph 5.05 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents as a result of any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work, appear in Paragraph 5.06 of the General Conditions.

5.4. Site access will be limited to one scheduled date. On this date, Owner will provide Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as Bidder deems necessary for submission of a Bid. Bidder shall fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies. Bidder shall comply with all applicable Laws and Regulations relative to excavation and utility locates.

5.4.1. Site Visit Date: Pre-Bid Conference. 10:00 a.m., January 15, 2025.

5.4.2. Bidders interested in visiting the Site will meet at the Anniston Water Works and Sewer Boards office located at 1429 Noble St., Anniston, AL 36201 at the date and time stated above. A site visit to the plant will follow the pre-bid conference.

5.5. Safety: Paragraph 7.12.C of the General Conditions indicates that if an Owner safety program exists, it will be noted in the Supplementary Conditions.

5.6. It is responsibility of each Bidder before submitting a Bid to:

5.6.1. Examine and carefully study the Bidding Documents, other related data identified in the Bidding Documents, and any Addenda.

5.6.2. Visit the Site to become familiar with and satisfy Bidder as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

5.6.3. Become familiar with and satisfy Bidder as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

5.6.4. Carefully study all:

5.6.4.1. Reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) that have been identified in Paragraph 5.03 of the Supplementary Conditions as containing reliable “technical data”.

5.6.5. Agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price(s) Bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

5.6.6. Become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

5.6.7. Promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in Bidding Documents and confirm that written resolution thereof by Engineer is acceptable to Bidder.

5.6.8. Determine Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance of the Work.

5.7. Submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this article; that without exception the Bid is premised upon performing and furnishing the Work required by Bidding Documents and applying specific means, methods, techniques, sequences, and procedures of construction that may be shown or indicated or expressly required by Bidding Documents; that Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in Bidding Documents and the written resolutions thereof by Engineer are acceptable to Bidder; and that Bidding Documents are generally sufficient to indicate and convey understanding of terms and conditions for performing and furnishing the Work.

6. SPECIAL PRODUCT REQUIREMENTS

6.1. Bidder’s attention is directed to the Supplementary Conditions, Paragraph 7.03.

7. PREBID CONFERENCE

7.1. MANDATORY prebid conference will be held at 10:00 a.m. local time on Wednesday, January 15, 2025, at the at the Anniston Water Works and Sewer Boards office located at 1429 Noble St., Anniston, AL 36201. Representatives of Owner and Engineer will be present to discuss the Project. Bidders are required to attend and participate in the conference. Bids will not be accepted from Bidders that do not have a representative at the prebid conference. Engineer will transmit to prospective Bidders of record such Addenda as Engineer considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective. Contact Dustin Harris, P.E., Jacobs, at 205-960-3788 for details.

8. SITE AND OTHER AREAS

8.1. The Site is identified in the Bidding Documents. Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by Owner, unless otherwise provided in the Bidding Documents. All additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment to be incorporated in the Work are to be obtained and paid for by Contractor.

9. INTERPRETATIONS AND ADDENDA

9.1. All questions about the meaning or intent of the Bidding Documents are to be submitted to Engineer in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by the office issuing documents as having received the Bidding Documents. Questions received less than 3 days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

9.2. Addenda may also be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Owner or Engineer.

10. BID SECURITY

10.1. Bid shall be accompanied by Bid security made payable to Owner in an amount of 5 percent of Bidder’s maximum Bid price (or maximum amount of $10,000) and in the form of a certified check, bank money order, or a penal Bid bond (on the attached form), issued by a surety meeting the requirements of Paragraph 6.01 of the General Conditions.

10.2. The Bid security of the Successful Bidder will be retained until such Bidder has executed the Contract Documents, furnished the required contract security and met the other conditions of the Notice of Award, whereupon the Bid security will be returned. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within the time period specified in Article Signing of Agreement, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited. Such forfeiture shall be Owner’s exclusive remedy if Bidder defaults. Bid security of other Bidders whom Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of the 7th day after the Effective Date of the Agreement or the number of days specified for all Bids to remain subject to acceptance in Article Bids to Remain Subject to Acceptance, whereupon Bid security furnished by such Bidders will be returned.

10.3. All Bid guaranties, except those of the three lowest bona fide Bidders, shall be returned immediately after Bids have been checked, tabulated, and the relation of the bids established. The Bid guaranties of the three lowest Bidders shall be returned as soon as the contract bonds and the Contract of the successful Bidder have been properly executed and approved.

11. CONTRACT TIMES

11.1. The number of days within which, or the dates by which, the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

12. LIQUIDATED DAMAGES

12.1. Provisions for liquidated damages, if any, are set forth in the Agreement.

13. SUBSTITUTE AND “OR-EQUAL” ITEMS

13.1. The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration of possible substitute or “or-equal” items. Whenever it is specified or described in the Bidding Documents that a substitute or “or-equal” item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, application for such acceptance will not be considered by Engineer until after the Effective Date of the Agreement.

14. SUBCONTRACTORS, SUPPLIERS, AND OTHERS

14.1. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, individuals, or entities to be submitted to Owner in advance of a specified date prior to the Effective Date of the Agreement, apparent Successful Bidder, and any other Bidder so requested, shall within 5 days after Bid opening, submit to Owner a list of all such Subcontractors, Suppliers, individuals, or entities proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, individual, or entity if requested by Owner.

14.2. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit a substitute without an increase in Bid.

14.3. If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers, individuals, or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to revocation of such acceptance after the Effective Date of the Agreement as provided in General Conditions Paragraph 7.06.E.

14.4. Contractor shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom Contractor has reasonable objection.

15. PREPARATION OF BID

15.1. With each copy of the Bidding Documents, Bidder will be furnished one separate unbound copy of the Bid Form, and, if applicable, the Bid Bond Form. No substitution of the Bid Form will be allowed.

15.2. All blanks on the Bid Form shall be completed by typing or printing with ink and the Bid Form signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each Bid item listed therein or the words “No Bid,” “No Change,” or “Not Applicable” entered.

15.3. A Bid by a corporation shall be executed in the corporate name by the president or a vice president or other corporate officer accompanied by evidence of authority to sign. The corporate seal shall be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation shall be shown.

15.4. A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be shown.

15.5. A Bid by a limited liability company shall be executed in the name of the firm by a member and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown.

15.6. A Bid by an individual shall show the Bidder’s name and official address.

15.7. A Bid by a joint venture shall be executed by each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown.

15.8. All names shall be typed or printed in ink below the signatures.

15.9. The Bid shall contain an acknowledgement of receipt of all Addenda; the numbers of which shall be filled in on the Bid Form.

15.10. Postal and e-mail addresses and telephone number for communications regarding the Bid shall be shown.

15.11. The Bid shall contain evidence of Bidder's authority and qualification to do business in the state where the Project is located, or Bidder shall covenant in writing to obtain such authority and qualification prior to award of the Contract and attach such covenant to the Bid. Bidder's state contractor license number and class, if applicable, shall also be shown on the Bid Form.

16. BASIS OF BID; COMPARISON OF BIDS

16.1. Lump Sum:

16.1.1. Bidders shall submit a Bid on a lump sum basis as set forth in the Bid Form. Allowances will be added to the Lump Sum for Total Bid Price.

17. SUBMISSION OF BID

17.1. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the following data:

17.1.1. Documentation for supporting data will include a list of referenced projects meeting the Bidder's experience requirements and listing the name and phone number for contacting references familiar with each project listed.

17.1.2. Documentation for supporting data of subcontractor's experience will include a list of referenced projects meeting the Subcontractor's experience requirements and listing the name and phone number for contacting reference familiar with each project listed.

17.2. Nonresident Bidder's home state preference for resident bidders, in accordance with Article, Preparation of Bids.

17.3. A Bid shall be submitted no later than the date and time prescribed, and at the place indicated in the Invitation to Bid. Enclose Bid in a plainly marked package with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted), name and address of Bidder, and accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED."

18. MODIFICATION AND WITHDRAWAL OF BID

18.1. A Bid may be modified or withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids.

18.2. If within 24 hours after Bids are opened any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, that Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Work is rebid, that Bidder will be disqualified from further bidding on the Work.

19. OPENING OF BIDS

19.1. Bids will be opened at the time and place indicated in the Invitation to Bid and unless obviously nonresponsive, read aloud publicly.

20. BIDS TO REMAIN SUBJECT TO ACCEPTANCE

20.1. All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

21. EVALUATION OF BIDS AND AWARD OF CONTRACT

21.1. Pursuant to Code of Alabama 39-3-5, a resident Bidder shall be allowed a preference over a nonresident Bidder from a state which gives or requires a preference to Bidders from that state. The preference shall be equal to the preference given or required by the state of the nonresident Bidder.

21.2. Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced or conditional Bids. Owner further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to not be responsible. Owner may also reject the Bid of any Bidder if Owner believes that it would not be in the best interest of the Project to make an award to that Bidder. Owner also reserves the right to waive all informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder.

21.3. More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.

21.4. In evaluating Bids, Owner will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

21.5. In evaluating Bidders, Owner may consider the qualifications of Bidders and may consider the qualifications and experience of Subcontractors, Suppliers, and other individuals or entities proposed for those portions of the Work for which the identity of Subcontractors, Suppliers, and other individuals or entities must be submitted either with the Bid, or otherwise prior to issuance of the Notice of Award.

21.6. Owner may conduct such investigations as Owner deems necessary to establish responsibility, qualifications, and financial ability of Bidders, proposed Subcontractors, Suppliers, individuals, or entities proposed for those portions of the Work in accordance with the Contract Documents.

21.7. If the Contract is to be awarded, Owner will award the Contract to Bidder whose Bid is in the best interests of the Project.

22. CONTRACT SECURITY AND INSURANCE

22.1. Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to bonds and insurance. When Successful Bidder delivers executed Agreement to Owner, it shall be accompanied by such bonds.

23. SIGNING OF AGREEMENT

23.1. When Owner issues a Notice of Award to Successful Bidder, it shall be accompanied by the required number of unsigned counterparts of the Agreement along with the other Contract Documents that are identified in the Agreement as attached thereto. Within 10 days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner. Within 10 days thereafter, Owner shall deliver one fully signed counterpart to Successful Bidder with a complete set of the Drawings with appropriate identification.

24. SALES AND USE TAXES

24.1. Owner is exempt for Alabama state sales and use taxes on applicable materials and equipment to be incorporated in the Work that meet the requirements of the Alabama Department of Revenue's Exemptions of Certain Purchases by Contractors and Subcontractors in Conjunction with Construction Contracts with Certain Governmental Entities (Rule 810-6-3-.77). Said taxes shall not be included in the Bid. The Contractor should familiarize themselves with the requirements of the rule and be prepared to submit required forms before exemption status on purchases are granted. Include estimated tax savings on space provided in Bid Form per tax exemption rule requirements.

25. RETAINAGE

25.1. Provisions concerning retainage and Contractor's rights to deposit securities in lieu of retainage, if applicable, are set forth in the Agreement.

END OF SECTION

ESCROW BID DOCUMENT CERTIFICATE

The undersigned hereby certifies that the Bid Documentation contained herein constitutes all the information used in the preparation of the Bid and has personally examined and found Bid Documentation is complete.

Project Name: _____

By: _____

Title: _____

Firm: _____

Date: _____

NOTE TO BIDDER: Use typewriter or ink for completing this Bid Form.

BID FORM

1. BID RECIPIENT

1.1. This Bid is submitted to:

Owner: **The Anniston Water Works and Sewer Board**

Address: **1429 Noble St., Anniston, AL 36201**

Project Identification: **PAUL B. KREBS WATER TREATMENT PLANT IMPROVEMENTS**

1.2. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

2. BIDDER'S ACKNOWLEDGEMENTS

2.1. Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

3. BIDDER'S REPRESENTATIONS

3.1. In submitting this Bid, Bidder represents that:

3.1.1. Bidder has examined and carefully studied the Bidding Documents, the other related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged.

3.1.2.

Addendum No.	**Addendum Date**

(Bidder shall insert number of each Addendum received.)

3.1.3. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

3.1.4. Bidder is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

3.1.5. Bidder has carefully studied: i) reports of explorations and tests of subsurface conditions at or contiguous to the Site and drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) which have been identified in Paragraph 5.03 of the Supplementary Conditions as containing reliable “technical data,”.

3.1.6. Bidder has considered the information known to Bidder; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents; and (3) Bidder’s safety precautions and programs.

3.1.7. Based on information and observations referred to in paragraph above, Bidder does not consider that further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) Bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

3.1.8. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

3.1.9. Bidder has given Engineer written notice of conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

3.1.10. The Bidding Documents are generally sufficient to indicate and convey understanding of terms and conditions for the performance of the Work for which this Bid is submitted.

3.1.11. The Bidder will submit written evidence of its authority to do business in the state where the Project is located not later than the date of its execution of the Agreement.

4. BIDDER'S CERTIFICATION

4.1. Bidder certifies:

4.1.1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization or corporation;

4.1.2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

4.1.3. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

4.1.4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this paragraph:

4.1.4.1."corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process;

4.1.4.2."fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish Bid prices at artificial noncompetitive levels, or (c) to deprive Owner of the benefits of free and open competition;

4.1.4.3."collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, noncompetitive levels; and

4.1.4.4."coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

4.1.5. Required sales and use taxes are included in the stated Bid prices for the Work unless provision is made herein for the Bidder to separately itemize the estimated amount of sales tax or if Instructions to Bidders state Owner is tax exempt.

5. BASIS OF BIDS

5.1. Bidder shall complete the Work in accordance with the Contract Documents for the following price(s):

5.1.1. Unit Price Bid:

Item No.	Description	Unit / Quantity	Unit Price in Words	Unit Price in Figures	Total Amount
1.	Mobilization for deep foundation/drilled pier installation.	LS / 1			$ _____
2.	Demobilization for deep foundation/drilled pier installation.	LS / 1			$ _____
3.	30-inch diameter drilled pier through earthen soil	LF / 980			$ _____
4.	30-inch diameter drilled pier through rock	LF / 245			$ _____
5.	24-inch diameter drilled pier through earthen soil	LF / 500			$ _____
6.	24-inch diameter drilled pier through rock	LF / 125			$ _____
7.	AirTrack / Core drilling through earth and rock.	LF / 2,220			$ _____
8.	Unconfined Compressive Strength Tests for Rock	EA / 10			$ _____

Item No.	Description	Unit / Quantity	Unit Price in Words	Unit Price in Figures	Total Amount
9.	Exposed Concrete reinforcement repair within Chlorine Contact Basin	SF / 5,000			$ _____
10.	Wet/Leaking Concrete Crack Repair within Chlorine Contact Basin	LF / 500			$ _____
11.	Dry Concrete Crack Repair within Chlorine Contact Basin	LF / 200			$ _____
12.	Concrete surface repair for vertical and overhead surfaces within the Chlorine Contact Basin	SF / 200			$ _____
13.	Concrete surface repair for horizontal concrete surfaces within the Chlorine Contact Basin	SF / 200			$ _____
14.	Additional excavation	CY / 150			$ _____
15.	Additional structural fill.	CY / 100			$ _____
16.	Additional granular fill.	CY / 100			
17.	Additional concrete demolition and removal.	CY / 25			$ _____
TOTAL UNIT PRICE AMOUNT					$ _____

5.1.2 Lump Sum Bid Price (NOT INCLUDING 5.1.1, 5.1.4, 5.1.5, OR 5.1.6):

$_____(Number)

_____

_____

_____(Words)
(Amount in words has precedence)

5.1.3 Base Bid Summary:

5.1.3.1 Total Unit Price:
$_____

5.1.3.2 Lump Sum Bid Price
$_____

5.1.3.3 Total Base Bid Amount (Total From Base Bid Summary Above):

$_____(Number)

_____

_____

_____(Words)
(Amount in words has precedence)

5.1.4 Additive Alternative 1 (if applicable):

$_____(Number)

_____

_____

_____(Words)
(Amount in words has precedence)

5.1.5 Additive Alternative 2 (if applicable):

$_____(Number)

_____

_____

_____(Words)
(Amount in words has precedence)

5.1.6 Additive Alternative 3 (if applicable):

$_____(Number)

_____

_____

_____(Words)
(Amount in words has precedence)

6 OWNER-SELECTED EQUIPMENT/SUPPLIER

6.1 All Owner-Selected Equipment/Supplier items shall be bid according to the following:

The product(s) noted as "(A)" selection for each item of equipment listed in the following Owner Selected Equipment/Supplier Schedule has been designated by the Owner for use in the Project. Where more than one product is noted as (A), Bidder must circle the item on which the bid is based. The Bidder may indicate substitute equipment/supplier either by circling a named (B), (C), etc., item or by writing in and circling a substitute, and writing in the amount of deduction for the substitute equipment/supplier.

The prior naming of substitute equipment/suppliers is based on a belief that the substitute should be able to furnish "equal" equipment/service as that specified, although it may not be the supplier's standard. Should the circled substitute or circled write in substitute be disallowed by the Owner as "not equal" or "not desired," then the Bidders shall supply the circled (A) item. If no substitute is indicated, the Bidder must supply the circled (A) item. Should Bidder fail to circle one, or circle more than one, then Bid will be deemed by Owner to be based upon the first-listed equipment/supplier, and Bidder, if awarded the Contract, shall provide same.

The Bidder must supply a base bid for the Owner-Selected Equipment/Supplier items. The bidder may supply a deductive cost from the base bid for at least one of the products noted as (B), (C), (D), etc. This amount will be deducted from the base bid if the Owner in its sole discretion determines that the acceptance of the substitute product is in its own best interest.

Substitute equipment/suppliers will generally be deemed equal provided the "equal" product is equivalent to or better than the product named and described in the Specifications in form, function, performance, reliability, quality, and general configuration. Determination of equality in reference to the project design requirements will be made solely by the Owner. The Owner in its sole discretion may determine any substitute "not desired" and reject said substitute.

Additional substitutes will not be considered after receipt of the Bidder's Proposal.

Design of this Project is based upon the manufacturer's equipment or product noted as the "A" item in the schedule. Should a Bidder propose furnishing substitute equipment, he shall comply with the following:

In addition to the deduct (if any) offered, the Bidder SHALL REIMBURSE JACOBS (THE "ENGINEER") THROUGH THE OWNER FOR ANY ASSOCIATED REDESIGN AND/OR CONSTRUCTION DRAWINGS by any DIMENSIONAL, MECHANICAL, ELECTRICAL, AND STRUCTURAL CHANGES AND/OR REQUIREMENTS FOR THE SUBSTITUTE'S USE. Bidder, therefore, shall include in his bid for such substitute equipment/supplier mechanical, architectural, structural, electrical, and engineering redesign costs associated with that substitute equipment, material, or supplier. The bid for such substitute equipment/supplier shall also include any paid-up licenses necessary for the use of the equipment if required by the manufacturer.

Reimbursement for engineering redesign shall be based on the Engineer's labor costs times a multiplier of 3.0.

MAJOR EQUIPMENT SUBMITTAL REQUIREMENTS FOR NAMED SUBSTITUTE EQUIPMENT/SUPPLIER. In order that the Owner may determine if the proposed named substitute shall be allowed for the specified and named (A) equipment/supplier, the information below shall be submitted if requested by the Owner for each named substitute entered within 7 days of Owner's request. This request will only be made after receipt of Proposal.

This submittal requirement does not apply to unnamed substitute equipment/suppliers, the requirements for which are outlined below.

THIS INFORMATION MUST BE SUBMITTED WITHIN 7 DAYS OF OWNER'S REQUEST:

A. Dimensional and weight information on components and assemblies.

B. Catalog information and cuts.

C. List of requested exceptions to the Contract Documents.

D. Any additional information requested by the Owner.

MAJOR EQUIPMENT SUBMITTAL REQUIREMENTS FOR UNNAMED SUBSTITUTE (WRITE IN) EQUIPMENT/SUPPLIERS. In order that the Owner may determine if the proposed, unnamed substitute write in shall be allowed for the specified and named (A) equipment/supplier, the information below shall be SUBMITTED WITH THIS PROPOSAL. This submittal is not required for named substitute equipment/suppliers listed as (B), (C), etc.

THE FOLLOWING MUST BE SUBMITTED WITH THE PROPOSAL:

A. List of any and all exceptions to the Contract Documents.

B. Dimensional and weight information on components and assemblies.

C. Catalog information and cuts.

D. Manufacturer's specifications, including materials description and paint system.

E. Perform data and pump curves, as applicable.

F. Horsepower of all motors supplied.

G. Outside utility requirements for each component, such as water, power, air, etc.

H. Addresses and phone numbers of nearest service center and a listing of the manufacturers or manufacturer's representatives' services available at this location.

I. Addresses and phone numbers for the nearest parts warehouse capable of providing full parts replacement and/or repair service.

J. A list of the three most recent installations where similar equipment by the manufacturer or manufacturer's representative is currently in service; include contact name, telephone number, mailing address, and the names of the Engineer, Owner, and Installation Contractor; if three installations do not exist, the list shall include all that do exist, if any.

K. Description of structural, electrical, mechanical, and all other changes or modifications necessary to adapt the equipment or system to the arrangement shown and/or functions described on the Drawings and in the Technical Specifications.

L. Any additional information requested by the Owner.

Section Number	Description		Manufacturer/Supplier	Amount of Deduct for Substitute Equipment/Supplier
26 32 13	Generators	(A)	Caterpillar	XXXXXX
		(A)	Cummins/Onan	XXXXXX
		(B)	_____	$_____
44 42 56.03	Vertical Turbine Pumps	(A)	Goulds Water Technology	XXXXXX
		(A)	Sulzer	XXXXXX
		(A)	Floway Pumps	XXXXXX
		(A)	Flowserve	XXXXXX
		(B)	_____	$_____

7 TIME OF COMPLETION

7.1 Bidder agrees the Work will be substantially complete within 840 calendar days after the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within 900 calendar days after the date when the Contract Times commence to run.

7.2 Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work, within the Contract Times.

8 ATTACHMENTS TO THIS BID

8.1 The following documents are submitted with and made a condition of this Bid:

8.1.3 Required Bid security in the form of Bid bond.

8.1.4 The Bidder shall submit a list of at least four (4) projects involving the construction of water or wastewater treatment plants or expansions that have achieved substantial completion within the past five (5) years, and where the contract amount of at least one project was greater than ten million dollars ($10,000,000).

8.1.5 Required Subcontractor Qualification Statement with Supporting Data.

8.1.6 Nonresident Bidder's state preference for resident bidders.

9 DEFINED TERMS

9.1 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

10 BID SUBMITTAL

10.1 This Bid submitted by:

If Bidder is:

An Individual

Name (typed or printed): _____

By (signature): _____

Doing business as: _____

A Partnership

Partnership Name: _____ (SEAL)

By: _____
(Signature of general partner – attach evidence of authority to sign)

Name *(typed or printed)*: _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____

Type (General Business, Professional, Service, Limited Liability): ____

By: _____
(Signature – attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____ (CORPORATE SEAL)

Attest: _____
(Signature of Corporate Secretary)

Date of Qualification to do business in Alabama is:
_____.

A Joint Venture

Joint Venturer Name: _____ (SEAL)

By: _____
(Signature of joint venture partner – attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

Bidder's Business Address: _____

_____

Phone No.:_____ FAX No.: _____

E-mail: _____

SUBMITTED on _____, 20_____

Alabama Contractor's License No.: _____

Contractor's License Class (where applicable): _____

END OF SECTION

BID BOND

Any singular reference to Bidder, Surety, Owner, or other party shall be considered plural where applicable.

BIDDER (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):

BID

Bid Due Date:
Project (Brief Description Including Location):

BOND

Bond Number:
Date (Not later than Bid due date):

Penal sum _____ _____

(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Bid Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

BIDDER	SURETY
_____(Seal)	_____(Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature and Title	Signature and Title (Attach Power of Attorney)
Attest: _____	Attest: _____
Signature and Title	Signature and Title

Note: Above addresses are to be used for giving required notice.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Surety's liability.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2. All Bids are rejected by Owner, or

3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default by Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

END OF SECTION

PART 2

CONTRACTING REQUIREMENTS

AGREEMENT

THIS AGREEMENT is by and between _____

_____

(Owner) and _____

_____ (Contractor).

Owner and Contractor, in consideration of the mutual covenants set forth herein, agree as follows:

1. WORK

1.1. Contractor shall complete the Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

1.1.1. Base Bid

1.1.1.1. Installation of new finished water pump station.

1.1.1.1.1. Replace all existing finished water pumps with five new canned vertical turbine pumps.

1.1.1.1.2. Install space and pump cans for two future vertical turbine pumps to serve the distribution system downstream.

1.1.1.1.3. Construct new finished water pump station to house the new vertical turbine pumps south of the existing finish water pump station. The new pump station shall be constructed with individual cans per each pump housing the vertical turbine pumps. This includes the corresponding check valves, isolation valves, air release valves, and instrumentation as required. The pumps and corresponding pipe headers will be located within the building.

1.1.1.1.4. Demolition of the existing maintenance building and modifications to surrounding area as required to allow for construction of the new finished water pump station and electrical building.

1.1.1.1.5. Installation of pneumatic surge tank and corresponding compressors, instrumentation, sensors, and appurtenances.

1.1.1.1.6. Installation of all new yard piping for connection of existing clearwell effluent piping to the new finished water pump station and the pump station discharge piping to the connection of the plants high service distribution system piping. Yard piping installation will include tie-ins, flow meters, and valves.

1.1.2. Installation of electrical and SCADA upgrades.

1.1.2.1. Installation of new 277/460V-3-phase power service to replace exiting radial-type distribution power.

1.1.2.2. Installation of two new on-site standby generators and paralleling switchgear with isolated/redundant main distribution buses and two separate utility service laterals.

1.1.2.3. Update half of the existing main plant process loads currently fed from existing MCC-A to be fed from a new redundant MCC-A2.

1.1.2.4. Construct new electrical room within the new finished water pump station to house new electrical gear for the facility including new electrical gear for finished water pump station and generators.

1.1.2.5. Replace existing lighting with new, energy-efficient LED lighting systems throughout the interior and exterior of the plant.

1.1.2.6. Upgrade SCADA with a new RTU in the new finished water pump station.

1.1.2.7. Installation of new 277/460V-3-phase power service to replace exiting radial-type distribution power.

1.1.3. Fluoride Tank Containment Area and Supports

1.1.3.1. Construction of containment area and tank supports for the new client-provided fluoride tank. This shall include instrumentation, level sensors, loading station, emergency shower and eyewash, and all chemical piping to connect to the existing system.

1.1.4. Spring Basin and Containment Wall

1.1.4.1. Provide waterproofing and repair of the existing Coldwater Spring retaining wall and concrete valley gutters to mitigate surface stormwater short circuiting into the spring.

1.1.5. Clearwell/Chlorine Contact Basin Repairs

1.1.5.1. Repair of collapsed baffle wall. Demolish approximately half of the wall length and reconstruct based on original details. Inspect floor at baffle wall failure location and repair.

1.1.5.2. Clean all silt from clearwell floor, inspect for cracks or damage, and repair.

1.1.5.3. Repair two concrete pilasters.

1.1.5.4. Seal cracks in exterior dome roof and coat exterior.

1.1.5.5. Repair cracks in interior clearwell walls.

1.1.5.6. Provide new exterior coating system.

1.1.5.7. Repair interior dome roof. Coat and repair exposed wire mesh and rebar. Provide interior coating of surface to prevent future exposure and deterioration.

1.1.6. General Site Work

1.1.6.1. New loop road to improve access around the site for maintenance and chemical deliveries.

1.1.6.2. Demolition of existing entrances and installation of new entrance gate and site fencing.

1.1.6.3. All stormwater and erosion control measures as required.

1.1.6.4. Provide site grading and stormwater system improvements per contract documents.

1.1.6.5. Demolition of existing asphalt wearing surface and installation of new wearing surface as indicated in contract documents.

1.1.7. Additive Bid Alternative 1: Replace and Repair Existing Air Stripping Towers

1.1.7.1. Portions of the Air Stripping Towers to be replaced:

1.1.7.1.1. 24 feet of 3.5-inch Jaeger Tripack Packing Media (2500 cf).

1.1.7.1.2. Two flanged aluminum shell sections above tower packing to be replaced with Type 304 stainless steel Construction.

1.1.7.1.3. 4 screen air outlet screens on the tower shell above the mist eliminator.

1.1.7.1.4. Flanged access doors.

1.1.7.1.5. Polypropylene mesh mist eliminator with support and hold-down. The mist eliminator is 4-inch thick, 138-inch diameter polypropylene mesh.

1.1.8. Additive Bid Alternative 2: Installation of new Air Stripping Tower

1.1.8.1. Installation of new Air Stripping Tower with corresponding blower, valves, piping, instrumentation, sensors and appurtenances.

1.1.9. Additive Bid Alternative 3: Replace existing Main DFS control panel with latest generation DFS control panel

1.1.9.1. Replace the existing Main DFS control panel in the existing finished water pump station electrical room with a latest generation DFS control panel to include minimum 50% more I/O of each signal type. All existing signals will be re-terminated in the new control panel with minimal disruption to plant operations.

2. ENGINEER

2.1. The Project has been designed by Jacobs (Engineer), who is to act as Owner's representative, assume duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

3. CONTRACT TIMES

3.1. Time of the Essence: Time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

3.2. Days to Achieve Milestone 1:

3.2.1 Milestone 1 shall be met within 56 days of from the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions.

3.3. Days to Achieve Substantial Completion and Final Payment:

3.3.1. The Work shall be substantially completed within 840 days from the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within 900 days after the date when the Contract Times commence to run.

3.4. Liquidated Damages:

3.4.1. Contractor and Owner recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not completed within the times specified in Paragraph Contract Times above, plus any extensions thereof allowed in accordance with Article 11 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty) Contractor shall pay Owner $1,000 for each day that expires after the time specified herein for Substantial Completion until the Work is substantially complete.

3.4.2. After Substantial Completion, if Contractor neglects, refuses, or fails to complete remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner $1,000 for each day that expires after the time specified herein for completion and readiness for final payment until the Work is completed and ready for final payment.

4. CONTRACT PRICE

4.1. Owner will pay Contractor for completion of the Work in accordance with the Contract Documents and based on the Proposal contained herein:

Base Bid:

$_____

_____Words

($_____Figures).

Additive Alternative 1:

$_____

_____Words

($_____Figures).

Additive Alternative 2:

$_____

_____Words

($_____Figures).

Additive Alternative 3:

$_____

_____Words

($_____Figures).

5. PAYMENT PROCEDURES

5.1. Submittal and Processing of Payments: Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

5.2. Progress Payments and Retainage: Owner will make progress payments on account of the Contract Price on the basis of Contractor's Application for Payment on the date of each month as established in the preconstruction conference during performance of the Work as provided herein. All such payments will be measured by the Schedule of Values established as provided in Paragraph 2.05 of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided in the General Requirements.

5.2.1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 15.01 of the General Conditions:

5.2.1.1. 95 percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, Owner, on recommendation of Engineer, may determine that as long as the character and progress of the Work remain satisfactory to them, there will be no additional retainage; and

5.2.1.2. 95 percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

5.3. Final Payment:

5.3.1. Upon final completion and acceptance of the Work in accordance with Paragraph 15.06 of the General Conditions, Owner will pay the remainder of the Contract Price as recommended by Engineer as provided in Paragraph 15.06.

6. CONTRACTOR'S REPRESENTATIONS

6.1. In order to induce Owner to enter into this Agreement, Contractor makes the following representations:

6.1.1. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.

6.1.2. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

6.1.3. Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

6.1.4. Contractor has considered the information known to Contractor; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and Site-related reports and drawings identified in the Contract Documents, with respect to the effect of such information, observations, and documents on 1) the cost, progress, and performance of the Work; 2) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Contract Documents; and 3) Contractor's safety precautions and programs.

6.1.5. Based on the information and observations referred to above, Contractor does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.

6.1.6. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

6.1.7. Contractor has given Engineer written notice of conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

6.1.8. The Contract Documents are generally sufficient to indicate and convey understanding of terms and conditions for performance and furnishing of the Work.

7. CONTRACT DOCUMENTS

7.1. Contents:

7.1.1. The Contract Documents that are attached to this Agreement (except as expressly noted otherwise) consist of the following:

7.1.1.1. This Agreement.

7.1.1.2. Performance bond.

7.1.1.3. Payment bond.

7.1.1.4. General Conditions.

7.1.1.5. Supplementary Conditions.

7.1.1.6. Specifications as listed in the table of contents of the Project Manual.

7.1.1.7. Drawings.

7.1.1.8. Addenda.

7.2. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 11.01 of the General Conditions.

8. MISCELLANEOUS

8.1. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

8.2. Successors and Assigns: Owner and Contractor each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

8.3. Severability: Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree the Contract Documents shall 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.

8.4. Assignment of Contract:

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

8.5. Contractor's Certifications:

8.5.1. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this paragraph:

8.5.1.1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in Contract execution;

8.5.1.2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract Price at artificial noncompetitive levels, or (c) to deprive Owner of the benefits of free and open competition;

8.5.1.3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, noncompetitive levels; and

8.5.1.4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement in triplicate. One counterpart each has been delivered to Owner, Contractor, and Engineer. All portions of the Contract Documents have been signed or identified by Owner and Contractor or on their behalf.

This Agreement will be effective on _____, 2025 (which is the Effective Date of the Agreement).

OWNER: The Water Works and Sewer Board of the City of Anniston, Alabama

By: _____

Title: _____

[CORPORATE SEAL]

Attest: _____

Title: _____

Address for giving notices:

1429 Noble Street

Anniston, AL 36201

(If Owner is a corporation, attach evidence of authority to sign. If Owner is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)

CONTRACTOR: _____

_____

By: _____

Title: _____

[CORPORATE SEAL]

Attest: _____

Title: _____

Address for giving notices:

_____

_____

License No. _____
(Where applicable)

Agent for service or process: _____

_____

(If Contractor is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)

END OF SECTION

PERFORMANCE BOND FORM

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR
(Name and Address):

SURETY
(Name and Address of Principal Place of Business):

OWNER (Name and Address):

CONTRACT

Date:
Amount:
Description (Name and Location):

BOND

Bond Number:
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Performance Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

Attest: _____
Signature and Title

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)

SURETY

_____(Seal)

Name and Title

Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

Attest: _____
Signature and Title

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner for the performance of the Contract, which is incorporated herein by reference.

2. If Contractor performs the Contract, Surety and Contractor have no obligation under this Bond, except to participate in conferences as provided in Paragraph 3.1.

3. If there is no Owner Default, Surety's obligation under this Bond shall arise after:

3.1. Owner has notified Contractor and Surety, at the addresses described in Paragraph 10 below, that Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with Contractor and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. If Owner, Contractor and Surety agree, Contractor shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Owner's right, if any, subsequently to declare a Contractor Default; and

3.2. Owner has declared a Contractor Default and formally terminated Contractor's right to complete the Contract. Such Contractor Default shall not be declared earlier than 20 days after Contractor and Surety have received notice as provided in Paragraph 3.1; and

3.3. Owner has agreed to pay the Balance of the Contract Price to:

1. Surety in accordance with the terms of the Contract;

2. Another contractor selected pursuant to Paragraph 4.3 to perform the Contract.

4. When Owner has satisfied the conditions of Paragraph 3, Surety shall promptly and at Surety's expense take one of the following actions:

4.1. Arrange for Contractor, with consent of Owner, to perform and complete the Contract; or

4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to Owner for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by Owner and Contractor selected with Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Contract, and pay to Owner the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by Owner resulting from Contractor Default; or

4.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:

1. After investigation, determine the amount for which it may be liable to Owner and, as soon as practicable after the amount is determined, tender payment therefor to Owner; or

2. Deny liability in whole or in part and notify Owner citing reasons therefor.

5. If Surety does not proceed as provided in Paragraph 4 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Owner to Surety demanding that Surety perform its obligations under this Bond, and Owner shall be entitled to enforce any remedy available to Owner. If Surety proceeds as provided in Paragraph 4.4, and Owner refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Owner shall be entitled to enforce any remedy available to Owner.

6. After Owner has terminated Contractor's right to complete the Contract, and if Surety elects to act under Paragraph 4.1, 4.2, or 4.3 above, then the responsibilities of Surety to Owner shall not be greater than those of Contractor under the Contract, and the responsibilities of Owner to Surety shall not be greater than those of Owner under the Contract. To a limit of the amount of this Bond, but subject to commitment by Owner of the Balance of the Contract Price to mitigation of costs and damages on the Contract, Surety is obligated without duplication for:

6.1. The responsibilities of Contractor for correction of defective Work and completion of the Contract;

6.2. Additional legal, design professional, and delay costs resulting from Contractor's Default, and resulting from the actions or failure to act of Surety under Paragraph 4; and

6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of Contractor.

7. Surety shall not be liable to Owner or others for obligations of Contractor that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than Owner or its heirs, executors, administrators, or successors.

8. Surety hereby waives notice of any change, including changes of time, to Contract or to related subcontracts, purchase orders, and other obligations.

9. Any proceeding, legal or equitable, under this 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 shall be instituted within two years after Contractor Default or within two years after Contractor ceased working or within two years after 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 period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12. Definitions.

12.1. Balance of the Contract Price: The total amount payable by Owner to Contractor under the Contract after all proper adjustments have been made, including allowance to Contractor of any amounts received or to be received by Owner in settlement of insurance or other Claims for damages to which Contractor is entitled, reduced by all valid and proper payments made to or on behalf of Contractor under the Contract.

12.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

12.3. Contractor Default: Failure of Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.

12.4. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

FOR INFORMATION ONLY – Name, Address and Telephone
Surety Agency or Broker
Owner's Representative (engineer or other party)

END OF SECTION

PAYMENT BOND FORM

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR
(Name and Address):

SURETY
(Name and Address of Principal Place of Business):

OWNER (Name and Address):

CONTRACT

Date:
Amount:
Description (Name and Location):

BOND

Bond Number:
Date (Not earlier than Contract Date):
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Payment Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

(Space is provided below for signatures of additional parties, if required.)

Attest: _____
Signature and Title

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

Attest: _____
Signature and Title

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.

2. With respect to Owner, this obligation shall be null and void if Contractor:

2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and

2.2. Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.

3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.

4. Surety shall have no obligation to Claimants under this Bond until:

4.1. Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the addresses described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

4.2. Claimants who do not have a direct contract with Contractor:

1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and

2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor had indicated the claim will be paid directly or indirectly; and

3. Not having been paid within the above 30 days, have sent a written notice to Surety and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.

5. If a notice by a Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.

6. Reserved.

7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.

8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.

9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to

related Subcontracts, purchase orders and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, 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 shall be applicable.

12. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Owner, or Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. Definitions:

15.1. Claimant: An individual or entity having a direct contract with Contractor, or with a first-tier subcontractor of Contractor, to furnish labor, materials, or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms “labor, materials or equipment” that part of water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of Contractor and 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.

15.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

15.3. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

FOR INFORMATION ONLY – Name, Address and Telephone
Surety Agency or Broker:
Owner’s Representative (engineer or other party):

END OF SECTION

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

Issued and Published Jointly by

These General Conditions have been prepared for use with the Agreement Between Owner and Contractor for Construction Contract (EJCDC® C-520, Stipulated Sum, or C-525, Cost-Plus, 2013 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other.

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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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 form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting 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, or both; 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, or both; 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; or (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. 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), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to (a) the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§9601 et seq. ("CERCLA"); (b) the Hazardous Materials Transportation Act, 49 U.S.C. §§5501 et seq.; (c) the Resource Conservation and Recovery Act, 42 U.S.C. §§6901 et seq. ("RCRA"); (d) the Toxic Substances Control Act, 15 U.S.C.

§§2601 et seq.; (e) the Clean Water Act, 33 U.S.C. §§1251 et seq.; (f) the Clean Air Act, 42 U.S.C. §§7401 et seq.; or (g) any other federal, state, or local statute, law, rule, regulation, ordinance, resolution, code, order, or decree 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 the 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. *Engineer*—The individual or entity named as such in the Agreement.

21. *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.

22. *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. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated in the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, does not establish a Hazardous Environmental Condition.

23. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

24. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.

25. *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.

26. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.

27. *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.

28. *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.

29. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

30. *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.

31. *Project Manual*—The written documents prepared for, or made available for, procuring and constructing

the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.

32. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or "RPR" includes any assistants or field staff of Resident Project Representative.

33. *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.

34. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals and the performance of related construction activities.

35. *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.

36. *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.

37. *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 furnished by Owner which are designated for the use of Contractor.

38. *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.

39. *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.

40. *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 thereof.

41. *Successful Bidder*—The Bidder whose Bid the Owner accepts, and to which the Owner makes an award of contract, subject to stated conditions.

42. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.

43. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, 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.

44. *Technical Data*—Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (a) subsurface conditions at the Site, or physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) or (b) 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 the data contained in boring logs, recorded measurements of subsurface water levels, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical or environmental report prepared for the Project and made

available to Contractor are hereby defined as Technical Data with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06.

45. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including but not limited to those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, fiber optic transmissions, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

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

47. *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.

48. *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 the following paragraphs are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. Intent of Certain Terms or Adjectives:

1. 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:

1. The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. Defective:

1. The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

a. does not conform to the Contract Documents; or

b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

c. 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 15.04).

E. Furnish, Install, Perform, Provide:

1. The word "furnish," when used in connection with services, materials, or equipment, shall mean 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, shall mean 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, shall mean 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. 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 Bonds and Evidence of Insurance*

A. *Bonds*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. *Evidence of Contractor's Insurance*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract), the certificates and other evidence of insurance required to be provided by Contractor in accordance with Article 6.

C. *Evidence of Owner's Insurance*: After receipt of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or otherwise), 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 executed 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 specifically 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 *Initial 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 for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.03.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall 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.

2.06 *Electronic Transmittals*

A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may transmit, and shall accept, Project-related correspondence, text, data, documents, drawings, information, and graphics, including but not limited to Shop Drawings and other submittals, in electronic media or digital format, either directly, or through access to a secure Project website.

B. If the Contract does not establish protocols for electronic or digital transmittals, then Owner, Engineer, and Contractor shall jointly develop such protocols.

C. When transmitting items in electronic media or digital format, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items 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 items, or from those established in applicable transmittal protocols.

ARTICLE 3 – DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one 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 or digital versions of the Contract Documents (including any printed copies derived from such electronic or digital versions) and the printed record version, the printed record version shall 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.

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, shall mean 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, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, 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, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, 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 Documents 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 Documents 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 shall 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 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 thereunder.

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 give written notice to Owner and Contractor 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 editions, 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 shall preclude 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 thirtieth 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 sixtieth day after the day of Bid opening or the thirtieth 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 shall 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 shall 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 shall 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 the Contract Times and Contract Price. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the 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. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall 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 utility owners (other than those performing other work at or adjacent to the Site by arrangement with the Owner, as contemplated in Article 8); and

4. acts of war or terrorism.

D. 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.

E. Paragraph 8.03 governs 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.

F. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times 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.

G. Contractor must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under this paragraph within 30 days of the commencement of the delaying, disrupting, or interfering event.

ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor 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; 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 7.12, 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 at law; 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 shall 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 known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site;

2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities); 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 upon the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. 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; or
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.

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 either:

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; or
2. is of such a nature as to require a change in the Drawings or Specifications; or
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 the necessity of Owner's obtaining 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 above; 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. Possible Price and Times Adjustments:

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, or both, 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 conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

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; or

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 as 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, or both, then any such adjustment shall 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, or both, 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.

5.05 *Underground Facilities*

A. *Contractor's Responsibilities*: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or adjacent to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer do not warrant or guarantee the accuracy or completeness of any such information or data provided by others; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

a. reviewing and checking all information and data regarding existing Underground Facilities at the Site;

b. locating all Underground Facilities shown or indicated in the Contract Documents as being at the Site;

c. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and

d. 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 in the Contract Documents, or was not shown or indicated 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), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.

C. *Engineer's Review*: Engineer will promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the Underground Facility in question; 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 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. Possible Price and Times Adjustments:

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, or both, to the extent that any existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, 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. Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Underground Facility in question;

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;

c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times; and

d. 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, or both, then any such adjustment shall 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, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

5.06 *Hazardous Environmental Conditions at Site*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and

2. 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 Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. 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; or

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, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, 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.

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 or 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.H shall obligate 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 shall obligate 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 all of Contractor's obligations under the Contract. These bonds shall 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 Supplementary Conditions, or other specific provisions of the Contract. Contractor shall also furnish such other bonds as are required by the Supplementary Conditions or other specific provisions of the Contract.

B. All bonds shall be in the form prescribed by the Contract except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (as amended and supplemented) by the Financial Management Service, Surety Bond Branch, 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 shall show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

C. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds in the required amounts.

D. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state or jurisdiction where any part of the Project is located, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements above.

E. 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.

F. Upon request, Owner shall provide a copy of the payment bond to any Subcontractor, Supplier, or other person or entity claiming to have furnished labor or materials used in the performance of the Work.

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. Contractor shall deliver to Owner, with copies to each named insured and additional insured (as identified in this Article, in the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Contractor has obtained and is maintaining the policies, coverages, and

endorsements 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 and endorsements, and documentation of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

D. Owner shall deliver to Contractor, with copies to each named insured and additional insured (as identified in this Article, the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Owner has obtained and is maintaining the policies, coverages, and endorsements 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 and endorsements, and documentation of applicable self-insured retentions and deductibles. Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

E. 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, shall not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

F. If either party does not purchase or maintain all of 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.

G. If Contractor has failed to obtain and maintain required insurance, Owner may exclude the Contractor from the Site, impose an appropriate set-off against payment, and exercise Owner's termination rights under Article 16.

H. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect 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 shall be adjusted accordingly.

I. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests.

J. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner and other individuals and entities in the Contract.

6.03 *Contractor's Insurance*

A. *Workers' Compensation*: Contractor shall purchase and maintain workers' compensation and employer's liability insurance for:

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts.

2. United States Longshoreman and Harbor Workers' Compensation Act and Jones Act coverage (if applicable).

3. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees (by stop-gap endorsement in monopolist worker's compensation states).

4. Foreign voluntary worker compensation (if applicable).

B. *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:

1. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees.

2. claims for damages insured by reasonably available personal injury liability coverage.

3. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.

C. *Commercial General Liability—Form and Content*: Contractor's commercial liability policy shall be written on a 1996 (or later) ISO

commercial general liability form (occurrence form) and include the following coverages and endorsements:

1. Products and completed operations coverage:
    a. Such insurance shall 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, to the extent permitted by law, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
3. Broad form property damage coverage.
4. Severability of interest.
5. Underground, explosion, and collapse coverage.
6. Personal injury coverage.
7. 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); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.
8. 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.

D. *Automobile liability*: Contractor shall purchase and maintain automobile liability insurance against claims 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 shall be written on an occurrence basis.

E. *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. Subject to industry-standard exclusions, the coverage afforded shall follow form as to each and every one of the underlying policies.

F. *Contractor's pollution liability insurance*: Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance shall be maintained for no less than three years after final completion.

G. *Additional insureds*: The Contractor's commercial general liability, automobile liability, umbrella or excess, and pollution liability policies shall include and list as additional insureds Owner and Engineer, and any individuals or entities identified in the Supplementary Conditions; include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds; and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Contractor shall obtain all necessary endorsements to support these requirements.

H. *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 shall provide protection against claims arising out of performance of professional design or related services, and caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by Contractor itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.

I. *General provisions*: The policies of insurance required by this Paragraph 6.03 shall:

1. include at least the specific coverages provided in this Article.

2. be written for not less than the limits of liability provided in this Article and in the Supplementary Conditions, or required by Laws or Regulations, whichever is greater.

3. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 10 days prior written notice has been given to Contractor. Within three days of receipt of any such written notice, Contractor shall provide a copy of the notice to Owner, Engineer, and each other insured under the policy.

4. remain in effect at least until final payment (and longer if expressly required in this Article) 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 Documents.

5. be appropriate for the Work being performed and provide protection from claims that may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed 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.

J. The coverage requirements for specific policies of insurance must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

6.04 *Owner's Liability Insurance*

A. In addition to the insurance required to be provided by Contractor under Paragraph 6.03, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

B. 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.

6.05 *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 full insurable replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the Owner and Contractor as named insureds, and all Subcontractors, and any individuals or entities required by the Supplementary Conditions to be insured under such builder's risk policy, as insureds or named insureds. For purposes of the remainder of this Paragraph 6.05, Paragraphs 6.06 and 6.07, and any corresponding Supplementary Conditions, the parties required to be insured shall collectively be referred to as "insureds."

2. be written on a builder's risk "all risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire; lightning; windstorm; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; flood; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; water damage (other than that caused by flood); and such other perils or causes of loss as may be specifically required by the Supplementary Conditions. 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 may be provided through other insurance policies acceptable to Owner and Contractor.

3. 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.

4. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects).

5. 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).

6. extend to cover damage or loss to insured property while in transit.

7. allow for partial occupation or use of the Work by Owner, such that those portions of the Work that are not yet occupied or used by Owner shall remain covered by the builder's risk insurance.

8. allow for the waiver of the insurer's subrogation rights, as set forth below.

9. provide primary coverage for all losses and damages caused by the perils or causes of loss covered.

10. not include a co-insurance clause.

11. include an exception for ensuing losses from physical damage or loss with respect to any defective workmanship, design, or materials exclusions.

12. include performance/hot testing and start-up.

13. be maintained in effect, subject to the provisions herein regarding Substantial Completion and partial occupancy or use of the Work by Owner, until the Work is complete.

B. *Notice of Cancellation or Change*: All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 6.05 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed 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.

C. *Deductibles*: The purchaser of any required builder's risk or property insurance shall pay for costs not covered because of the application of a policy deductible.

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 notice of such occupancy or use to the builder's risk insurer. The builder's risk insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy; rather, those portions of the Work that are occupied or used by Owner may come off the builder's risk policy, while those portions of the Work not yet occupied or used by Owner shall remain covered by the builder's risk insurance.

E. *Additional Insurance*: 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 6.05, it may do so at Contractor's expense.

F. *Insurance of Other Property*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, such as tools, construction equipment, or other personal property owned by Contractor, a Subcontractor, or an employee of Contractor or a Subcontractor, then the entity or individual owning such property item will be responsible for deciding whether to insure it, and if so in what amount.

6.06 *Waiver of Rights*

A. All policies purchased in accordance with Paragraph 6.05, expressly including the builder's risk policy, shall contain provisions to the effect that in the event of payment of any loss or damage the insurers 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. 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 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 Subcontractors, all individuals or entities identified in the Supplementary Conditions as 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. None of the above waivers shall extend 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. 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:

1. loss 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 perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner 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.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 6.06.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them.

D. Contractor shall be responsible for assuring that the agreement under which a Subcontractor performs a portion of the Work 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 any of the perils or causes of loss covered by builder's risk insurance and any other property insurance applicable to the Work.

6.07 *Receipt and Application of Property Insurance Proceeds*

A. Any insured loss under the builder's risk and other policies of insurance required by Paragraph 6.05 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 6.05 shall 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, the damaged Work shall be repaired or replaced, the money so received applied on account thereof, and the Work and the cost thereof covered by Change Order, if needed.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

7.01 *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. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.02 *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 at all times maintain good discipline and order at the Site.

B. 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 shall 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.

7.03 *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 shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall 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 shall 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.

7.04 *"Or Equals"*

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, 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 material or equipment, or items from other proposed suppliers under the circumstances described below.

1. If Engineer in its sole discretion determines that an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer shall deem it an "or equal" item. For the purposes of this paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance,

strength, and design characteristics;

2) it 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) it has a proven record of performance and availability of responsive service; and

4) it is not objectionable to Owner.

b. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times; and

2) it 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 shall result in any change in Contract Price. The Engineer's denial of an "or-equal" request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents.

E. *Treatment as a Substitution Request*: If Engineer determines that an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer considered the proposed item as a substitute pursuant to Paragraph 7.05.

7.05 *Substitutes*

A. 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 no substitution is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment under the circumstances described below. To the extent possible such requests shall 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 material or equipment from anyone other than Contractor.

2. The requirements for review by Engineer will be as set forth in Paragraph 7.05.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 material or equipment that Contractor seeks to furnish or use. The application:

a. shall 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 that specified, and

3) be suited to the same use as that 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 that specified, and

2) available engineering, sales, maintenance, repair, and replacement services.

d. shall 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 shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.05.D, by timely submittal of a Change Proposal.

7.06 *Concerning Subcontractors, Suppliers, and Others*

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner.

B. Contractor shall retain specific Subcontractors, Suppliers, or other individuals or entities 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, Supplier, or other individual or entity 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 five days.

E. Owner may require the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work. 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, Suppliers, or other individuals or entities 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, Supplier, or other individual or entity so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity.

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 be entitled to an adjustment in Contract Price or Contract Times, or both, 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, Supplier, or other individual or entity, whether initially or as a replacement, shall 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 fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions.

J. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors, Suppliers, and all other individuals or entities performing or furnishing any of the Work.

K. Contractor shall restrict all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed herein.

L. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

M. All Work performed for Contractor by a Subcontractor or Supplier shall be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer.

N. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor on account of Work performed for Contractor by the particular Subcontractor or Supplier.

O. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier, or other individual or entity; nor

2. shall create 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.

7.07 *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 a particular 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 shall be disclosed by Owner 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.

7.08 *Permits*

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

7.09 *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.

7.10 *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. Except where otherwise expressly required by applicable Laws and Regulations, 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 shall not be Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

C. Owner or Contractor may give 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 notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.11 *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.

7.12 *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. 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.

B. 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. Contractor shall notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site, when 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.

C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.

D. 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.

E. All damage, injury, or loss to any property referred to in Paragraph 7.12.A.2 or 7.12.A.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).

F. Contractor's duties and responsibilities for safety and protection shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 15.06.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

G. Contractor's duties and responsibilities for safety and protection shall 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.

7.13 *Safety Representative*

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

7.14 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of 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 threatened 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 thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

7.16 *Shop Drawings, Samples, and Other Submittals*

A. Shop Drawing and Sample Submittal Requirements:

1. Before submitting a Shop Drawing or Sample, Contractor shall have:

a. reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

c. determined and verified 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

d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

2. Each submittal shall 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 submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Engineer for review and approval of each such variation.

B. *Submittal Procedures for Shop Drawings and Samples*: Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals. Each submittal will be identified as Engineer may require.

1. Shop Drawings:

a. Contractor shall submit the number of copies required in the Specifications.

b. Data shown on the Shop Drawings will 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.D.

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.D.

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. *Other Submittals*: Contractor shall submit other submittals to Engineer in accordance with the accepted Schedule of Submittals, and pursuant to the applicable terms of the Specifications.

D. Engineer's Review:

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. 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, conform to the information given in 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 shall 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.

5. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 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, shall 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, Sample, or other submittal shall 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.D.4.

E. Resubmittal Procedures:

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 submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.

3. If Contractor requests a change of a previously approved submittal item, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due to

Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

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 and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper 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.

C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:

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. any inspection, test, or approval by others; or

8. any correction of defective Work by Owner.

D. 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 shall 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 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 performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury 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 shall 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.

C. The indemnification obligations of Contractor under Paragraph 7.18.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees,

agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

7.19 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable Laws and Regulations.

B. If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this paragraph, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 7.16.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria specified by Owner or Engineer.

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 utility work at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford each other contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work. 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.

D. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 8, 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.

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 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 shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. 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 shall 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. When applicable, any such equitable adjustment in Contract Price shall 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 is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

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. 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 to 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.

C. 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 to Contractor.

D. 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 shall 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 Documents (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 10.08. 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 *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 Paragraph 10.08. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent, or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

10.04 *Rejecting Defective Work*

A. Engineer has the authority to reject Work in accordance with Article 14.

10.05 *Shop Drawings, Change Orders and Payments*

A. Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, are set forth in Paragraph 7.16.

B. Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, are set forth in Paragraph 7.19.

C. Engineer's authority as to Change Orders is set forth in Article 11.

D. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.06 *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.

10.07 *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.

10.08 *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, shall 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 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 10.08 shall also apply to the Resident Project Representative, if any.

10.09 *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 (if any) of which Engineer has been informed.

ARTICLE 11 – AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

11.01 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.

1. Change Orders:

a. If an amendment or supplement to the Contract Documents includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order. A Change Order also may be used to establish amendments and supplements of the Contract Documents that do not affect the Contract Price or Contract Times.

b. Owner and Contractor may amend those terms and conditions of the Contract Documents that do not 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, without the recommendation of the Engineer. Such an amendment shall be set forth in a Change Order.

2. *Work Change Directives*: 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 11.04 regarding change of Contract Price. Contractor must submit any Change Proposal seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 30 days after the completion of the Work set out in the Work Change Directive. Owner must submit any Claim seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 60 days after issuance of the Work Change Directive.

3. *Field Orders*: 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. If Contractor

believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.02 *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. Such changes shall be supported by Engineer's recommendation, to the extent the change involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters. Such changes 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 shall be performed under the applicable conditions of the Contract Documents. Nothing in this paragraph shall obligate 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.

11.03 *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.

11.04 *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 shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment of Contract Price shall 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); or

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 11.04.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 11.04.C).

C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit shall 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 shall be 15 percent;

   b. for costs incurred under Paragraph 13.01.B.3, the Contractor's fee shall be five 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 11.01.C.2.a and 11.01.C.2.b is that the Contractor's fee shall be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.A.1 and 13.01.A.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 five 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 shall be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the work;

d. no fee shall 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 will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 11.04.C.2.a through 11.04.C.2.e, inclusive.

11.05 *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 shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of Article 12.

B. An adjustment of the Contract Times shall be subject to the limitations set forth in Paragraph 4.05, concerning delays in Contractor's progress.

11.06 *Change Proposals*

A. Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; appeal an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract. The Change Proposal shall specify any proposed change in Contract Times or Contract Price, or both, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents.

1. *Procedures*: Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 30 days) after the start of the event giving rise thereto, or after such initial decision. 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. The supporting data shall 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. Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal.

2. *Engineer's Action*: Engineer will review each Change Proposal and, within 30 days after receipt of the Contractor's supporting data, either deny the Change Proposal in whole, approve it in whole, or deny it in part and approve it in part. Such actions shall 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.

3. *Binding Decision*: Engineer's decision will be final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

B. *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 that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice shall be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

11.07 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders covering:

1. changes in the 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 11.02, (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 in the Contract Price or Contract Times, or other changes, which embody the substance of any final and binding results under Paragraph 11.06, or Article 12.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of this Paragraph 11.07, it shall be deemed to be of full force and effect, as if fully executed.

11.08 *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 shall be submitted 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; and

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.

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 shall rest with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, or both, 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall 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 shall be incorporated in a Change Order 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. 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 shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 13.01.C, and shall 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. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, 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, shall 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 shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case

the cash discounts shall accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment shall 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, who 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 shall 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 for services specifically related to the Work.

5. Supplemental costs including 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, and hand tools not owned by the workers, 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.

    c. Rentals of all construction equipment and machinery, and the parts thereof, whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the 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 property insurance established in accordance with Paragraph 6.05), 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 shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall 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 shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, 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. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

4. 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.

5. 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*: When the Work as a whole is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 11.04.C.

E. *Documentation*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

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 on account of any of the foregoing will be valid.

C. *Contingency Allowance*: Contractor agrees that a 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 on account of Work covered by allowances, and the Contract Price shall 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, subject to the provisions of the following paragraph.

E. Within 30 days of Engineer's written decision under the preceding paragraph, Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price if:

1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement;

2. there is no corresponding adjustment with respect to any other item of Work; and

3. Contractor believes that it is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price, and the parties are unable to agree as to the amount of any such increase or decrease.

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 will 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 therewith 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 shall 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 shall 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 shall 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 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 shall 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 special 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, or both, 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 shall 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 rejected Work as required by Engineer, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, then Owner may, after seven 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 on account of 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. 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 shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens, and 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.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. 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, or

b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or

c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or

d. to make any examination to ascertain how or for what purposes Contractor has used the money paid on account of the Contract Price, 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 on account of Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages on account of 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 that would constitute a default by Contractor and therefore justify a termination for cause has occurred;

j. liquidated 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;

l. there are other items entitling 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 shall 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 shall be treated as an amount due as determined by Paragraph 15.01.C.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 seven 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 shall 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 seven 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 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 6.05 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 7.11), and other documents, Contractor may make application for final payment.

2. The final Application for Payment shall 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 disputes that Contractor believes are unsettled; 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 Application and Acceptance:

1. 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 ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the Application for Payment to Owner for payment. Such recommendation shall 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. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to the provisions of Paragraph 15.07. 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. *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.

D. *Payment Becomes Due*: Thirty days after the presentation to Owner of the final Application for Payment and accompanying documentation, the amount recommended by Engineer (less any further sum Owner is entitled to set off against Engineer's recommendation, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions above with respect to progress payments) will become due and shall be paid by Owner to Contractor.

15.07 *Waiver of Claims*

A. The making of final payment will not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 15.05, from Contractor's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, from outstanding Claims by Owner, or from Contractor's continuing obligations under the Contract Documents.

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 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 terms of any applicable special guarantee required by the

Contract Documents, or by any specific provision of the Contract Documents), any Work is found to be defective, or if the repair of any damages to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas used by Contractor as permitted by Laws and Regulations, is found to be defective, then 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 other adjacent areas;
2. correct such defective Work;
3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, 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 therefrom.

B. If 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 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 correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others).

C. 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.

D. 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.

E. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph shall not 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, 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*

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) ten 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) 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 seven 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 shall govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate For Convenience*

A. Upon seven 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 on account of loss of anticipated overhead, profits, or revenue, 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 seven 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, seven 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; and

2. Disputes between Owner and Contractor concerning the Work or obligations under the Contract Documents, and arising 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; or

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 Documents requires the giving of written notice, it will be deemed to have been validly given if:

1. delivered in person, by a commercial courier service or otherwise, to the individual or to a member of the firm or to an officer of the corporation for which it is intended; or

2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the sender of the notice.

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 shall not constitute a waiver of that provision, nor shall 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 or completion of the Contract or termination 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 *Headings*

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

State of Alabama
Alabama Department of Environmental Management
State Revolving Fund (SRF) Loan Program

SRF Section
Permits and Services Division
Alabama Department of Environmental Management
Post Office Box 301463
Montgomery, Alabama 36130-1463

(334) 271-7793
(334) 271-7950 FAX

Supplemental General Conditions

for SRF Assisted

Public Drinking Water and Wastewater
Facilities Construction Contracts

Clean Water
State Revolving Fund

Protect Our Health from Source to Tap
Drinking Water State Revolving Fund

SRF Project Number: _____

Table of Contents:

I – ADEM Special Conditions

1. Construction within State rights-of-way shall be in accordance with the Alabama Department of Transportation policies and procedures.

2. Construction is to be carried out in compliance with applicable NPDES permits and in a manner that prevents bypassing of raw wastewater flows during construction. If bypassing is anticipated, the ADEM NPDES Enforcement Branch (334-271-7975) shall be advised in advance and the contractor shall take all necessary steps to minimize the impacts of bypassing.

3. Siltation and soil erosion shall be minimized during construction. The contractor shall obtain an NPDES storm water permit for construction if required.

4. The owner shall provide and maintain competent and adequate supervision and inspection.

5. ADEM and EPA shall have access to the site and the project work at all times.

6. These Special Conditions shall supersede any conflicting provisions of this contract.

7. **A project sign is required.** See **Parts XVII and XVIII, pages SGC-38 – SGC-39**, for more information.

II – Bonds and Insurance

Bonding requirements shall comply with Alabama Act No. 97-225. Provisions of the Act are summarized below:

1. Bid Bond – Not less than 5% of either the owner's estimated cost or of the proposed prime contractor's bid up to a maximum of $10,000. The bid guarantee shall consist of a cashier's check drawn on an Alabama bank or a bid bond executed by a surety company duly authorized and qualified to make bonds in the State of Alabama.

2. Performance Bond – In an amount not less than 100% of the contract price.

3. Payment Bond – Payable to the awarding authority, shall be executed in an amount not less than 50% of the contract price.

In addition to the insurance requirements elsewhere in the specifications, the owner or the contractor, as appropriate, must acquire any flood insurance made available by the Federal Emergency Management Agency as required by 40 CFR 30.600 (b), if construction will take place in a flood hazard area identified by the Federal Emergency Management Agency.

III – Utilization of Disadvantaged Businesses Enterprises (DBEs)

It is the policy of the State Revolving Loan Fund (SRF) to promote a "fair share" of sub-agreement awards to **small, minority, and/or women-owned businesses** for equipment, supplies, construction, and services. Compliance with these contract provisions is required in order for project costs to be eligible for SRF funding. *The "fair share" objective is a goal, not a quota.* DBE (Disadvantaged Business Enterprise) is an all-inclusive business classification, which includes MBE (minority business enterprises and/or WBE (women business enterprises) and is used synonymously when these entities are referenced individually or collectively.

Failure on the part of the apparent successful bidder to submit required information to the Loan Recipient (Owner) may be considered (by the Loan Recipient (Owner)) in evaluating whether the bidder is responsive to the bid requirements. The project objectives for utilization of Minority Business Enterprises (MBEs) and Women's Business Enterprises (WBEs) are as follows:

Commodities (Supplies)	MBE 4%	WBE 11%
Contractual (Services)	MBE 8%	WBE 30%
Equipment	MBE 5%	WBE 20%
Construction	MBE 2.5%	WBE 3%

For purposes of clarification:

- This objective applies to any Federally assisted procurement agreement in excess of $10,000.
- This objective necessitates three responsibilities; separate solicitations must be made of small and minority and women's business enterprises.
- A minority business is a business, at least 51 percent of which is owned and controlled by minority group members (Black; Hispanic; Asian American; American Indian; and, any other designations approved by the Office of Management and Budget).
- A women's business is a business, at least 51 percent of which is owned and controlled by one or more women.
- The control determination will revolve around the minority or woman owner's involvement in the day-to-day management of the business enterprise.
- Solicitation should allow adequate time for price analysis. ADEM recommends that contact be made no later than 15 days before bid opening.
- Efforts taken to comply with this objective must be documented in detail; maintain records of firms contacted, including any negotiation efforts to reach competitive price levels, and awards to the designated firms.
- ADEM recommends that the Loan Recipient (Owner) or proposed Prime Contractor utilizes the services of the Minority Business Development Service Centers. These Centers are funded by the U.S. Department of Commerce to provide technical, financial and contracting assistance to minority and women's business enterprises. These Centers are located in a number of Regional cities.
- Use of the services provided by these Centers does not absolve the Loan Recipient (Owner) or proposed Prime Contractor from pursuing additional efforts to meet this objective.

IV – Six Affirmative Steps for Good Faith DBE (MBE-WBE) Solicitation

The Loan Recipient (Owner) shall follow the six affirmative steps found in the SRF application when using loan funds to procure sources of supplies, construction and services.

If the successful bidder plans to subcontract a portion of the project, the bidder must submit to the owner within 10 days after bid opening, evidence of the affirmative steps taken to utilize small, minority and women's businesses. These six affirmative steps or ‘good faith efforts’ are required methods to ensure that DBEs have the opportunity to compete for procurements funded by EPA financial assistance dollars. Such affirmative steps are described as follows:

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. This will include placing DBEs on solicitation lists and soliciting them whenever there 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 solicitation 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. 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 resources, services, and assistance of the AL Department of Transportation (ALDOT), Small Business Administration (SBA), and the Minority Business Development Agency of the Department of Commerce (MBDA).

6. If the Contractor awards subcontracts, it must take the steps described in items (1) through (5) listed above.

V – Documentation Required from Loan Recipient (Owner) and Contractor

The low, responsive, responsible bidder must forward the following items, in duplicate, to the loan recipient (owner) no later than 10 days after bid opening. The Loan Recipient (Owner) shall transmit one (1) copy of its DBE documentation of the prime contractor solicitation and one (1) copy of the prime contractor's/bidder's DBE documentation of all subcontractor solicitation to the SRF Section within 14 days after bid opening.

1. SRF project number and project name/loan name*. (*not contract name)

2. List of **all** subcontractors (DBE **and** non-DBE) with name, address, telephone number, estimated contract dollar amount and duration. If there are to be no subcontractors, please indicate such in a letter on company letterhead.

3. List of any subcontract work yet to be committed with estimate of dollar amount and duration of contract.

4. MBE-WBE (DBE) Documents - See **Part V, page SGC-6**.

5. Debarred Firms Certification – See **Part XIV, page SGC-25**.

6. Certification Regarding Equal Employment Opportunity – See **Part XIII, page SGC-24.**

The Loan Recipient (Owner) shall submit annual MBE/WBE Utilization Reports (EPA Form 5700-52A, **pages SGC-16 - SGC-17**) within 30 days of the end of the annual reporting period **(October 30th, i.e. by November 30th)**. Submit reports directly to:

Diane Lockwood, DBE Coordinator
Administrative Section
Fiscal Branch
Alabama Department of Environmental Management
Post Office Box 301463
Montgomery, Alabama 36130-1463

The proposed Prime Contractor must submit the following items to the Loan Recipient (Owner):

1) DBE Compliance Form. The Loan Recipient (Owner) must submit this information to the SRF Section to demonstratecompliance with the DBE requirements. ADEM's approval is required prior to award of the construction contract and commencement of any SRF-funded construction. **(Page SGC-8)**

2) Certification Regarding Equal Employment Opportunity. This form is required of the proposed prime contractor(re: all subcontracts executed) and should be submitted with the prime proposed contractor's MBE-WBE solicitation submittal to the Loan Recipient (Owner). (**Page SGC-24**)

3) Debarred Firms Certification. This form is required of the proposed prime contractor (re: all subcontracts executed) and should be submitted with the prime proposed contractor's MBE-WBE solicitation submittal to the Loan Recipient (Owner). (**Page SGC-25**)

4) EPA Form 6100-2 DBE Subcontractor Participation Form. This form gives a DBE subcontractor the opportunity to describe the work the DBE subcontractor received from the proposed prime contractor, how much the DBE subcontractor was paid, and any other concerns the DBE subcontractor might have. The proposed prime contractor must provide this form to each DBE subcontractor for the DBE subcontractor's submittal to the SRF Section's MBE-WBE Compliance Staff (to be forwarded to EPA's DBE Coordinator). **(Page SGC-10)**

5) EPA Form 6100-3 DBE Subcontractor Performance Form. This form captures an intended DBE subcontractor's description of work to be performed for the proposed prime contractor and the price of the work. The proposed prime contractor must provide this form to each DBE subcontractor for the DBE subcontractor's submittal to the SRF Section's MBE-WBE Compliance Staff (to be forwarded to EPA's DBE Coordinator). **(Page SGC-12)**

6) EPA Form 6100-4 DBE Subcontractor Utilization Form. This form captures the proposed prime contractor's intended use of all identified DBE subcontractors and the estimated dollar amount of the work. The proposed prime contractor must provide this form to each DBE subcontractor for the DBE subcontractor's submittal to the SRF Section's MBE-WBE Compliance Staff (to be forwarded to EPA's DBE Coordinator). **(Page SGC-14)**

7) EPA Form 5700-52 A MBE/WBE Utilization Reports (DBE Annual Report), if applicable. The Loan Recipient (Owner) must submit this information to the SRF Section within 30 days of the end of the annual reporting period (October 30th), i.e., **by November 30th)**. **(Pages SGC-16 - SGC-17)**

8) Changes to Approved DBE Compliance Form, if applicable. If any changes, substitutions, or additions are proposed to the subcontractors included in previous Department approvals, the Owner must submit this information to the Department for prior approval in order for the affected subcontract work to be eligible for SRF funding. **(Page SGC-23)**

9) Certified Payrolls. These should be submitted to the Loan Recipient (Owner), at least, monthly for the prime contractor and all subcontractors. The Loan Recipient (Owner) must maintain payroll records and make these available for inspection

Please note that DBEs, MBEs, and WBEs must be certified **in writing** by EPA, SBA, or DOT (or by state, local, Tribal, or private entities whose certification criteria match EPA's). Depending upon the certifying agency, a DBE may be classified as a Disadvantaged Business Enterprise (DBE), a Minority Business Enterprise (MBE), or a Women's Business Enterprise (WBE). Written certification as a DBE (MBE or WBE) is required in order to be counted toward the Loan Recipient/Owner's MBE-WBE accomplishments.

The documentation of these good faith solicitation efforts must be detailed in order to allow for satisfactory review. Such documentation might include fax confirmation sheets, copies of solicitation letters/emails, printouts of the online solicitations, printouts of online search results, affidavits of publication in newspapers, etc. The proposed prime contractor is strongly encouraged to follow up each written, fax, or email solicitation with, at least, 1 logged phone call.

The proposed prime contractor must employ the six affirmative steps to subcontract with DBEs, even if the proposed prime contractor has achieved its fair share objectives.

The prime contractor must employ the six affirmative steps to subcontract with DBEs, even if the proposed prime contractor has achieved its fair share objectives. If a DBE subcontractor fails to complete work under the subcontract for any reason, the proposed prime contractor must notify the Loan Recipient (Owner) in writing prior to any termination and must employ the six 'good faith efforts' described above if using a replacement subcontractor. Any proposed changes from an approved DBE subcontractor must be reported to the Loan Recipient (Owner) and to the SRF Section on the Changes to Approved Subcontractors Form prior to initiation of the action. EPA Forms Nos. 6100-3 and 6100-4 must also be submitted to the SRF Section for new DBE subcontracts.

VI – Resources for Identifying MBE-WBE (DBE) Contractors/Subcontractors

The following organizations may provide assistance in soliciting DBE participation:

City of Birmingham
Office of Economic Development
ATTN: **Monique Shorts**, Economic Specialist
710 20th Street North
Birmingham, Alabama 35203
Ph: (205) 254-2799
Fax: (205) 254-7741
Monique.shorts@birmingham.gov

U.S. Small Business Administration
http://www.pro-net.sba.gov

National Association of Minority Contractors (NAMC)
https://namcatlanta.org/

Alabama Department of Transportation
ATTN: **John Huffman**
1409 Coliseum Boulevard
Montgomery, Alabama 36130
Ph: (334) 244-6261
http://www.dot.state.al.us

U.S. Department of Commerce
Minority Business Development Agency
ATTN: **Donna Ennis**
75 5th Street NW,
Suite 300
Atlanta, Georgia 30308
Ph: (404) 894-2096
http://www.mbda.gov/

Governor's Office of Minority and Women's Business Enterprises
Hilda Lockhart, STEP Project Director
401 Adams Avenue
Suite 360
Montgomery, Alabama 36130
Ph: (334) 242-2220

Birmingham Construction Industrial Authority ATTN: **Ashley Orl** or **Kimberly Bivins**
601 37th Street South
Birmingham, Alabama 35222
Ph: (205) 324-6202
aorl@bcia1.org
kbaylorbivins@bcia1.org

NOTE:

(1) The Loan Recipient (Owner) and the proposed Prime Contractor shall use the necessary resources to identify and directly solicit no less than three (3) certified DBE/MBE/WBE companies to bid in each expected contract/subcontract area. If a diligent and documented search of ALDOT, SBA, and MBDA directories does not identify three (3) potential certified DBE/MBE/WBE firms, then the proposed Prime Contractor shall post an advertisement in, at least, one (1) of the other online or print resources. Whenever possible, post solicitation for bids or proposals should be posted/advertised for a minimum of 30 calendar days before the bid or proposal closing date.

(2) Expenditures to a DBE that acts merely as a broker or passive conduit of funds, without performing, managing, or supervising the work of its subcontract in a manner consistent with normal business practices may not be counted.

(3) The proposed Prime Contractor should attempt to identify and first solicit DBEs in the geographic proximity of the project before soliciting those located farther away.

(4) In addition, our SRF DBE Compliance Staff is readily available for assistance, as follows: Diane Lockwood (DBE Coordinator) at (334) 271-7815 or dpl@adem.alabama.gov.

VII – DBE Compliance Form

NOTE: FOR DBE COMPLIANCE, ONE (1) COPY OF THIS FORM (WITH ALL INFORMATION OUTLINED) IS REQUIRED (WITH THE LOAN RECIPIENT (OWNER)'S DBE SUBMITTAL) FOR EACH PR&CS REVIEW. THE LOAN RECIPIENT (OWNER) AND PROPOSED PRIME CONTRACTOR SHOULD ENSURE THAT THIS INFORMATION IS COMPLETE *PRIOR TO THE PR&CS SUBMITTAL TO THE SRF SECTION*.

Loan Recipient: _____ SRF Loan (Project) Number: _____

CERTIFICATIONS:

I certify that the information submitted on and with this form is true and accurate and that this company has met and will continue to meet the conditions of this construction contract regarding DBE solicitation and utilization. I further certify that criteria used in selecting subcontractors and suppliers were applied equally to all potential participants and that EPA Forms 6100-2 and 6100-3 were distributed to all DBE subcontractors.

_____ Date_____

(Proposed Prime Contractor Signature)

_____

(Printed Name and Title)

I certify that I have reviewed the information submitted on and with this form and that it meets the requirements of the Loan Recipient's/Owner's State Revolving Fund loan contract.

(Only ONE (1) signature required below.)**

_____ Date_____

(Signature of Loan Recipient (Owner))

OR**

_____ Date_____

(Loan Recipient's (Owner's) Representative's Signature, (**P.E.**))

_____

(Printed Name and Title)

GENERAL INFORMATION:

Loan Recipient (Owner) Contact: _____

Loan Recipient (Owner) Phone Number/Email: _____

Consulting Engineer Contact: _____

Consulting Engineer Phone Number/Email: _____

Proposed Prime Contractor: _____

Proposed Prime Contractor Contact: _____

Proposed Prime Contractor Phone Number/Email:_____

Proposed Prime Contract Amount: $ _____

Proposed Total DBE/MBE Participation: $ _____ Percentage: ____% Goal: 2.5%

Proposed Total WBE Participation: $ _____ Percentage: ____% Goal: 3.0%

_____

Please ensure the following is submitted in the *full* DBE submittal (with the DBE COMPLIANCE FORM (page SGC-8)):

(1) **List of all committed and uncommitted subcontractors** by trade, including company name, address, telephone number, contact person, dollar amount of subcontract, and DBE/MBE/WBE status. Indicate in writing if no solicitations were made because the contractor intends to use only its own forces to accomplish the work.

(2) **Proof of certification (certificate or letter)** by EPA, SBA, DOT (or by state, local, Tribal, or private entities whose certification criteria match EPA's) for each subcontractor listed as a DBE, MBE, or WBE.

(3) **Documentation of solicitation effort for prospective DBE firms**, such as fax confirmation sheets, copies of solicitation letters/emails, printout of the online solicitations, printouts of online search results, affidavits of publication in newspapers, etc. The prime contractor is strongly encouraged to follow up each written, fax, or email solicitation with at least 1 logged phone call. Whenever possible, post solicitation for bids or proposals should be for a minimum of 30 calendar days before the bid or proposal closing date.

(4) **Justification for not selecting a certified DBE subcontractor** that submitted a low bid for any subcontract area.

(5) **Certification By Proposed Prime Contractor or Subcontractor Regarding Equal Opportunity Employment. (Page SGC-24**)

(6) **Debarred Firms Certification**. (**Page SGC-25**)

(7) **EPA Form 6100-2 DBE Subcontractor Participation Form** for **each** proposed **certified** DBE subcontractor.* (**Page SGC-10**) (*This form is completed by the proposed prime contractor. It is signed by **each** proposed subcontractor **only**.)

(8) **EPA Form 6100-3 DBE Subcontractor Performance Form** for each DBE subcontractor.** (**Page SGC-12**) (**This form is completed by the proposed prime contractor and signed by each proposed certified subcontractor and the proposed prime contractor per subcontract.)

(9) **EPA Form 6100-4 DBE Subcontractor Utilization Form** to summarize all DBE subcontracts/subcontractors.*** (**Page SGC-14**) (***This form is completed and signed by the proposed prime contractor **only**.)

NOTE:

ALL DBE contractors selected must have a current DBE certificate or letter of certification by an approved certifying agency.

Loan Recipient (Owner) DBE Submittal

At minimum, the Loan Recipient (Owner)'s DBE submittal should **always** consist of **a cover letter** (*preferred, but optional*) **and a VII - DBE Compliance Form (page SGC-8) and DBE solicitation documentation** (i.e., DBE solicitation list(s) with source(s) of list(s) clearly identified, contractor contact information and results/outcomes of each solicitation (or of the overall solicitation effort, if all results/outcomes were the same), documentation of solicitation method (i.e., copies of emails, phone logs, faxes, etc.).

Prime Contractor DBE Submittal

At minimum, the Prime Contractor's DBE submittal should **always** consist of **a cover letter** (*preferred, but optional*) **and DBE solicitation documentation** (i.e., DBE solicitation list(s) with source(s) of list(s) clearly identified, subcontractor contact information and results/outcomes of each solicitation (or of the overall solicitation effort, if all results/outcomes were the same), documentation of solicitation method (i.e., copies of emails, phone logs, faxes, etc.) **OR** a "No Subcontractors" Letter (*if none will be utilized*) **and** a List of ***ALL*** *(DBE/non-DBE) subcontractors* contracted/yet to be contracted **and** ***ALL EPA 6100 Forms*** *described above* (*DBE subcontractors selected* ***or not)*** **and** Certification Regarding Equal Employment Opportunity **and** Debarred Firms Certification.

EPA United States Environmental Protection Agency

OMB Control No: 2090-0030

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

An EPA Financial Assistance Agreement Recipient must require its prime contractors to provide this form to its DBE subcontractors. This form gives a DBE[1] subcontractor[2] the opportunity to describe work received and/or report any concerns regarding the EPA-funded project (e.g., in areas such as termination by prime contractor, late payments, etc.). The DBE subcontractor can, as an option, complete and submit this form to the EPA DBE Coordinator at any time during the project period of performance.

Subcontractor Name		Project Name
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Prime Contractor Name		Issuing/Funding Entity:

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services , Equipment or Supplies	Amount Received by 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.

EPA FORM 6100-2 (DBE Subcontractor Participation Form)

EPA United States Environmental Protection Agency

OMB Control No: 2090-0030

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

Please use the space below to report any concerns regarding the above EPA-funded project:

Subcontractor Signature	Print Name
Title	**Date**

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

EPA FORM 6100-2 (DBE Subcontractor Participation Form)

United States Environmental Protection Agency

OMB Control No: 2090-0030

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

This form is intended to capture the DBE[1] subcontractor's[2] description of work to be performed and the price of the work submitted to the prime contractor. An EPA Financial Assistance Agreement Recipient must require its prime contractor to have its DBE subcontractors complete this form and include all completed forms in the prime contractors bid or proposal package.

Subcontractor Name		Project Name
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Prime Contractor Name		Issuing/Funding Entity:

Contract Item Number	Description of Work Submitted to the Prime Contractor Involving Construction, Services, Equipment or Supplies	Price of Work Submitted to the Prime Contractor
DBE Certified By: O DOT O SBA O Other: _____	Meets/ exceeds EPA certification standards? O YES O NO O 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.

EPA FORM 6100-3 (DBE Subcontractor Performance Form)

EPA United States Environmental Protection Agency

OMB Control No: 2090-0030

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

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**

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

EPA FORM 6100-3 (DBE Subcontractor Performance Form)

EPA United States Environmental Protection Agency

OMB Control No: 2090-0030

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 DBE[1] subcontractors[2] and the estimated dollar amount of each subcontract. An EPA Financial Assistance Agreement Recipient must require its 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 No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Issuing/Funding Entity:		

I have identified potential DBE certified subcontractors	○ YES	◉ NO
If yes, please complete the table below. If no, please explain:		

Subcontractor Name/ Company Name	Company Address/ Phone/ Email	Est. Dollar Amt	Currently DBE Certified?

Continue on back if needed

[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.

EPA FORM 6100-4 (DBE Subcontractor Utilization Form)

EPA United States Environmental Protection Agency

OMB Control No: 2090-0030

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form

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**

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

EPA FORM 6100-4 (DBE Subcontractor Utilization Form)

U.S. ENVIRONMENTAL PROTECTION AGENCY
MBE/WBE UTILIZATION UNDER FEDERAL GRANTS AND COOPERATIVE AGREEMENTS

PART I OF II
(PAGES SGC-16 & SGC-17)

FOR COOPERATIVE AGREEMENTS OR OTHER FEDERAL FINANCIAL ASSISTANCE WHERE THE COMBINED TOTAL OF FUNDS BUDGETED FOR PROCURING SUPPLIES, EQUIPMENT, CONSTRUCTION OR SERVICES EXCEED $150,000.

PART 1: PLEASE REVIEW INSTRUCTIONS BEFORE COMPLETING

1A. FEDERAL FISCAL YEAR (Oct 1- Sep 30)	1B. REPORT TYPE
20_____	☐ Annual ☐ Last Report (Project completed)

1C: REVISION OF A PRIOR YEAR REPORT? ◯ No ◯ Yes, Year_____

IF YES, BRIEFLY DESCRIBE THE REVISIONS YOU ARE MAKING:

2A. EPA FINANCIAL ASSISTANCE OFFICE ADDRESS (ATTN: DBE COORDINATOR)	3A. RECIPIENT NAME AND ADDRESS
2B. EPA DBE COORDINATOR Name: Email: Phone: Fax:	3B. RECIPIENT REPORTING CONTACT Name: Address: Phone: Email:
4A. FINANCIAL ASSISTANCE AGREEMENT ID NUMBER (SRF State Recipients, refer to Instructions for Completion of blocks 4A, 5A and 5C)	4B. FEDERAL FINANCIAL ASSISTANCE PROGRAM TITLE OR CFDA NUMBER:
5A. TOTAL ASSISTANCE AGREEMENT AMOUNT EPA Share: $ _____ Recipient Share: $ _____ ☐ **N/A (SRF Recipient)/Loan Amount: $_____**	5B. If NO procurements and NO accomplishments were made this reporting period (by the recipients, sub-recipients, loan recipients, and prime contractors), **CHECK and SKIP to Block No. 7**. (Procurements are all expenditures through contract, order, purchase, lease or barter of supplies, equipment, construction, or services needed to complete Federal assistance programs. Accomplishments, in this context, are procurements made with MBEs and/or WBEs.) ☐

5C. Total Procurements This Reporting Period (Only include amount not reported in any prior reporting period)

Total Procurement Amount $_____

(Include total dollar values awarded by recipient, sub-recipients and SRF loan recipients, including MBE/WBE expenditures.)

5D. Were sub-awards issued under this assistance agreement? Yes ◯ No ◯

Were contracts issued under this assistance agreement? Yes ◯ No ◯

5E. MBE/WBE Accomplishments This Reporting Period

Actual MBE/WBE Procurement Accomplished (Include total dollar values awarded by recipient, sub-recipients, SRF loan recipients and Prime Contractors.)

	Construction	Equipment	Services	Supplies	Total
$MBE:	_____	_____	_____	_____	0.00
$WBE:	_____	_____	_____	_____	0.00

6. COMMENTS: (If no MBE/WBE procurements, please summarize how certified MBEs/WBEs were notified of the opportunities to compete for the procurement dollars entered in Block 5C and why certified MBEs /WBEs were not awarded any procurements during this reporting period.)

7. NAME OF RECIPIENT'S AUTHORIZED REPRESENTATIVE	TITLE
8. SIGNATURE OF RECIPIENT'S AUTHORIZED REPRESENTATIVE	DATE

EPA FORM 5700-52A available electronically at https://www.epa.gov/sites/production/files/2014-09/documents/epa_form_5700_52a.pdf

If reporting DBE procurement, please enter the Loan Project Number and the information in the grid below, as applicable.
If no additional DBE procurement to report, please enter the Loan Project Number and enter 'N/A' in the black box below.

PART II.

MBE/WBE PROCUREMENTS MADE DURING REPORTING PERIOD

SRF Financial Assistance Agreement Number: _____

1. Procurement Made By			2. Business Enterprise		3. $ Value of Procurement	4. Date of Procurement MM/DD/YY	5. Type of Product or Service (Enter Code)	6. Name/Address/Phone Number of MBE/WBE Contractor or Vendor
Recipient	Sub-Recipient and/or SRF Loan Recipient	Prime	Minority	Women				

Type of Product or Service Codes: 1 = Construction 2 = Supplies 3 = Services 4 = Equipment

Note: Recipients are required to submit MBE/WBE reports to EPA beginning with the Federal fiscal year the recipients receive the award, continuing until the project is completed.

Instructions:

A. General Instructions:

MBE/WBE utilization is based on 40 CFR Part 33. The reporting requirement reflects the class deviation issued on November 8, 2013, clarified on January 9, 2014 and modified on December 2, 2014. EPA Form 5700-52A must be completed annually by recipients of financial assistance agreements where the combined total of funds budgeted for procuring supplies, equipment, construction or services exceeds $150,000.This reporting requirement applies to all new and existing awards and voids all previous reporting requirements.

In determining whether the $150,000 threshold is exceeded for a particular assistance agreement, the analysis must focus on funds budgeted for procurement under the supplies, equipment, construction, services or "other" categories, and include funds budgeted for procurement under sub-awards or loans

Reporting will also be required in cases where the details of the budgets of sub-awards/loans are not clear at the time of the grant awards and the combined total of the procurement and sub-awards and/or loans exceeds the $150,000 threshold.

When reporting is required, all procurement actions are reportable, not just the portion which exceeds $150,000.

If at the time of award the budgeted funds exceed $150,000 but actual expenditures fall below, a report is still required.

If at the time of award, the combined total of funds budgeted for procurements in any category is less than or equal to $150,000 and is maintained below the threshold, no DBE report is required to be submitted.

Recipients are required to report 30 days after the end of each federal year, per the terms and conditions of the financial assistance agreement.

Last reports are due October 30th or 90 days after the end of the project period, whichever comes first.

MBE/WBE program requirements, including reporting, are material terms and conditions of the financial assistance agreement.

B. Definitions:

Procurement is the acquisition through contract, order, purchase, lease or barter of supplies, equipment, construction or services needed to accomplish Federal assistance programs.

A ***contract*** is a written agreement between an EPA recipient and another party (also considered "prime contracts") and any lower tier agreement (also considered "subcontracts") for equipment, services, supplies, or construction necessary to complete the project. This definition excludes written agreements with another public agency. This definition includes personal and professional services, agreements with consultants, and purchase orders.

A ***minority business enterprise*** **(MBE)** is a business concern that is (1) at least 51 percent owned by one or more minority individuals, or, in the case of a publicly owned business, at least 51 percent of the stock is owned by one or more minority

individuals; and (2) whose daily business operations are managed and directed by one or more of the minority owners. In order to qualify and participate as an MBE prime or subcontractor for EPA recipients under EPA's DBE Program, an entity must be properly certified as required by 40 CFR Part 33, Subpart B.

U.S. citizenship is required. Recipients shall presume that minority individuals include Black Americans, Hispanic Americans, Native Americans, Asian Pacific Americans, or other groups whose members are found to be disadvantaged by the Small Business Act or by the Secretary of Commerce under section 5 of Executive order 11625. The reporting contact at EPA can provide additional information.

A ***woman business enterprise*** **(WBE)** is a business concern that is, (1) at least 51 percent owned by one or more women, or, in the case of a publicly owned business, at least 51 percent of the stock is owned by one or more women and (2) whose daily business operations are managed and directed by one or more of the women owners. In order to qualify and participate as a WBE prime or subcontractor for EPA recipients under EPA's DBE Program, an entity must be properly certified as required by 40 CFR Part 33, Subpart B.

Business firms which are 51 percent owned by minorities or women, but are in fact not managed and operated by minorities or females do not qualify for meeting MBE/WBE procurement goals. U.S. Citizenship is required.

Good Faith Efforts

A recipient is required to make the following good faith efforts whenever procuring construction, equipment, services, and supplies under an EPA financial assistance agreement. These good faith efforts for utilizing MBEs and WBEs must be documented. Such documentation is subject to EPA review upon request:

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. For Indian Tribal, State and Local and 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 Indian Tribal, 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 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 steps in paragraphs (a) through (e) of this section.

C. Instructions for Part I:

1A. Specify Federal fiscal year this report covers. The Federal fiscal year runs from October 1st through September 30th (**e.g. November 29, 2014 falls within Federal fiscal year 2015**)

1B. Specify report type. Check the annual reporting box. Also indicate if the project is completed.

1C. Indicate if this is a revision to a previous year and provide a brief description of the revision you are making.

2A-B. Please refer to your financial assistance agreement for the mailing address of the EPA financial assistance office for your agreement.

The "EPA DBE Reporting Contact" is the DBE Coordinator for the EPA Region from which your financial assistance agreement was originated. For a list of DBE Coordinators please refer to the EPA OSBP website at http://epa.gov/osbp/dbe_cord.

3A-B. Identify the agency, state authority, university or other organization which is the recipient of the Federal financial assistance and the person to contact concerning this report.

4A. Provide the Assistance Agreement number assigned by EPA. A separate report must be submitted for each Assistance Agreement.

***For SRF recipients**: In box 4a list numbers for ALL OPEN Assistance Agreements being reported on this form.

4B. Refer back to Assistance Agreement document for this information.

5A. Provide the total amount of the Assistance Agreement which includes Federal funds plus recipient matching funds and funds from other sources.

***For SRF recipients only**: SRF recipients will not enter an amount in 5a. SRF recipients should check the "N/A" box.

5B. Self-explanatory.

5C. Provide the total dollar amount of **ALL** procurements awarded this reporting period by the recipient, sub-recipients, and SRF loan recipients, **including** MBE/WBE expenditures, not just the portion which exceeds $150,000. For example: Actual dollars for procurement from the procuring office; actual contracts let from the contracts office; actual goods, services, supplies, etc., from other sources including the central purchasing/ procurement centers).

***NOTE**: To prevent double counting on line 5C, if any amount on 5E is for a subcontract and the prime contract has already been included on Line 5C in a prior reporting period, then report the amount going to MBE or WBE subcontractor on line 5E, but exclude the amount from Line 5C. To include the amount on 5C again would result in double counting because the prime contract, which includes the subcontract, would have already been reported.

***For SRF recipients only**: In 5c please enter the total annual procurement amount under all of your SRF Assistance Agreements. The figure reported in this section is **not** directly tied to an individual Assistance Agreement identification number. **(SRF state recipients report state procurements in this section)**

5D. State whether or not sub-awards and/or subcontracts have been issued under the financial assistance agreements by indicating “yes” or “no”.

5E. Where requested, also provide the total dollar amount of all MBE/WBE procurement awarded during this reporting period by the recipient, sub-recipients, SRF loan recipients, and prime contractors in the categories of construction, equipment, services and supplies. These amounts include Federal funds plus recipient matching funds and funds from other sources.

6. If there were no MBE/WBE accomplishments this reporting period, please briefly how certified MBEs/WBEs were notified of the opportunities to compete for the procurement dollars entered in Block 5C and why certified MBEs /WBEs were not awarded any procurements during this reporting period.

7. Name and title of official administrator or designated reporting official.

8. Signature, month, day, and year report submitted.

D. Instructions for Part II:

For each MBE/WBE procurement made under this financial assistance agreements during the reporting period, provide the following information:

1. Check whether this procurement was made by the recipient, sub-recipient/SRF loan recipient, or the prime contractor.

2. Check either the MBE or WBE column. If a firm is both an MBE and WBE, the recipient may choose to count the entire procurement towards EITHER its MBE or WBE accomplishments. The recipient may also divide the total amount of the procurement (using any ratio it so chooses) and count those divided amounts toward its MBE and WBE accomplishments. If the recipient chooses to divide the procurement amount and count portions toward its MBE and WBE accomplishments, please state the appropriate amounts under the MBE and WBE columns on the form. **The combined MBE and WBE amounts for that MBE/WBE contractor must not exceed the “Value of the Procurement” reported in column #3**

3. Dollar value of procurement.

4. Date of procurement, shown as month, day, year. Date of procurement is defined as the date the contract or procurement was awarded, **not** the date the contractor received payment under the awarded contract or procurement, unless payment occurred on the date of award. **(Where direct purchasing is the procurement method, the date of procurement is the date the purchase was made)**

5. Using codes at the bottom of the form, identify type of product or service acquired through this procurement (e.g., enter 1 if construction, 2 if supplies, etc.).

6. Name, address, and telephone number of MBE/WBE firm.

**This data is requested to comply with provisions mandated by: statute or regulations (40 CFR Parts 30, 31, and 33 and/or 2 CFR Parts 200 and 1500); OMB Circulars; or added by EPA to ensure sound and effective assistance management. Accurate, complete data are required to obtain funding, while no pledge of confidentiality is provided.

The public reporting and recording burden for this collection of information is estimated to average l hour per response annually. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclosure or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, OPPE Regulatory Information Division, U.S. Environmental Protection Agency (2136), 1200 Pennsylvania Avenue, NW, Washington, D.C. 20460. Include the OMB Control number in any correspondence. Do not send the completed form to this address.

XII – Changes to Approved DBE Compliance Form

NOTE: THIS FORM IS REQUIRED OF THE LOAN RECIPIENT (OWNER) (WITH THE PRIME CONTRACTOR'S INPUT) FOR DBE COMPLIANCE ONLY IF A SUBCONTRACTOR/SUPPLIER/VENDOR IS SOUGHT AND/OR PROCURED AFTER THE CONTRACT ATA (APPROVAL-TO-AWARD) HAS BEEN ISSUED. IT IS SIMILAR TO THE DBE COMPLIANCE FORM (PAGE SGC-8) IN THAT IT IS THE COVER/SUMMARY FORM USED TO DOCUMENT THE ADDITIONAL DBE SOLICITATION AND/OR REVISE THE ORIGINAL DBE APPROVAL STATUS.

Loan Recipient: _____ Loan (Project) Number: _____

CERTIFICATIONS:

I certify that the information submitted on and with this form is true and accurate and that this company has met and will continue to meet the conditions of this construction contract regarding DBE solicitation and utilization. I further certify that criteria used in selecting subcontractors and suppliers were applied equally to all potential participants and that EPA Forms 6100-2 and 6100-3 were distributed to all DBE subcontractors.

_____ Date_____
(Prime Contractor Signature)

_____
(Printed Name and Title)

I certify that I have reviewed the information submitted on and with this form and that it meets the requirements of the Loan Recipient's/Owner's State Revolving Fund loan contract. **(*Only ONE (1) signature required below.)**

_____ Date_____
(Signature of Loan Recipient (Owner))

OR*

_____ Date_____
(Loan Recipient's (Owner's) Representative's Signature, (**P.E.**))

_____
(Printed Name and Title)

GENERAL INFORMATION: (Please attach additional pages to address 1 through 5, as needed.)

(1) If an approved subcontractor is terminated or replaced, please identify this company and briefly state the reason.

(2) For new or additional subcontractors, list name, trade, address, telephone number, contact person, dollar amount of subcontract and DBE status.

(3) Attach proof of certification by EPA, SBA, DOT (or by state, local, Tribal or private entities whose certification criteria match EPA's) for each subcontractor listed as a DBE, MBE or WBE.

(4) Attach documentation of solicitation effort for prospective DBE firms, such as fax confirmation sheets, copies of solicitation letters/emails, printouts of the online solicitations, printouts of online search results, affidavits of publication in newspapers, etc. The prime contractor is strongly encouraged to follow up each solicitation with, at least, one (1) logged phone call. Whenever possible, post solicitation for bids or proposals should be for a minimum of 30 calendar days before the bid or proposal closing date.

(5) Provide justification for not selecting a certified DBE subcontractor that submitted a low bid for any subcontract area.

XIII – Certification Regarding Equal Employment Opportunity

The prime contractor is required to comply with Executive Order 112-46 of September 24, 1965 entitled "Equal Employment Opportunity" as amended by Executive Order 11375 of October 13, 1967.

The contract for the work under this proposal will obligate the prime contractor and its subcontractors not to discriminate in employment practices.

The prime contractor shall not maintain or provide for his/her employees the facilities, which are segregated on a basis of race, creed, color or national origin, whether such facilities are segregated by directive or on a de facto basis.

The prime contractor must, if requested, submit a compliance report concerning their employment practices and policies in order to maintain his/her eligibility to receive the award of the contract.

The prime contractor must be prepared to comply in all respects with any contract provisions regarding non-discrimination stipulated in conjunction with labor standards.

PRIME CONTRACTOR'S CERTIFICATION:

Prime Contractor's Name: _____

Address: _____

_____

_____

1. Bidder has participated in a previous contract or subcontract subject to the Equal Opportunity Clause. Yes____ No____
2. Compliance Reports were required to be filed in connection with such contract or subcontract. Yes____ No____
3. Bidder has filed all compliance reports due under applicable contract requirements. Yes____ No____

If answer to item 3 is "No", please explain in detail on reverse side of this certification.

Certification - The information above is true and complete to the best of my knowledge and belief.

Signature of Prime Contractor: _____

Title: _____

Date: _____

XIV – Debarred Firms Certification

All prime construction contractors shall certify that Subcontracts have not and will not be awarded to any firm that is currently on the General Service Administration's Master List of Debarred, Suspended and Voluntarily Excluded Persons, in accordance with the provisions of ADEM Administrative Code 335-6-14-.35. Debarment action is taken against a firm for noncompliance with Federal Law.

All bidders shall complete this certification in duplicate and submit both copies to the Loan Recipient (Owner) with the bid proposal. The Loan Recipient (Owner) shall transmit one copy to the SRF Section within 14 days after the bid opening.

Project Name/Loan Name*: _____
(*not **Contract** Name)

SRF Project No.: _____

The undersigned hereby certifies that the firm of _____

_____ has not and will not award a subcontract, in connection with any contract awarded to it as the result of this bid, to any firm that is currently on the General Service Administration's Master List of Debarred, Suspended, and Voluntarily Excluded Persons.

Signature of Prime Contractor: _____

Title: _____

Date: _____

XV – Davis-Bacon and Related Acts

Labor Standards Provisions for Federally Assisted Contracts

Wage Rate Requirements Under FY 2013 Continuing Appropriation

I. Requirements under the Consolidated and Further Continuing Appropriations Act. 2013 (P.L. 113-6) For Subrecipients That Are 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. 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. If a State recipient needs guidance, the recipient may contact Cynthia Y. Edwards at Edwards.Cynthiay@epa.gov or at 404-562-9340 of EPA, Region 4 Grants and SRF Management Section, for guidance. The recipient or subrecipient may also obtain additional guidance from DOL's web site at http://www.dol.gov/whd/

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 shall obtain the wage determination for the locality in which a covered activity subject to DB will take place prior to issuing requests for bids, proposals, quotes or other methods for soliciting contracts (solicitation) for activities subject to DB. 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.wdol.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.wdol.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.wdol.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 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 2010 appropriation , 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 https://www.dol.gov/agencies/whd/forms/wh347 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 by 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 hat 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. At a minimum, the subrecipient should conduct interviews with a representative group of covered employees within two weeks of each contractor or subcontractor's submission of its initial weekly payroll data and two weeks prior to the estimated completion date for the contract or subcontract. Subrecipients must conduct more frequent interviews if the initial interviews or other information
indicates that there is a risk that the contractor or subcontractor is not complying with DB. Subrecipients shall immediately conduct necessary 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 listed at https://www.dol.gov/agencies/whd/contact/local-offices.

(Insert applicable wage rate determination here.)

Wage Rates are county specific for *Heavy Construction* and can be found at:
https://sam.gov/content/wage-determinations

XVI – American Iron and Steel Requirement

Section 4.13 Compliance with 2014 Appropriations Act. (a) The Loan Recipient agrees to comply with all federal requirements applicable to the Authority Loan (including those imposed by P.L. 113-76, Consolidated Appropriations Act (the "2014 Appropriations Act") and related SRF Policy Guidelines) which the Loan Recipient understands includes, among other things, requirements that all of the iron and steel products used in the Project are to be produced in the United States ("American Iron and Steel") unless (i) the Loan Recipient has requested and obtained a waiver from the U.S. Environmental Protection Agency pertaining to the Project or (ii) the Authority has otherwise advised the Loan Recipient in writing that the Buy American Requirement is not applicable to the Project. .

(b) The Loan Recipient also agrees to comply with all recordkeeping and reporting requirements under the Clean Water Act (codified generally under 33 U.S.C. §1251 et seq.) (the "Clean Water Act"), including any reports required by a federal agency or the Authority such as performance indicators of program deliverables, information on costs and Project progress. The Loan Recipient understands that (i) each contract and subcontract related to the Project is subject to audit by appropriate federal and state entities, and (ii) failure to comply with the Clean Water Act and this Agreement may be an Event of Default hereunder that results in a repayment of the Authority Loan in advance of the maturity of the Evidence of Indebtedness and/or other remedial actions.

The Loan Recipient agrees to cause all contractors and subcontractors to comply with (through the inclusion of appropriate terms and conditions in all contracts, subcontracts and lower tiered transactions, such terms and conditions to be in substantially the form set forth in connection with the development and construction of the project

The Contractor acknowledges to and for the benefit of the _____, Alabama ("Purchaser"), and the Alabama Water Pollution Control Authority or the Drinking Water Finance Authority (the "State Authority") that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund that have statutory requirements commonly known as "American Iron and Steel;" that requires all of the iron and steel products used in the project to be produced in the United States ("American Iron and Steel") including iron and steel products provided by the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State Authority that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State Authority. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State Authority to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney's fees) incurred by the Purchaser or State Authority resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State Authority or any damages owed to the State Authority by the Purchaser). While the Contractor has no direct contractual privity with the State Authority, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State Authority is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State Authority.

XVII – Build America, Buy America (BABA) Requirement

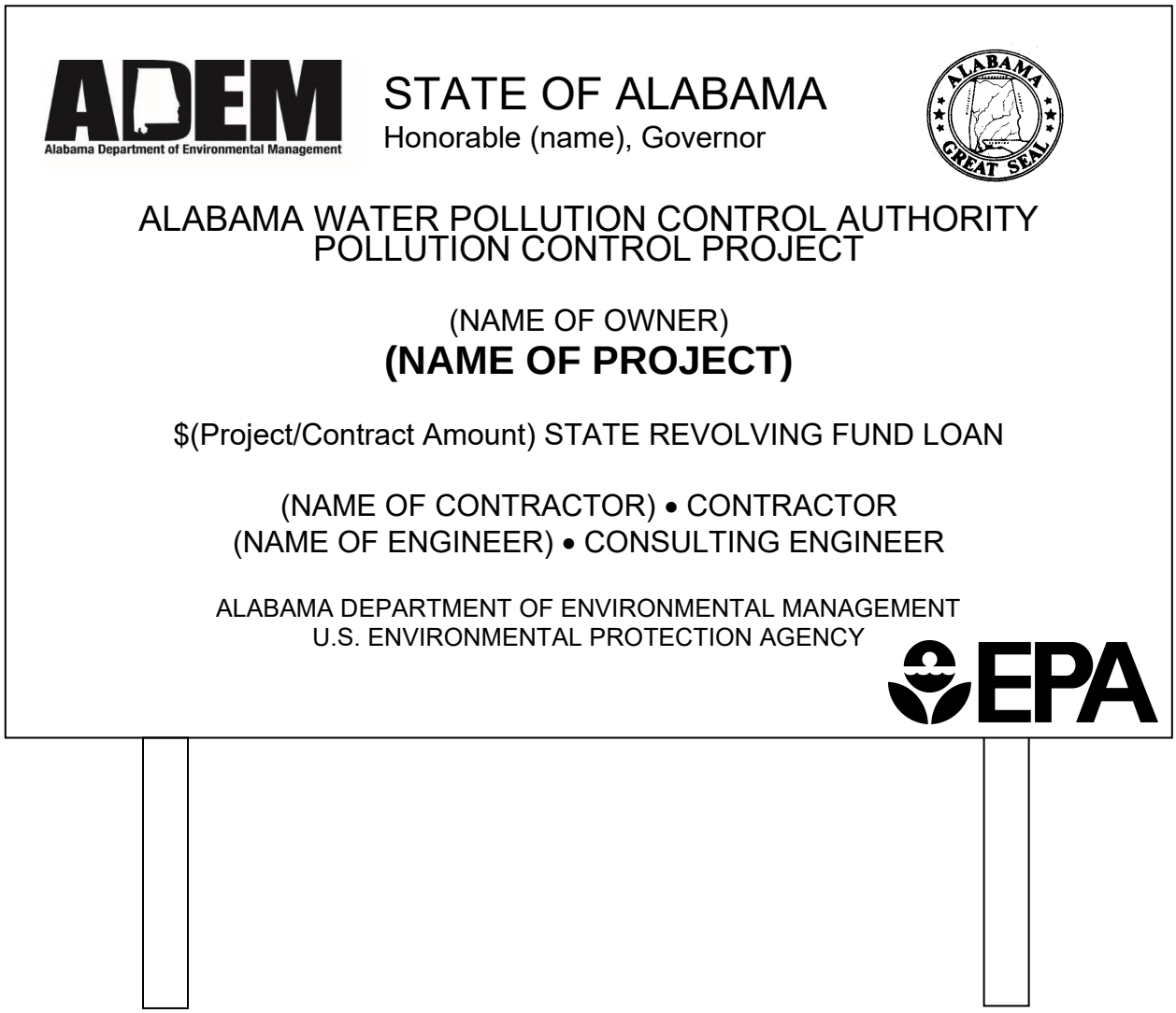
Comply with all federal requirements applicable to the assistance received (including those imposed by the Infrastructure Investment and Jobs Act ("IIJA"), Public Law No. 117-58) which the Participant understands includes, but is not limited to, the following requirements: that all of the iron and steel, manufactured products, and construction materials used in the Project are to be produced in the United States ("Build America, Buy America Requirements") unless (i) the Participant has requested and obtained a waiver from the cognizant Agency[1] 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 Participant in writing that the Build America, Buy America Requirements are not applicable to the Project. Comply with all record keeping and reporting requirements under all applicable legal authorities, including any reports required by the funding authority (such as EPA and/or a state), such as performance indicators of program deliverables, information on costs and project progress. The Participant understands that (i) each contract and subcontract related to the Project is subject to audit by appropriate federal and state entities and (ii) failure to comply with the applicable legal requirements and this Agreement may result in a default hereunder that results in a repayment of the assistance agreement in advance of the maturity of the Bonds, termination and/or repayment of grants, cooperative agreements, direct assistance or other types of financial assistance, and/or other remedial actions.

ALL CONSTRUCTION CONTRACTS MUST HAVE A CLAUSE REQUIRING COMPLIANCE WITH THE BABA REQUIREMENTS. The loan recipient agrees to cause all contractors and subcontractors to comply with (through the inclusion of appropriate terms and conditions in all contracts, subcontracts, and lower tiered transactions) such terms and conditions to be in substantially the form set forth in connection with the development and construction of the project.

The Contractor acknowledges to and for the benefit of the _____ ("Owner") and the _____ (the "Funding Authority") that it understands the goods and services under this Agreement are being funded with federal monies and have statutory requirements commonly known as "Build America, Buy America;" that requires all of the iron and steel, manufactured products, and construction materials used in the project to be produced in the United States ("Build America, Buy America Requirements") including iron and steel, manufactured products, and construction materials provided by the Contactor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Owner and Funding Authority (a) the Contractor has reviewed and understands the Build America, Buy America Requirements, (b) all of the iron and steel, manufactured products, and construction materials used in the project will be and/or have been produced in the United States in a manner that complies with the Build America, Buy America Requirements, unless a waiver of the requirements is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the Build America, Buy America Requirements, as may be requested by the Owner or the Funding Authority. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Owner or Funding Authority to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney's fees) incurred by the Owner or Funding Authority resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part,

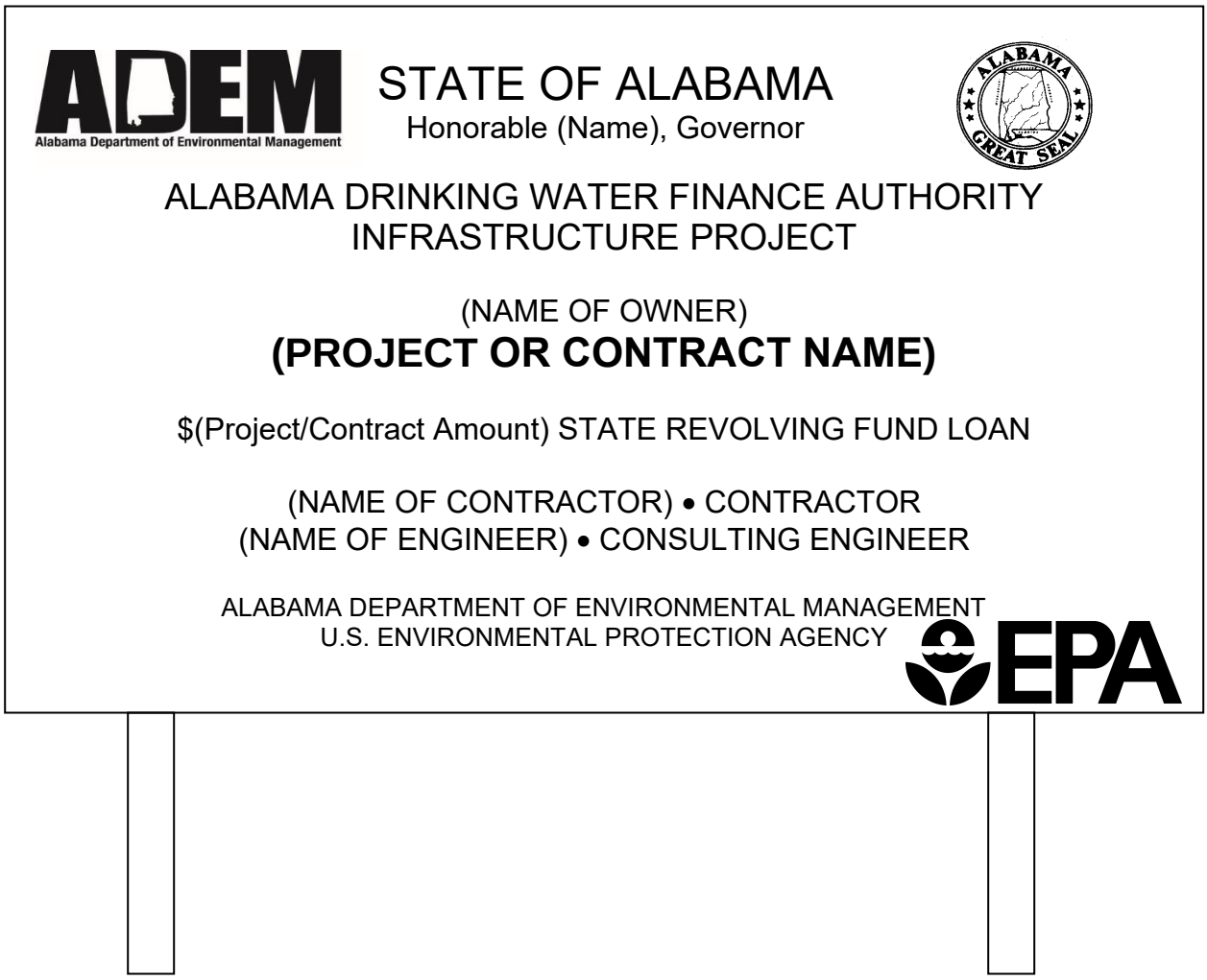
from the Funding Authority or any damages owed to the Funding Authority by the Owner). If the Contractor has no direct contractual privity with the Funding Authority, as a lender or awardee to the Owner for the funding of its project, the Owner and the Contractor agree that the Funding Authority is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the Funding Authority.

XVIII – Project Sign Detail - CWSRF



1. Sign is to be constructed of ½" MDO plywood, 4' x 8'. Alternate materials may be used if approved by ADEM prior to use.
2. Paint with two (2) coats oil-base enamel before lettering.
3. Background color white; lettering black.
4. Lettering may be painted or vinyl. All lettering sizes to be proportionate to sign layout.
5. Sign shall be attached to 4" x 4" x 8' treated posts. Alternatives may be used if approved by ADEM prior to use.
6. Sign shall be placed in prominent location, easily readable from existing street or roadway.
7. Sign shall be maintained in good condition until completion of project.

XIX – Project Sign Detail - DWSRF



1. Sign is to be constructed of ½" MDO plywood, 4' x 8'. Alternate materials may be used if approved by ADEM prior to use.
2. Paint with two (2) coats oil-base enamel before lettering.
3. Background color white; lettering black.
4. Lettering may be painted or vinyl. All lettering sizes to be proportionate to sign layout.
5. Sign shall be attached to 4" x 4" x 8' treated posts. Alternatives may be used if approved by ADEM prior to use.
6. Sign shall be placed in prominent location, easily readable from existing street or roadway.
7. Sign shall be maintained in good condition until completion of project.

DW ARPA SIGN DETAIL (Reference: ADEM DW ARPA Agreement)

O. The recipient must construct a project sign that meets the following requirements:

(a) Sign is to be constructed of ½" MDO plywood or similar material, 4' x 8'.

(b) Paint with two (2) coats of enamel paint (or equivalent) prior to lettering.

(c) Background color white, lettering black.

(d) Lettering may be painted or vinyl. All lettering sizes to be proportionate to sign layout.

(e) Sign shall be attached to 4" x 4" x 8' treated posts.

(f) Sign shall be placed in prominent location near the project area, easily readable from existing street or roadway.

(g) Sign shall be maintained in good condition until completion of project.

(h) Sign shall follow the format below and include the following information only:

ADEM
Alabama Department of Environmental Management

STATE OF ALABAMA
Honorable Kay Ivey, Governor

ALABAMA GREAT SEAL

AMERICAN RESCUE PLAN ACT (ARPA)
DRINKING WATER INFRASTRUCTURE PROJECT

(NAME OF OWNER)

(PROJECT OR CONTRACT NAME)

$(Project/Contract Amount) ARPA Funds
$(Project/Contract Amount) STATE REVOLVING FUNDS (If Applicable)

(CONTRACTOR NAME)• CONTRACTOR
(NAME OF ENGINEER) • CONSULTING ENGINEER

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

EPA

XX – Construction Contract Requirements

This checklist is to be completed by the Loan Recipient (Owner)/Engineer when submitting plans and specifications to the SRF Section for review. It affirms to the SRF reviewer that the Loan Recipient (Owner)/Engineer has addressed these items (in boilerplate form) within the specifications manual.

Contract Page No.	Satisfied Yes/No	
_____	_____	Bid Advertisement (including date, time, and location of bid opening).
_____	_____	Bid Bond.
_____	_____	Performance Bond (100%).
_____	_____	Payment Bond (Not less than 50%).
_____	_____	Contract Length.
_____	_____	Liquidated Damages.
_____	_____	Liability Insurance (including workman's comp, public liability, and builder's risk, if applicable).
_____	_____	Method of Award (i.e. lowest, responsive, responsible bidder).
_____	_____	Air testing of gravity sewers (if applicable).

Within 14 days after the bid opening, the Loan Recipient (Owner)/Engineer is to prepare the Project Review and Cost Summary (per the **PR&CS Checklist, page SGC-39**) and submit it to the SRF Section of ADEM. Upon completion of review, a ***written*** ATA (Approval-to-Award) will be issued.

NOTE:

The Loan Recipient (Owner) assumes all financial risk, if the construction contract is awarded prior to the issuance of an ATA letter by the SRF Section.

XXI– Project Review and Cost Summary

ADEM Alabama Department of Environmental Management	SRF Project Review and Cost Summary	Form Revised **07-2021**

This form is to be completed and submitted (with supporting documentation) to the SRF Section within 14 days after bid opening. Following satisfactory review, an ATA (Approval-to-Award) letter will be issued. After the ATA is issued/ award of the contract, a pre-construction conference should be scheduled (**with the SRF Project Manager in attendance**). *A complete, bound set of the executed contract documents manual should be forwarded to the SRF Section for review and written approval following the pre-construction conference.*

Loan Recipient: Project Number:

Project Name:

Contract Number: Contract Name:

1. Date of plans and specifications concurrence letter from ADEM-SRF Section:

   Date of construction permit issuance from ADEM-DW Branch:

2. Attach copies of the following documents:

   a. Bid advertisement with certification by publisher and date(s) of publication.

   b. Certified bid tabulation.

   c. Proposal of the selected bidder.

   d. Bid bond.

   e. Engineer's letter to the loan recipient recommending award of the contract. If the award is made to other than the low bidder, provide justification.

   f. Site certificates for the project, if not previously submitted with the SRF loan application.

   g. DBE Documentation from **the loan recipient (owner) and the prime contractor**. Utilization, solicitation and documentation requirements (with a list of required documents) are discussed in detail in Parts III - V (pages SGC-3 - SGC-23) of the ADEM *SRF Supplemental General Conditions* for SRF Assisted Public Drinking Water and Wastewater Facilities Construction Contracts.

   h. Copy of the wage determination used in bidding.

   i. Any addenda that have been issued after ADEM review of the plans and specifications.

Comments:

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract as indicated below. All provisions that are not so amended or supplemented remain in full force and effect.

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 thereto.

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

> 2.02.A. Owner shall furnish to Contractor 2 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 executed 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. Add the following new paragraph immediately after Paragraph 2.03.A:

> 2.03.B. Prior to starting Work and in accordance with the Code of Alabama 39-2-14, nonresident Contractor is required to register and deposit 5 percent of the Contract amount with the Alabama Department of Revenue. Within 30 days after registration, nonresident Contractor shall file statement with Department of Revenue itemizing machinery, materials, supplies, and equipment that will be on hand at time Contract begins where such tangible property has been brought, shipped, or transported from outside the State of Alabama upon which neither use taxes or ad valorem taxes have been paid and shall pay tax due at time of filing and there after shall report and pay tax as required by Commissioner of Revenue.

SC-3.01. Add the following new paragraph immediately after Paragraph 3.01.E:

> 3.01.F. Sections of Division 01, General Requirements, govern the execution of the Work of all sections of the Specifications.

SC-4.01. Delete the first two sentences of Paragraph 4.01.A and replace it with the following:

> The Contract Times will commence to run on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 15 days after the Effective Date of the Agreement.

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

5.03.C. The following reports of explorations and tests of subsurface conditions at or adjacent to the Site are known to Owner:

5.03.C.1. Report dated July 1997 prepared by Paul B. Krebs & Associates entitled Boring Logs for ***Construction of the Paul B. Krebs Water Treatment Facility Additions and Improvements*** consisting of 84 pages and 3 additional drawings from the contract drawing for reference. The Technical Data contained in such report upon whose accuracy Contractor may rely are those indicated in the definition of Technical Data in the General Conditions.

5.03.C.2. Report dated January 22, 2024 prepared by Contour Engineering entitled ***Report of Geotechnical Exploration – REV1 Paul B Krebs Water Treatment Plant Improvements*** consisting of 33 pages and 3 additional drawings from the contract drawing for reference. The Technical Data contained in such report upon whose accuracy Contractor may rely are those indicated in the definition of Technical Data in the General Conditions.

SC-5.06. Delete Paragraph 5.06.A and Paragraph 5.06.B in their entirety and insert the following in their place:

5.06.A. No reports or drawings related to Hazardous Environmental Conditions are known to Owner.

SC-6.01. Delete the first sentence of Paragraph 6.01.A and replace it with the following:

In accordance with Code of Alabama, Contractor shall furnish performance bond in an amount equal to 100 percent of the Contract Price and payment bond in an amount equal to 50 percent of the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. Payment and performance bonds furnished shall adhere to, at a minimum, the provisions included in the bond forms as made a part of the Contract.

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

6.02.A.1. Surety and insurance companies from which the bonds and insurance for this Project are purchased shall have an A.M. Best's rating of no less than A- in addition to other requirements specified herein.

SC-6.03. Add the following new paragraph immediately following Paragraph 6.03.A.4:

6.03.A.5. The limits of liability for the insurance required by Paragraph 6.03 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

6.03.A.5.a. Workers' Compensation and related coverages under Paragraph 6.03.A.1 and Paragraph 6.03.A.3 of the General Conditions:

6.03.A.5.a.1. State: Statutory.

6.03.A.5.a.2. Applicable Federal (e.g., Longshoreman's): Statutory.

6.03.A.5.a.5. Employer's Liability:

Bodily Injury, Each Accident: $1,000,000

Bodily Injury by Disease, Each Employee: $1,000,000

Bodily Injury/Disease Aggregate: $1,000,000

SC-6.03. Add the following new paragraph immediately following Paragraph 6.03.C.8:

6.03.C.9. Contractor's General Liability under Paragraph 6.03.B. and Paragraph 6.03.C of the General Conditions which shall eliminate the exclusion with respect to property under the care, custody and control of Contractor:

6.03.C.9.a. General Aggregate	$2,000,000
6.03.C.9.b. Products - Completed Operations Aggregate	$2,000,000
6.03.C.9.c. Personal and Advertising Injury (per person/Organization)	$1,000,000
60.3.C.9.d. Each Occurrence (Bodily Injury and Property Damage)	$1,000,000

6.03.C.9.e. Property Damage liability insurance will provide Explosion, Collapse, and Underground coverages where applicable.

SC-6.03. Add the following new paragraph immediately following Paragraph 6.03.D:

6.03.D.1. Contractor's Automobile Liability

6.03.D.1.a. Combined Single Limit of $1,000,000

SC-6.03. Add the following new paragraph immediately following Paragraph 6.03.E:

6.03.E.1. Excess or Umbrella Liability:

a) General Aggregate $5,000,000

b) Each Occurrence $5,000,000

SC-6.03. Add the following new paragraph immediately following Paragraph 6.03.F:

6.03.F.1. Pollution Liability:

a) Each Occurrence $1,000,000

b) General Aggregate $2,000,000

SC-6.03. Add the following language after Paragraph 6.03.G:

6.03.G.1. Include the following parties or entities as additional insured:

6.03.G.1.a. The Water Works and Sewer Board of the City of Anniston, Alabama, 1429 Noble Street, Anniston, AL 36201.

6.03.G.1.b. Jacobs, 1 Perimeter Park S. Ste 315N, Birmingham, AL 35243.

6.03.G.1.c. The City of Anniston, Alabama, 4309 McClellan Blvd., Anniston, AL 36206.

SC-6.05. Insert the following paragraph after 6.05.A.1:

6.05.A.1.a. In addition to the individuals and entities specified in Paragraph 6.05.A.1, include as insureds, the following:

6.05.A.1.a.1) Jacobs, 1 Perimeter Park S. Ste 315N, Birmingham, AL 35243.

SC-7.02. Add the following language to the end of Paragraph 7.02.B:

7.02.B.1. Contractor and Subcontractor regular working hours consist of up to 10 working hours within an 11-hour period between 7:00 a.m. and 6:00 p.m., excluding Sundays and holidays. Overtime work is work in excess of 40 hours per week.

SC-7.02. Add the following new paragraph immediately after Paragraph 7.02.B:

7.02.C. Contractor shall be responsible for the cost of any overtime pay or other expense incurred by the Owner for Engineer's services (including those of the Resident Project Representative, if any), Owner's representative, and construction observation services, occasioned by the performance of Work on Saturday, Sunday, any legal holiday, or as overtime on any regular work day. If Contractor is responsible but does not pay, or if the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

7.03. Add the following new paragraphs immediately after Paragraph 7.03.C:

7.03.D. Domestic Products:

7.03.D.1. In accordance with Code of Alabama 39-3-1, Contractor agrees to use materials, supplies, and products manufactured, mined, processed, or produced in the United States or its territories, if products are available at reasonable and competitive prices and are not contrary to any sole source specification. If agreement to use domestic products is breached and domestic products are not used, there shall be a downward adjustment in Contract Price equal to any realized savings or benefits to Contractor.

7.03.D.2. In accordance with Code of Alabama 39-3-4, Contractor agrees to use steel produced within the United States when specifications require the use of steel and do not limit its supply to a sole source specification. Owner has right to waive this requirement in the event of national emergency, national strike, or other cause. If agreement to use domestic steel is breached and domestic steel is not used, there shall be a downward adjustment in Contract Price equal to any realized savings or benefits to Contractor.

SC-7.06. Add the following language at the end of Paragraph 7.06.A:

Contractor shall perform a minimum of 75 percent of the onsite labor with its own employees.

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

7.09.B. Owner is exempt from payment of sales and compensating use taxes of the State of Alabama and of cities and counties thereof on materials to be incorporated into the Work.

7.09.B.1. Owner will furnish the required certificates of tax exemption to Contractor for use in the purchase of materials and equipment to be incorporated into the Work.

7.09.B.2. Owner's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to materials and equipment not incorporated into the Work.

SC-8.02. Add the following new paragraph immediately following Paragraph 8.02.B:

8.02.C. Other work anticipated to be performed at the Site by others that is either directly or indirectly related to the scheduled performance of the Work under these Contract Documents is described in Section 01 31 13, Project Coordination.

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

10.03.B. Resident Project Representative (RPR) will be furnished by Engineer. The responsibilities, authority, and limitations of the RPR are limited to those of Engineer in accordance with Paragraph 10.08 and as set forth elsewhere in the Contract Documents and are further limited and described below.

10.03.C. Responsibilities and Authority:

10.03.C.1. Schedules: Review and monitor Progress Schedule, Schedule of Submittals, and Schedule of Values prepared by Contractor and consult with Engineer concerning acceptability.

10.03.C.2. Conferences and Meetings: Conduct or attend meetings with Contractor, such as preconstruction conferences, progress meetings, Work conferences and other Project related meetings.

10.03.C.3. Liaison: (i) Serve as Engineer's liaison with Contractor, working principally through Contractor's authorized representative, and assist in understanding the intent of the Contract Documents; (ii) assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's onsite operations; (iii) assist in obtaining from Owner additional details or information when required for proper execution of the Work.

10.03.C.4. Interpretation of Contract Documents: Inform Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.

10.03.C.5. Submittals: Receive submittals that are furnished at the Site by Contractor, and notify Engineer of availability for examination. Advise Engineer and Contractor of the commencement of any Work or arrival of materials and equipment at Site, when recognized, requiring a Shop Drawing or Sample if the submittal has not been approved by Engineer.

10.03.C.6. Modifications: Consider and evaluate Contractor's suggestions for modifications in Drawings or Specifications and provide recommendations to Engineer; transmit to Contractor, in writing decisions as issued by Engineer.

10.03.C.7. Review of Work and Rejection of Defective Work: (i) Conduct onsite observations of the Work in progress to assist Engineer in determining if the Work is, in general, proceeding in accordance with the Contract Documents; (ii) inform Engineer and Contractor whenever RPR believes that any Work is defective; (iii) advise Engineer whenever RPR believes that any Work will not produce a completed Project that conforms generally to the Contract Documents or will imperil the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged or does not meet the requirements of any inspection test, or approval required to be made; and advise Engineer of that part of the Work in progress that RPR believes should be corrected or rejected or uncovered for observation, or requires special testing, inspection, or approval.

10.03.C.8. Inspections, Tests, and System Startups: (i) Verify tests, equipment and systems startups and operating and maintenance training are conducted in the presence of appropriate personnel, and that Contractor maintains adequate records thereof; (ii) observe, record, and report to Engineer appropriate details relative to the test procedures and system startups; and (iii) accompany visiting inspectors representing public or other agencies having jurisdiction over the Project, record the results of these inspections, and report to Engineer.

10.03.C.9. Records: (i) Maintain records for use in preparing Project documentation; (ii) keep a diary or log book recording pertinent Site conditions, activities, decisions and events; (iii) record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of Contractors, Subcontractors, and major Suppliers of materials and equipment.

10.03.C.10. Reports: (i) Furnish Engineer periodic reports of progress of the Work and of Contractor's compliance with the Progress Schedule and Schedule of Submittals; (ii) immediately notify Engineer of the occurrence of Site accidents, emergencies, acts of God endangering the Work, damage to property by fire or other causes, or the discovery of any Hazardous Environmental Condition; and (iii) assist Engineer in drafting proposed Change Orders, Work Change Directives, and Field Orders; obtain backup material from Contractor as appropriate.

10.03.C.11. Payment Requests: Review Applications for Payment with Contractor for compliance with the established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.

10.03.C.12. Certificates, Operation and Maintenance Manuals: During the course of the Work, verify materials and equipment certificates and operation and maintenance manuals and other data required by Specifications to be assembled and furnished by Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have these documents been delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

10.03.C.13. Completion: (i) Participate in a Substantial Completion inspection; assist in determination of Substantial Completion and the preparation of lists of items to be completed or corrected; (ii) Participate in a final inspection in the company of Engineer, Owner, and Contractor and prepare a final list of items to be completed and deficiencies to be remedied; and (iii) observe whether items on final list have been completed or corrected, and make recommendations to Engineer concerning acceptance.

10.03.D. Limitations of Authority: Resident Project Representative will not:

10.03.D.1. have authority to authorize a deviation from Contract Documents or substitution of materials or equipment, unless authorized by Engineer; or

10.03.D.2. exceed the limitations of Engineer's authority as set forth in Contract Documents; or

10.03.D.3. undertake any of the responsibilities of Contractor, Subcontractors, Suppliers, or Contractor's authorized representative; or

10.03.D.4. advise on, issue directions relative to, or assume control over an aspect of the means, methods, techniques, sequences, or procedures of Contractor's work unless such advice or directions are specifically required by the Contract Documents; or

10.03.D.5. advise on, issue directions regarding, or assume control over safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor; or

10.03.D.6. participate in specialized field or laboratory tests or inspections conducted offsite by others, except as specifically authorized by Engineer; or

10.03.D.7. accept Shop Drawings or Samples from anyone other than Contractor; or

10.03.D.8. authorize Owner to occupy the Project in whole or in part.

SC-10.08. Add the following new paragraph immediately after Paragraph 10.08.E:

10.08.F. Contractors, Subcontractors, Suppliers, and others on the Project, or their sureties, shall maintain no direct action against Engineer, its officers, employees, affiliated corporations, and subcontractors, for any Claim arising out of, in connection with, or resulting from the engineering services performed. Only the Owner will be the beneficiary of any undertaking by Engineer.

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

SC 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, shall 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 Article 15.

SC-15.06. Add the following new paragraphs immediately after Paragraph 15.06.A.3:

15.06.A.4. Notice of Completion: In accordance with Code of Alabama 39-1-1, immediately after completion of the Work under these Contract Documents, Contractor shall publish a Notice of Completion in a newspaper of general circulation in the city or county where the Work was performed. Such notice shall be published for a period of 4 successive weeks. No final payment and acceptance will be made on the Work of these Contract Documents until 30 days after completion of Contractor's notice. Submit proof of publication of notice in form of an affidavit of the publisher and a printed copy of the notice. If no newspaper is published in county where the Work is done, notice may be made by posting at courthouse for 30 days.

15.06.A.5. Nonresident Contractor shall submit to Owner proof that all taxes due and payable have been paid prior to final payment as required by the Code of Alabama 39-2-12.

SC-17.03. Add the following new paragraph immediately after Paragraph 17.02:

SC-17.03 Attorneys' Fees: 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.

END OF SECTION

"General Decision Number: AL20240084 01/12/2024

Superseded General Decision Number: AL20230084

State: Alabama

Construction Type: Building
BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories)

County: Calhoun County in Alabama.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least $17.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2024.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least $12.90 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2024.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/05/2024
1	01/12/2024

ASBE0078-001 10/01/2023

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR	$ 30.50	16.10

BOIL0108-001 01/01/2021

	Rates	Fringes
BOILERMAKER	$ 30.49	23.13

ENGI0312-001 10/01/2013

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
Crane	$ 27.05	11.38
Forklift	$ 26.05	11.38

IRON0092-003 09/01/2023

	Rates	Fringes
IRONWORKER, STRUCTURAL	$ 32.16	13.13

IRON0092-007 09/01/2023

	Rates	Fringes
IRONWORKER, REINFORCING	$ 32.16	13.13

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* SUAL2015-012 08/02/2017

	Rates	Fringes
BRICKLAYER	$ 22.00	0.00
CARPENTER	$ 15.72 **	1.85
CEMENT MASON/CONCRETE FINISHER	$ 18.91	4.39
ELECTRICIAN	$ 17.72	2.31
LABORER: Common or General	$ 12.93 **	0.00
LABORER: Mason Tender - Brick	$ 12.22 **	0.00
LABORER: Mason Tender - Cement/Concrete	$ 14.23 **	0.00
LABORER: Pipelayer	$ 15.59 **	0.00
OPERATOR: Backhoe/Excavator/Trackhoe	$ 21.48	11.20
OPERATOR: Bulldozer	$ 19.96	0.40
OPERATOR: Grader/Blade	$ 17.52	0.89

OPERATOR: Loader.....$ 14.69 ** 0.00

OPERATOR: Roller.....$ 14.00 ** 1.78

PAINTER (Brush and Roller).....$ 15.31 ** 1.41

PAINTER: Spray.....$ 14.31 ** 0.00

PIPEFITTER.....$ 20.78 5.04

PLUMBER.....$ 18.97 0.36

ROOFER.....$ 13.66 ** 0.00

SHEET METAL WORKER, Includes
HVAC Duct Installation.....$ 23.25 4.17

TILE SETTER.....$ 20.00 0.00

TRUCK DRIVER: Dump Truck.....$ 13.60 ** 0.00

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

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 ($17.20) or 13658 ($12.90). Please see the Note at the top of the wage determination for more information. Please also note that the minimum wage requirements of Executive Order 14026 are not currently being enforced as to any contract or subcontract to which the states of Texas, Louisiana, or Mississippi, including their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

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

The body of each wage determination lists the classification

and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

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

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

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

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

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

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

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

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

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

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

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

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END OF GENERAL DECISION"

"General Decision Number: AL20240105 01/05/2024

Superseded General Decision Number: AL20230105

State: Alabama

Construction Type: Heavy

County: Calhoun County in Alabama.

HEAVY CONSTRUCTION PROJECTS

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least $17.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2024.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least $12.90 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2024.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/05/2024

SUAL2015-033 08/02/2017

	Rates	Fringes
CARPENTER, Includes Form Work	$ 20.26	8.59
CEMENT MASON/CONCRETE FINISHER, Includes Water Sewer Lines	$ 13.71 **	0.00
ELECTRICIAN	$ 19.98	5.53
LABORER: Common or General, Includes Water Sewer Lines	$ 12.39 **	0.00
LABORER: Pipelayer, Includes Water Sewer Lines	$ 13.91 **	2.04
OPERATOR: Backhoe/Excavator/Trackhoe, Includes Water Sewer Lines	$ 18.99	3.63
TRUCK DRIVER: Dump Truck, Includes Water Sewer Lines	$ 12.25 **	2.58

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

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

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

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

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A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current

negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

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* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
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END OF GENERAL DECISION"

PART 3

SPECIFICATIONS

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

A. The completed Work will provide Owner with upgrades to the Paul B. Krebs Water Treatment Plant includes but is not limited to the following items:

1. Base Bid Items:

a. Installation of new finished water pump station.

1) Demolition of the existing maintenance building and modifications to surrounding area as required to allow for construction of the new finished water pump station and electrical building.
2) Replace all existing finished water pumps with five new canned vertical turbine pumps.
3) Install space and pump cans for two future vertical turbine pumps to serve the distribution system downstream.
4) Construct new finished water pump station to house the new vertical turbine pumps south of the existing finish water pump station. The new pump station shall be constructed with individual cans per each pump housing the vertical turbine pumps. This includes the corresponding check valves, isolation valves, air release valves, and instrumentation as required. The pumps and corresponding pipe headers will be located within the building.
5) Construction of deep foundation system involving drilled piers to support the new finished water pump station and generators.
6) Installation of pneumatic surge tank and corresponding compressors, instrumentation, sensors, and appurtenances.
7) Installation of all new yard piping for connection of existing clearwell effluent piping to the new finished water pump station and the pump station discharge piping to the connection of the plants high service distribution system piping. Yard piping installation will include tie-ins, flow meters, and valves.
8) Apply new coating system to all exposed ductile iron piping and valves at the existing Air Stripping Towers.

b. Installation of electrical and SCADA upgrades:
    1) Installation of new 277/460V-3-phase power service to replace exiting radial-type distribution power.
    2) Installation of two new on-site standby generators and paralleling switchgear with isolated/redundant main distribution buses and two separate utility service laterals.
    3) Update half of the existing main plant process loads currently fed from existing MCC-A to be fed from a new redundant MCC-A2.
    4) Construct new electrical room within the new finished water pump station to house new electrical gear for the facility including new electrical gear for finished water pump station and generators.
    5) Replace existing lighting with new, energy-efficient LED lighting systems throughout the interior and exterior of the plant.
        a) Upgrade SCADA with a new RTU in the new finished water pump station.

c. Fluoride Tank Containment Area and Supports:
    1) Construction of containment area and tank supports for the new client-provided fluoride tank. This shall include instrumentation, level sensors, loading station, emergency shower and eyewash, and all chemical piping to connect to the existing system.

d. Spring Basin and Containment Wall:
    1) Provide waterproofing and repair of the existing Coldwater Spring retaining wall and concrete valley gutters to mitigate surface stormwater short circuiting into the spring.

e. Clearwell/Chlorine Contact Basin Repairs:
    1) Clean interior and exterior of clearwell including the removal of silt from clearwell floor, inspect clearwell for cracks, deficiencies, damage, and repair as required.
    2) Repair two concrete pilasters.
    3) Coat exterior dome roof and walls.
    4) Repair cracks in interior clearwell walls covered under unit price item.
    5) Provide new exterior coating system.
    6) Repair any concrete surfaces as required based on inspection and covered under unit price items.

7) Repair all exposed rebar in interior of clearwell covered under unit price items.
   a) Repair interior dome roof.
      (1) Coat and repair exposed wire mesh and rebar in dome roof covered under unit price.
      (2) Provide interior coating of surface to prevent future exposure and deterioration.
   b) Repair of collapsed baffle wall. Demolish approximately half of the wall length and reconstruct based on details. Inspect floor at baffle wall failure location and repair.

8) General Site Work:
   a) New loop road to improve access around the site for maintenance and chemical deliveries.
   b) Demolition of existing entrances and installation of new entrance gate, additional street lighting, and site fencing.
   c) All stormwater and erosion control measures as required.
   d) Provide site grading and stormwater system improvements per contract documents.
   e) Demolition of asphalt wearing surface and installation of new wearing surface as indicated in contract documents.

B. Alternates:

1. Additive Bid Alternative 1: Repair of Existing Air Stripping Towers
   a. Update the existing Air Stripping Towers (6 Total) with the following items:
      1) Replace media inside of each tower.
      2) Replace shell sections above tower packing with Type 304 stainless steel shells.
      3) Replace 4 screen air outlet screens.
      4) New flanged access doors.
      5) Replace mesh mist eliminator with support and hold-down.
2. Additive Bid Alternative 2: Installation of new Air Stripping Tower
   a. Installation of new Air Stripping Tower with corresponding blower, valves, piping, instrumentation, sensors, concrete pad, and appurtenances.
3. Additive Bid Alternative 3: Replace existing Main DFS control panel with latest generation DFS control panel to include additional I/O signals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 PROPOSAL REQUESTS

A. Owner may, in anticipation of ordering an addition, deletion, or revision to the Work, request Contractor to prepare a detailed proposal of cost and times to perform contemplated change.

B. Proposal request will include reference number for tracking purposes and detailed description of and reason for proposed change, and such additional information as appropriate and as may be required for Contractor to accurately estimate cost and time impact on Project.

C. Proposal request is for information only; Contractor is neither authorized to execute proposed change nor to stop Work in progress as result of such request.

D. Contractor's written proposal shall be transmitted to Engineer promptly, but not later than 14 days after Contractor's receipt of Owner's written request. Proposal shall remain firm for a maximum period of 45 days after receipt by Engineer.

E. Owner's request for proposal or Contractor's failure to submit such proposal within the required time period will not justify a Claim for an adjustment in Contract Price or Contract Times (or Milestones).

1.02 CLAIMS

A. Include, at a minimum:

1. Specific references including (i) Drawing numbers, (ii) Specification section and article/paragraph number, and (iii) Submittal type, Submittal number, date reviewed, Engineer's comment, as applicable, with appropriate attachments.
2. Stipulated facts and pertinent documents, including photographs and statements.
3. Interpretations relied upon.
4. Description of (i) nature and extent of Claim, (ii) who or what caused the situation, (iii) impact to the Work and work of others, and (iv) discussion of claimant's justification for requesting a change to price or times or both.

5. Estimated adjustment in price claimant believes it is entitled to with full documentation and justification.
6. Requested Change in Contract Times: Include at least (i) Progress Schedule documentation showing logic diagram for request, (ii) documentation that float times available for Work have been used, and (iii) revised activity logic with durations including sub-network logic revisions, duration changes, and other interrelated schedule impacts, as appropriate.
7. Documentation as may be necessary as set forth below for Work Change Directive, and as Engineer may otherwise require.

1.03 WORK CHANGE DIRECTIVES

A. Procedures:

1. Engineer will:
   a. Initiate, including a description of the Work involved and any attachments.
   b. Affix signature, demonstrating Engineer's recommendation.
   c. Transmit electronic copy to Owner for authorization.
2. Owner will:
   a. Affix signature, demonstrating approval of the changes involved.
   b. Return four copies or an electronic copy to Engineer, who will retain one copy, send one copy to the Resident Project Representative or other field representative, and forward two copies or an electronic copy to Contractor.
3. Upon completion of Work covered by the Work Change Directive or when final Contract Times and Contract Price are determined, Contractor shall submit documentation for inclusion in a Change Order.
4. Contractor's documentation shall include but not be limited to:
   a. Appropriately detailed records of Work performed to enable determination of value of the Work.
   b. Full information required to substantiate resulting change in Contract Times and Contract Price for Work. On request of Engineer, provide additional data necessary to support documentation.
   c. Support data for Work performed on a unit price or Cost of the Work basis with additional information such as:
      1) Dates Work was performed, and by whom.
      2) Time records, wage rates paid, and equipment rental rates.
      3) Invoices and receipts for materials, equipment, and subcontracts, all similarly documented.

B. Effective Date of Work Change Directive: Date of signature by Owner, unless otherwise indicated thereon.

1.04 CHANGE ORDERS

A. Procedure:

1. Engineer will prepare an electronic copy of proposed Change Order and transmit such with Engineer's written recommendation and request to Contractor for signature.
2. Contractor shall, upon receipt, either: (i) promptly sign copies, retaining one for its file, and return five copies or an electronic copy to Engineer for Owner's signature, or (ii) return written justification for not executing Change Order.
3. Engineer will, upon receipt of Contractor signed copies, promptly forward Engineer's written recommendation and partially executed copies for Owner's signature, or if Contractor fails to execute the Change Order, Engineer will promptly so notify Owner and transmit Contractor's justification to Owner.
4. Upon receipt of Contractor-executed Change Order, Owner will promptly either:
    a. Execute Change Order, retaining one copy for its file and returning four copies or an electronic copy to Engineer; or
    b. Return to Engineer unsigned copies with written justification for not executing Change Order.
5. Upon receipt of Owner-executed Change Order, Engineer will transmit electronic copies to Contractor, Resident Project Representative or other field representative, and retain one copy, or if Owner fails to execute the Change Order, Engineer will promptly so notify Contractor and transmit Owner's justification to Contractor.
6. Upon receipt of Owner-executed Change Order, Contractor shall:
    a. Perform Work covered by Change Order.
    b. Revise Schedule of Values to adjust Contract Price and submit with next Application for Payment.
    c. Revise Progress Schedule to reflect changes in Contract Times, if any, and to adjust times for other items of Work affected by change.
    d. Enter changes in Project record documents after completion of change related Work.

B. In signing a Change Order, Owner and Contractor acknowledge and agree that:

1. Stipulated compensation (Contract Price or Contract Times, or both) set forth includes payment for (i) the Cost of the Work covered by the Change Order, (ii) Contractor's fee for overhead and profit, (iii) interruption of Progress Schedule, (iv) delay and impact, including cumulative impact, on other Work under the Contract Documents, and (v) extended overheads.
2. Change Order constitutes full mutual accord and satisfaction for the change to the Work.
3. Unless otherwise stated in the Change Order, all requirements of the original Contract Documents apply to the Work covered by the Change Order.

1.05 COST OF THE WORK

A. In determining the supplemental costs allowed in Paragraph 13.01.B.5 of the General Conditions for rental equipment and machinery, the following will apply.

B. Rental of construction equipment and machinery and the parts thereof having a replacement value in excess of $1,000, whether owned by Contractor or rented or leased from others, shall meet the following requirements:

1. Full rental costs for leased equipment shall not exceed rates listed in the Rental Rate Blue Book published by Equipment Watch, as adjusted to the regional area of the Project. Owned equipment costs shall not exceed the single shift rates established in the Cost Reference Guide (CRG) published by Equipment Watch. The most recent published edition in effect at commencement of actual equipment use shall be used.
2. Rates shall apply to equipment in good working condition. Equipment not in good condition, or larger than required, may be rejected by Engineer or accepted at reduced rates.
3. Leased Equipment: For equipment leased or rented in arm's length transactions from outside vendors, maximum rates shall be determined by the following actual usage/Payment Category:
   a. Less than 8 hours: Hourly rate.
   b. 8 or more hours but less than 7 days: Daily rate.
   c. 7 or more days but less than 30 days: Weekly rate.
   d. 30 days or more: Monthly rate.

4. Arm's length rental and lease transactions are those in which the firm involved in the rental or lease of equipment is not associated with, owned by, have common management, directorship, facilities and/or stockholders with the firm renting the equipment.
5. Financial arrangements associated with rental and lease transactions that provide Contractor remuneration or discounts not visible to the Owner must be disclosed and integrated with charged rates.
6. Leased Equipment in Use: Actual equipment use time documented by Engineer shall be the basis that equipment was on and utilized at the Project Site. In addition to the leasing rate above, equipment operational costs shall be paid at the estimated hourly operating cost rate set forth in the Rental Rate Blue Book if not already included in the lease rate. Hours of operation shall be based upon actual equipment usage to the nearest quarter hour, as recorded by Engineer.
7. Leased Equipment, When Idle (Standby): Idle or standby equipment is equipment onsite or in transit to and from the Work Site and necessary to perform the Work under the modification, but not in actual use. Idle equipment time, as documented by Engineer, shall be paid at the leasing rate determined above, excluding operational costs.
8. Owned and Other Equipment in Use: Equipment rates for owned equipment or equipment provided in other than arm's length transaction shall not exceed the single shift total hourly costs rate developed in accordance with the CRG and as modified herein for multiple shifts. This total hourly rate will be paid for each hour the equipment actually performs work. Hours of operation shall be based upon actual equipment usage as recorded by Engineer. This rate shall represent payment in full for Contractor's direct costs.
9. Owned and Other Equipment, When Idle (Standby): Equipment necessary to be onsite to perform the Work on single shift operations, but not utilized, shall be paid for at the ownership hourly expense rate developed in accordance with the CRG, provided its presence and necessity onsite has been documented by Engineer. Payment for idle time of portions of a normal workday, in conjunction with original contract Work, will not be allowed. In no event shall idle time claimed in a day for a particular piece of equipment exceed the normal Work or shift schedule established for the Project. It is agreed that this rate shall represent payment in full for Contractor's direct costs. When Engineer determines that the equipment is not needed to continuously remain at the Work Site, payment will be limited to actual hours in use.

10. Owned and Other Equipment, Multiple Shifts: For multiple shift operations, the CRG single shift total hourly costs rate shall apply to the operating equipment during the first shift. For subsequent shifts, up to two in a 24-hour day, operating rate shall be the sum of the total hourly CRG operating cost and 60 percent of the CRG ownership and overhaul expense. Payment for idle or standby time for second and third shifts shall be 20 percent of the CRG ownership and overhaul expense.
11. When necessary to obtain owned equipment from sources beyond the Project limits, the actual cost to transfer equipment to the Site and return it to its original location will be allowed as an additional item of expense. Move-in and move-out allowances will not be made for equipment brought to the Project if the equipment is also used on original Contract or related Work.
12. If the move-out destination is not to the original location, payment for move-out will not exceed payment for move-in.
13. If move is made by common carrier, the allowance will be the amount paid for the freight. If equipment is hauled with Contractor's own forces, rental will be allowed for the hauling unit plus the hauling unit operator's wage. If equipment is transferred under its own power, the rental will be 75 percent of the appropriate total hourly costs for the equipment, without attachments, plus the equipment operator's wage.
14. Charges for time utilized in servicing equipment to ready it for use prior to moving and similar charges will not be allowed.
15. When a breakdown occurs on any piece of owned equipment, payment shall cease for that equipment and any other owned equipment idled by the breakdown.
16. If any part of the Work is shut down by Owner, standby time will be paid during nonoperating hours if diversion of equipment to other Work is not practicable. Engineer reserves the right to cease standby time payment when an extended shutdown is anticipated.
17. If a rate has not been established in the CRG for owned equipment, Contractor may:
    a. If approved by Engineer, use the rate of the most similar model found, considering such characteristics as manufacturer, capacity, horsepower, age, and fuel type, or
    b. Request Equipment Watch to furnish a written response for a rate on the equipment, which shall be presented to Engineer for approval; or
    c. Request Engineer to establish a rate.

1.06 FIELD ORDER

A. Engineer will issue Field Orders, with an electronic copy to Contractor.

B. Effective date of the Field Order shall be the date of signature by Engineer, unless otherwise indicated thereon.

C. Contractor shall acknowledge receipt by signing and returning electronic copy to Engineer.

D. Field Orders will be incorporated into subsequent Change Orders, as a no-cost change to the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Schedule of Values: Submit on Contractor's standard form.
2. Schedule of Estimated Progress Payments:
   a. Submit with initially acceptable Schedule of Values.
   b. Submit adjustments thereto with Application for Payment.
3. Application for Payment.
4. Final Application for Payment.

1.02 SCHEDULE OF VALUES

A. Prepare a separate Schedule of Values for each schedule of the Work under the Agreement.

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

C. Lump Sum Work:

1. Reflect specified cash and contingency allowances and alternates, as applicable.
2. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, equipment testing, facility startup, and contract closeout separately.
   a. Mobilization includes, at minimum, items identified in Section 01 50 00, Temporary Facilities and Controls.
      1) A Mobilization line item is required and shall not exceed 4 percent of the Contract Price and will be paid in 4 payments, each of 25 percent of total amount for mobilization.
      2) A Demobilization line item is required and shall be at least 1 percent of Contract Price. Payments toward demobilization shall not be approved until after Substantial Completion.
   b. Include item(s) for monthly progress schedule update.
3. Break down by Division 02 through 49 with appropriate subdivision of each specification.
   a. Schedule of Values shall include breakdown costs for materials and equipment, and installation.

b. Schedule of Values shall show division of work between Contractor and Subcontractors.
c. Proportional Overhead and Profit shall be included in each line item and not included as separate line item.

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

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

1.03 SCHEDULE OF ESTIMATED PROGRESS PAYMENTS

A. Show estimated payment requests throughout Contract Times aggregating initial Contract Price.

B. Base estimated progress payments on initially acceptable progress schedule. Adjust to reflect subsequent adjustments in progress schedule and Contract Price as reflected by modifications to the Contract Documents.

1.04 APPLICATION FOR PAYMENT

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

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

C. Provide separate form for each schedule as applicable.

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

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

F. Preparation:

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

1.05 MEASUREMENT—GENERAL

A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, weigh material on scales furnished by Contractor and certified accurate by state agency responsible. Obtain weight or load slip from weigher and deliver to Owner's representative at point of delivery of material.

C. If material is shipped by rail, car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.

D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by Engineer. Each vehicle shall bear a plainly legible identification mark.

E. Haul materials that are specified for measurement by the cubic yard measured in the vehicle in transport vehicles of such type and size that actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. Load vehicles to at least their water level capacity. Loads hauled in vehicles not meeting above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

F. Quantities will be based on ground profiles shown. Field surveys will not be made to confirm accuracy of elevations shown.

G. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of 1 foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.

H. Units of measure shown on Bid Form shall be as follows, unless specified otherwise.

Item	Method of Measurement
AC	Acre—Field Measure by Engineer
CY	Cubic Yard—Field Measure by Engineer within limits specified or shown
EA	Each—Field Count by Engineer
GAL	Gallon—Field Measure by Engineer
HR	Hour
LB	Pound(s)—Weight Measure by Scale
LF	Linear Foot—Field Measure by Engineer
SF	Square Foot
SY	Square Yard
TON	Ton—Weight Measure by Scale (2,000 pounds)
LS	Lump Sum

1.06 PAYMENT

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

B. Payment for Lump Sum Work covers all the labor materials, and services necessary to furnish and install the following items:

Item No.	Item	Description
1	Lump Sum Bid Price	Lump sum costs to cover items described in the Contract Documents except for Unit Price Items, Additive Alternative Items, and Allowances.

Item No.	Item	Description
2	Additive Alternative No. 1 Replace and Repair Existing Air Stripping Towers	Lump sum costs to cover all work to complete the following: Portions of each existing Air Stripping Towers (6 Total) to be replaced: A) 24 vertical feet of 3.5-inch Jaeger Tripack Packing Media (2,500 cf). B) Two flanged aluminum shell sections above tower packing to be replaced with Type 304 stainless steel construction. C) 4 screen air outlet screens on the tower shell above the mist eliminator. D) Flanged access doors. E) Polypropylene mesh mist eliminator with support and hold down. The mist eliminator is 4-inch thick, 138-inch diameter polypropylene mesh.
3	Additive Bid Alternative No. 2 Installation of new Air Stripping Tower	Lump sum cost to provide and install a new Air Stripping Tower with corresponding blower, valves, piping, instrumentation, sensors, electrical items, concrete pad, and appurtenances as indicated in the Contract Documents.
4	Additive Bid Alternative No. 3 Replace existing Main DFS control panel with latest generation DFS control panel	Lump sum cost to cover all costs to replace the existing Main DFS control panel in the existing finished water pump station electrical room with a latest generation DFS control panel to include minimum 50 percent more I/O of each signal type. All existing signals will be re terminated in the new control panel with minimal disruption to plant operations.

C. Payment for unit price items covers all the labor, materials, and services necessary to furnish and install the bid items as designated on the Bid Form and in the individual Technical Specifications. Any item necessary to complete the installation or identified as required on the Drawings or Specifications but not designated for separate payment, shall be considered incidental to the installation and no separate payment will be made.

1. The quantities for the unit price items may change based on unpredictable circumstances and the Engineer has included certain quantities in the Bid Form to be used solely for the purpose of comparison of the bids. The Bidder shall not be entitled to an adjustment in the unit price bid as a result of changes in the quantity of these items. The Bidder shall make no claims for anticipated profits, or loss of profits, or for other damages as a result of changes in the quantities purchased.
2. Payment for Unit Price Bid Items is described further in following table:

Unit Price Item	Description
No. 1: Mobilization for deep foundation/drilled pier installation	Total lump sum amount covering all expenses and costs to mobilize equipment and staff to the project site for the completion of all drilled pier installations for the deep foundation of the new finished water pump station and generators per the Contract Documents. Cost shall cover all mobilizations if multiple mobilizations are required.
No. 2: Demobilization for deep foundation/drilled pier installation.	Total lump sum amount covering all expenses and costs to demobilize equipment and staff from the project site following completion of all drilled pier installations per the Contract Documents. Cost shall cover all demobilizations if multiple demobilizations are required.
No. 3: 30-inch diameter drilled pier through earthen soil	All cost associated with providing and installing 30-inch drilled piers through earthen soil per the requirements detailed in the Contract drawings and the Drilled Concrete Pier Specification Section 31 63 29. Costs shall include, but is not limited, to drilling equipment, concrete, reinforcing steel, steel casing, labor, dewatering, and waste disposal. Compensation for work shall be per linear footage of installed depth tracked during installation and approved by Engineer.

Unit Price Item	Description
No. 4: 30-inch diameter drilled pier through rock	All cost associated with providing and installing 30-inch drilled piers through rock per the requirements detailed in the Contract drawings and the Drilled Concrete Pier Specification Section 31 63 29. Costs shall include, but is not limited to; drilling equipment, concrete, reinforcing steel, steel casing, installation, dewatering, and waste disposal. Compensation for work shall be per linear footage of installed depth tracked during installation and approved by Engineer.
No. 5: 24-inch diameter drilled pier through earthen soil	All cost associated with providing and installing 24-inch drilled piers through earthen soil per the requirements detailed in the Contract drawings and the Drilled Concrete Pier Specification Section 31 63 29. Costs shall include, but is not limited, to drilling equipment, concrete, reinforcing steel, steel casing, labor, dewatering and waste disposal. Compensation for work shall be per linear footage of installed depth tracked during installation and approved by Engineer.
No. 6: 24-inch diameter drilled pier through rock	All cost associated with providing and installing 24-inch drilled piers through rock per the requirements detailed in the Contract drawings and the Drilled Concrete Pier Specification Section 31 63 29. Costs shall include, but is not limited, to drilling equipment, concrete, reinforcing steel, steel casing, labor, dewatering and waste disposal. Compensation for work shall be per linear footage of installed depth tracked during installation and approved by Engineer.
No. 7: AirTrack / Core drilling through earth and rock	All costs to perform subsurface exploration as defined and required per Drilled Concrete Pier Specification 31 63 29. Compensation for work shall be per linear footage of installed depth tracked during subsurface exploration work and approved by Engineer.
No. 8: Unconfined compressive strength test for rock	All cost to complete an unconfined strength test for rock per ASTM D2938. Test shall be performed when directed by Engineer.

Unit Price Item	Description
No. 9: Exposed Concrete reinforcement repair within Chlorine Contact Basin	All cost to complete proper repair of exposed rebar within the Chlorine Contact Basin per methods defined in specification section 03 01 32 Repair of Vertical and Overhead Concrete Surfaces and 03 01 33 Repair of Horizontal Concrete Surfaces. Square footage of exposed reinforcement in need of repair shall be determined by Contractor and presented to Engineer for review and approval prior to proceeding with the work. **Note:** All cost to complete inspection of the Chlorine Contact basin shall be included in Base Bid Price.
No. 10: Wet/Leaking Concrete Crack Repair within Chlorine Contact Basin	Repair of concrete cracks that are wet or leaking within the Chlorine Contact Basin. The unit price per linear foot shall include full compensation to complete the crack repair in accordance with specification 03 64 24 Polyurethane Injection Grouting or approved alternate. Linear footage of cracks in need of repair shall be determined by Contractor and presented to Engineer for review and approval prior to proceeding with the work. **Note:** All cost to complete inspection of the Chlorine Contact basin shall be included in Base Bid Price.
No. 11: Dry Concrete Crack Repair within Chlorine Contact Basin.	Repair of concrete cracks that are dry or relatively dry within the Chlorine Contact Basin. The unit price per linear foot shall include full compensation to complete the crack repair in accordance with specification 03 64 23 Epoxy Resin Grouting or approved alternate. Linear footage of cracks in need of repair shall be determined by Contractor and presented to Engineer for review and approval prior to proceeding with the work. **Note:** All cost to complete inspection of the Chlorine Contact basin shall be included in Base Bid Price.
No. 12: Concrete surface repair for vertical and overhead surfaces within the Chlorine Contact Basin	Concrete surface repair for vertical and overhead surfaces within the Chlorine Contact Basin. The unit price per square foot shall include full compensation to complete the repairs in accordance with specification 03 01 32 Repair of Vertical and Overhead Concrete Surfaces. Square footage of concrete surface areas in need of repair shall be determined by Contractor and submitted to Engineer for review and final approval prior to proceeding with the work. **Note:** All cost to complete inspection of the Chlorine Contact basin shall be included in Base Bid Price.

Unit Price Item	Description
No. 13: Concrete surface repair for horizontal concrete surfaces within the Chlorine Contact Basin	Concrete surface repair for vertical and overhead surfaces within the Chlorine Contact Basin. The unit price per square foot shall include full compensation to complete the repairs performed in accordance with specification 03 01 33 Repair of Horizontal Concrete Surfaces. Square footage of concrete surface areas in need of repair shall be determined by Contractor and submitted to Engineer for review and final approval prior to proceeding with the work. **Note:** All cost to complete inspection of the Chlorine Contact basin shall be included in Base Bid Price.
No. 14: Additional excavation	Additional excavation as directed by the Engineer outside of standard excavation limits. The unit price per cubic yard will be full compensation for excavating and proper disposing of the fill as required. Standard excavation limits for trench excavation are assumed to have a rectangular cross-section and defined by the pipe trench detail in the Contract Documents. Costs for trench boxes or sloping back of trench shall be included within the unit price. Additional excavation limits below structures shall extend from the horizontal limit of excavation at the bottom of the subgrade as indicated in the Contract Drawings to depth as directed by the Engineer and extending outward to a vertical plane one foot outside of the foundation limits of the structure.
No. 15: Additional structural fill.	Additional backfill with structural fill as directed by Engineer. The unit price per cubic yard shall include full compensation for material costs of structural fill material defined by Specification 31 23 23 Fill and Backfill, costs to deliver material to the project site, and install per the Contract Documents.
No. 16: Additional granular fill.	Additional backfill with granular fill as directed by Engineer. The unit price per cubic yard shall include full compensation for material costs of structural fill material defined by Specification 31 23 23 Fill and Backfill, costs to deliver material to the project site, and install per the Contract Documents.
No. 17: Additional concrete demolition and removal.	Additional concrete removal as directed by Engineer. The unit price per cubic yard shall include all work and equipment to remove and dispose of miscellaneous concrete. Volume to paid based on field measurements and approved by Engineer.

D. Nonpayment For Rejected or Unused Products:

1. Payment will not be made for following:
   a. Loading, hauling, and disposing of rejected material.
   b. Quantities of material wasted or disposed of in a manner not called for under Contract Documents.
   c. Material not unloaded from transporting vehicle.
   d. Defective Work not accepted by Owner.
   e. Material remaining on hand after completion of Work.

E. Partial Payment for Stored Materials and Equipment:

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

F. Partial Payment for Undelivered, Project Specific Manufactured or Fabricated Equipment, Operations and Maintenance Manuals, Field Testing, and Training of Operations and Maintenance Personnel:

1. Payment of no more than 15 percent of manufacturer's quoted price included in the line item for undelivered, Project-specific manufactured equipment will be made following Shop Drawing approval.
2. Payment of no more than 3 percent of manufacturer's quoted price may be apportioned to testing.
3. Payment of no more than 4 percent of manufacturer's quoted price for approved operations and maintenance manuals plus completion of associated training of operations and maintenance personnel when required.

G. Final Payment:

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational:

1. Shutdown Plans:
   a. All process shutdowns shall include a Shutdown Plan.
      1) Shutdown plans shall be submitted 60 days in advance of any process shutdowns to allow for proper review and coordination by the Owner.
      2) Shutdown plans shall include the following:
         a) Scope of shutdown.
         b) Anticipated schedule for shutdown and corresponding written description of step.
         c) Procedure for shutting down process and all methods of process isolation.
         d) Inventory of Equipment needed for shutdown and associated product data for special equipment (e.g. temporary pumping systems, etc).
         e) Inventory of Labor.
         f) Owner Coordination Items.
         g) Safety measures.
2. Photographs:
   a. Digital Images: Submit one digital USB storage media device containing images. Each image is to have a minimum file size of 1.4 Mb (1,400 Kb) so viewed resolution is high quality. The production of larger file sizes with higher resolution is encouraged.
3. Video Recordings: Submit one copy on digital media or through approved file sharing system.

1.02 UTILITY NOTIFICATION AND COORDINATION

A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work.

1.03 PROJECT MILESTONES

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

B. Project Milestones: Generally described in the Agreement Form. Following is a detailed description of each:

1. Milestone 1: Submittal of all shop drawings for Generator Sets, Automatic Switchgear, and Motor Control Centers critical to the release of the equipment for manufacturing within 56 days of the Notice to Proceed date of the project.
2. Substantial Completion: As defined in the General Conditions of these Contract Documents.
3. Final Completion: Final completion will be reached when all Work covered on the Drawings and in the Specifications has been completed, the Site has been returned to a condition acceptable to the Owner, and the Contractor has completely demobilized from the Project Site.

1.04 WORK SEQUENCING/CONSTRAINTS

A. Include the following work sequences in the Progress Schedule:

1. All Work sequencing shall be coordinated with and approved by Engineer and Owner.
2. Contractor to provide construction staking and layout for all work and verify installation matches construction documents as work progresses and provide information to Engineer. Maintain and update set of record drawings as work progresses.
3. Site clean-up, including asphalt patching is to follow along with the pipe laying operations. Work is to generally proceed in pipeline segments from valves to valves. Once a pipeline segment between valves has been installed, immediately begin testing of that pipeline section. Upon successful testing, immediately begin final surface restoration including asphalt patching. No additional pipeline laying will proceed until the prior pipeline work areas have been restored.

1.05 FACILITY OPERATIONS

A. Continuous operation of Owner’s facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.

B. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of Owner's operations.

C. There is an operating septic system located onsite near new construction activities. This system shall always be protected from damage during construction activities. Any damage to the septic system, field lines shall be prepared by an approved septic tank installer for Calhoun County. Temporary shutdowns of the sites sanitary system for completion of certain work activities shall be coordinated with plant staff and be limited to a maximum shutdown time of 4 hours.

D. The Contractor will encounter existing sanitary piping that lead to the sites sanitary system during construction as indicated in the drawings. These lines shall be protected at all times during construction. The sanitary line leading from the restroom facility near the fluoride chemical feed system and within the south side of the existing finished water pump station is located near the new pipe installations related to Tie-in 1 and may present some challenges to protect during construction. The Contractor may choose to temporarily remove this line during construction and re-installed in lieu of protecting the line during activities. This would result in the temporary shutdown of this restroom and shall be coordinated with the plant staff.

E. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items to maintain continuous operations of Owner's facility.

F. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.

G. Power Distribution System Electrical Studies are required per the Contract Documents. Refer to Section 26 05 73, Power Distribution System Electrical Studies for requirements of studies. These studies shall be coordinated with the project schedule as they are required to be submitted to the Engineer prior to shipment of any electrical distribution equipment.

H. Start-up and testing of new generators and appurtenances will have temporary impacts to plant operations. Coordination with Owner and Engineer for this testing is required.

I. Installation of two Padmount Service Transformers are required per the Contract Documents. The transformers are provided and installed by the power company and the metering is furnished by the power company; yet, installed by the Contractor. Contractor is responsible for coordinating with power company and completing the requirements of the Contract Documents in relation to the installation of the transformers.

J. The P.B. Krebs WTP Sodium Hypochlorite Conversion project is scheduled to be occurring simultaneously during a portion of this Project's Work. Project Drawings, Specification, status of the P.B. Krebs WTP Sodium Hypochlorite Conversion project are available for review from the Engineer by request. Contractor shall notify Engineer of any potential conflicts that will involve additional coordination between both Contractors and Owner. Reference the contract General Conditions for requirements concerning Other Work at the Site.

K. Process or Facility Shutdown:

1. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of facility operation.
2. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and bypass pumps to maintain continuous operations of Owner's facility.
3. Provide 14 days advance written request for approval of need to shut down a process or facility to Owner and Engineer. Written shut down requests should only follow the approval of the specific Shutdown Plan. The Owner reserved the right to cancel these shutdowns if unexpected events arise and water is needed in the distribution system. Temporary shutdowns are limited to a duration of two hours where not defined. Requests shall be submitted by the Contractor for all temporary shutdowns that the Contractor would like to perform outside of the anticipated shutdowns not defined in this specification. Additional allowed times are defined per specific shutdown defined in section below. Shutdowns are expected for the following activities:
    a. Temporary shutdowns of the existing Fluoride System for the new Fluoride System Startup and modifications to current chemical feed line in the vicinity of the existing containment area.
        1) Contractor shall install new piping and fittings as shown on drawings to connect the chemicals lines from the existing Fluoride System to the new Fluoride System. This Work shall be completed before startup of the new Fluoride system. Valves shall be installed to isolate the new chemical lines to the nozzle while maintaining the ability to feed fluoride to the system.
        2) Shutdown of existing Fluoride System shall not exceed 2-hours.

b. **Tie-in 3 and Tie-in 4:** Temporary shutdown of the existing Transfer Pump Station and raw water lines for the new Air Stripping Tower startup and modifications to current raw water lines.

1) Contractor shall install new piping and fittings as shown on Drawings to connect the existing raw water header pipes to the new Air Stripping Tower piping during one or two separate shutdowns of the raw water transfer pump station. Tie-in 3 will connect the raw water header to the Air Stripping Tower influent Piping. Tie-in 4 will connect the raw water header to the Air Stripping Tower effluent piping. The Chlorine Contact Basin and Finished Water Pumps will remain operable until the storage volume in the Chlorine Contact Basin is depleted. The plant will be completely shutdown once all water is depleted from the Chlorine Contact Basin. Contractor shall coordinate timing of this shutdown with plant operations and distribution system demands. This work shall be completed before start-up of the new Air Stripping Tower. Following the installation, the new isolation valves for the Air Stripping Tower shall be closed to allow water to bypass the new Air Stripping Tower and re-establish the water feed to the to the Chlorine Contact Basin. The Contractor is responsible for installing all pipe thrust restraints as required prior to pressurizing the new piping. Work during shutdown shall include removal of the plug on existing raw water piping tee's and connecting new Air Stripping Piping. All new piping shall be disinfected, and pressure tested prior to tie-ins. Note: Raw water must be treated through the Air Stripping Towers prior to entering the Chlorine Contact Basin; bypassing the air stripping towers is not permissible. The new isolation valves shall be re-opened following final start-up of the new Air Stripping Tower.
2) The Owner will operate all existing valves and pumps to complete the work.
3) Shutdown of the existing Transfer Pump Station and raw water line shall not exceed 4-hours per shutdown for Tie-in 3 and Tie-in 4.

c. **Tie-in 1 and Tie-in 2**: Partial shutdowns of existing finished water pump station for modifications to current suction/return piping (Tie-in 1) and distribution piping (Tie-in 2) locations as shown in the Contract Drawings.

a) Tie-in 1 will require isolating the south finished water suction line/return line that feeds two of the exiting Finished Water Pumps, Pump No. 1 and Pump No. 2. The Owner will operate the existing 36-inch gate valve for isolation of this line located in the large valve vault for the finished water suction/return line. Pump No. 3 and Pumps No. 4 will remain in operation. Operation of all pumps and valves will be performed by the Owner.

b) Tie-in 2 will require isolating the finished water line/water main leaving the plant to the north. This will require the shutting down of Pump No. 3 and Pumps No. 4 and closing the 24-inch finished water main's gate valve on the north side of the tee located west of the existing Finished Water Pump Station. The Owner will also need to close valves in the distribution system as required to prevent backflow/pressure from the system at the tie-in location. During the shutdown all flow from the plant will be flowing through the south distribution piping. Operation of all pumps and valves will be performed by the Owner.

(1) Contractor shall install new piping and fittings as shown on drawings to connect the suction and distribution lines from the existing system to the new finished water lines. This work shall be completed before start-up of new finished water pumps. Valves shall be installed to isolate the new suction and distribution lines at the Tie-in locations, to allow for the existing systems to be put back online following tie-in work. Contractor shall confirm distribution system is isolated from tie-in location prior to starting tie-in work. All piping and appurtenances shall be disinfected prior to connection to existing systems. Contractors shall install restraints as required during shutdown to allow for existing piping to be put back into service.

(2) Shutdown of the existing finished water pumps and distribution feeds to the north shall not exceed 8-hours per shutdown to complete tie-ins.

d. Permanent shutdown of existing finished water pumps:
   1) The existing finished water pump station shall remain operable during start-up and testing of new finished water pumps and pump station. The plant shall maintain the ability to operate both finished water pump stations individually until final disconnection of power to the existing finished water pumps. The Owner will operate the existing pumps and valves during this period.
   2) The new Finished Water Pump Station shall operate for 14 days consecutively providing finished water to the distribution system without any type of failures prior to permanently abandoning the existing finished water pumps. Proper training of the finished water pumps and all associated electrical gear and equipment supporting the new pump station shall be completed prior to 14-day testing period. Following training, the Owner will operate all valves and pumps as required during the testing period and the Contractor will perform all repairs during this period as required.

e. Chlorine Contact Shutdowns for completion of repairs.
   1) The clearwell consists of two sides. Each side can be isolated to operate independently during rehabilitation work, allowing the other side to operate as normal. The plant's capacity is not impacted during this work. The Contractor must maintain one side in operation at all times and must take all measures necessary to protect the operating side from any form of contamination during the work. It should be noted that chlorine is injected into the finished water for disinfection prior to entering Chlorine Contact Basin. Contractor should anticipate the need to provide proper ventilation during all work completed inside the Chlorine Contact Basin. Contractor shall provide means manage water leakage from the operating side based on observed leaking cracks during previous evaluations on the Chlorine Contact Basin.
   2) Videos and data of the interior drone inspections are available to the Contractor by request from the Engineer.
   3) Contractor shall coordinate with plant staff for operation of valves to isolate each side of the chlorine contact basin.

4) An inspection for each side shall be performed by a qualified individual experienced in the design and construction of prestressed concrete storage tanks. The inspection should include the identification and quantification of all concrete deficiencies categorized under the concrete repair items identified in the Bid Form and submitted to the Engineer for review. Repairs shall not begin prior to the Engineer's review and approval of unit price quantities. Note: Initial Inspection could occur as separate shutdown prior to beginning of work within the clearwell.
5) In addition to the Inspection Report and Shutdown Plan, Contractor shall submit a detailed Repair Plan clearly identifying all repair methods and materials. Submit shop drawings for repair materials as required per Contract Documents. Work shall not proceed until Repair Plan and all repair material has been approved by Engineer.
6) All identified work shall be completed in one side of the Chlorine Contact Basin prior to shutting down of the other side. The interior shall be fully cleaned and disinfected according per AWWA C653 prior to being placed back into service.
7) The time to complete all work within the Chlorine Contact Basin shall not exceed 120 calendar days.

4. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage. Provide temporary provisions for continuous power supply to critical facility components.

L. Install and maintain temporary connections required to keep Owner's facility operations on line. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.

M. Do not proceed with Work affecting a facility's operation without obtaining Owner's and Engineer's advance approval of the need for and duration of such Work.

N. Relocation of Existing Facilities:

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

1.06 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

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

B. Documentation:

1. Record and submit documentation of observations made on examination inspections as required.
2. Upon receipt, Engineer will review, sign, and return one record copy of documentation to Contractor to be kept on file in field office.
3. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor’s operations, and is for the protection of adjacent property owners, Contractor, and Owner.

1.07 CONSTRUCTION PHOTOGRAPHS

A. General:

1. Photographically document all phases of the Project including preconstruction, construction progress, and post-construction.
2. Engineer shall have right to select subject matter and vantage point from which photographs are to be taken.

B. Preconstruction and Post-Construction:

1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take a minimum of 48 photographs of Site and property adjacent to perimeter of Site.
2. Particular emphasis shall be directed to structures both inside and outside the Site.
3. Format: Digital, minimum resolution of 1832 by 3264**.**

C. Construction Progress Photos:

1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.
2. Monthly: Take 50 photographs using digital, minimum resolution of 1832 by 3264.

D. Documentation:

1. Digital Images:
   a. Electronic image shall have date taken embedded into image.
   b. Label each USB disk with Project and Owner’s name, and month and year images were produced.

1.08 AUDIO-VIDEO RECORDINGS

A. Prior to beginning the Work on Site or of a particular area of the Work, video graph Site and property adjacent to Site. Video should include all roadways and curbs.

B. In the case of preconstruction recording, no work shall begin in the area prior to Engineer’s review and approval of content and quality of video for that area.

C. Particular emphasis shall be directed to physical condition of existing vegetation, structures, and pavements within plant.

D. Engineer shall have right to select subject matter and vantage point from which videos are to be taken.

E. Video Format and Quality:

1. Digital format, with sound.
2. Video:
   a. Produce bright, sharp, and clear images with accurate colors, free of distortion and other forms of picture imperfections.
   b. Electronically, and accurately display the month, day, year, and time of day of the recording.
3. Audio:
   a. Audio documentation shall be done clearly, precisely, and at a moderate pace.
   b. Indicate date, project name, and a brief description of the location of recording, including:
      1) Facility name.
      2) Street names or easements.
      3) Address of private property.
      4) Direction of coverage, including engineering stationing, if applicable.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SALVAGE OF MATERIALS

A. Owner has first right of refusal for all salvageable materials.

B. Salvage materials for Owner’s use where shown.

1. Remove material with extreme care so as not to damage for future use.
2. Promptly remove salvaged materials from Work area.
3. Store materials where instructed by Owner.

C. Meet with Engineer and Owner prior to starting to dismantle equipment or piping designated to be salvaged. Engineer will indicate locations where equipment is to be disconnected.

D. Provide new or repair damaged equipment or material specified or indicated to be salvaged. Clean and protect equipment from dust, dirt, natural elements, and store as directed.

E. All materials or equipment to be removed that the Owner has not designated as salvaged, shall be disposed of by Contractor. The Contractor is responsible for legal disposal of all removed equipment and materials.

3.02 CUTTING, FITTING, AND PATCHING

A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.

B. Obtain prior written authorization of Engineer and Owner before commencing Work to cut or otherwise alter:

1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
2. Weather-resistant or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Work of others.

C. Refinish surfaces to provide an even finish.

1. Refinish continuous surfaces to nearest intersection.
2. Refinish entire assemblies.
3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.

D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on Drawings.

E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.

F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.

G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL

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

1.02 PRECONSTRUCTION CONFERENCE

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

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

B. Attendees will include:

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

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

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

1.04 PROGRESS MEETINGS

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

B. Attendees will include:

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

1.05 QUALITY CONTROL MEETINGS

A. In accordance with Section 01 45 16.13, Contractor Quality Control.

B. Scheduled by Engineer on regular basis and as necessary to review test and inspection reports, and other matters relating to quality control of the Work and work of other Contractors.

C. Attendees will include:

1. Contractor.
2. Contractor's designated quality control representative.
3. Subcontractors and Suppliers, as necessary.
4. Engineer's representatives.

1.06 PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) COORDINATION MEETINGS

A. Engineer will schedule meetings at Site, conducted as necessary to review specific requirements of PICS work.

B. Attendees will include:

1. Contractor.
2. Owner.
3. PICS Subcontractor/Installer.
4. Engineer's representatives.

1.07 PREINSTALLATION MEETINGS

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

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

C. Notify Engineer 4 days in advance of meeting date.

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

1.08 FACILITY STARTUP MEETINGS

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

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

C. Attendees will include:

1. Contractor.
2. Contractor’s designated quality control representative.
3. Subcontractors and equipment manufacturer’s representatives whom Contractor deems to be directly involved in facility startup.
4. Engineer’s representatives.
5. Owner’s operations personnel.
6. Others as required by Contract Documents or as deemed necessary by Contractor.

1.09 OTHER MEETINGS

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Preliminary Progress Schedule: Submit within time specified in paragraph 2.05 of the General Conditions.
2. Detailed Progress Schedule:
   a. Submit initial Detailed Progress Schedule within 60 days after Effective Date of the Agreement.
   b. Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.
3. Submit with Each Progress Schedule Submission:
   a. Contractor’s certification that Progress Schedule submission is actual schedule being used for execution of the Work.
   b. Progress Schedule: 4 legible copies.
   c. Narrative Progress Report: Same number of copies as specified for Progress Schedule.
4. Prior to final payment, submit a final Updated Progress Schedule.

1.02 PRELIMINARY PROGRESS SCHEDULE

A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration of 60 days, and a summary of balance of Project through Final Completion.

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

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

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

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

D. Format: In accordance with Article Progress Schedule – Bar Chart.

1.03 DETAILED PROGRESS SCHEDULE

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

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

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

D. Format: In accordance with Article Progress Schedule Critical – Bar Chart.

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

1.04 PROGRESS SCHEDULE—BAR CHART

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

B. Forman:

1. Unless otherwise approved, white paper, 11-inch by 17-inch sheet size.
2. Title Block: Show name of project and Owner, date submitted, revision or update number, and name of scheduler.
3. Identify horizontally, across the top of the schedule, the time frame by year, month, and day.
4. Identify each activity with a unique number and a brief description of the Work associated with that activity.

5. Legend: Describe standard and special symbols used.

C. Contents: Identify, in chronological order, those activities reasonably required to complete the Work, including as applicable, but not limited to:

1. Obtaining permits, submittals for early product procurement, and long lead time items.
2. Mobilization and other preliminary activities.
3. Initial Site work.
4. Specified Work sequences, constraints, and Milestones, including Substantial Completion date(s).
5. Subcontract Work.
6. Major equipment design, fabrication, factory testing, and delivery dates.
7. Delivery dates for Owner-furnished products, as specified in Section 01 11 00, Summary of Work.
8. Sitework.
9. Concrete Work.
10. Structural steel Work.
11. Architectural features Work.
12. Conveying systems Work.
13. Equipment Work.
14. Mechanical Work.
15. Electrical Work.
16. Instrumentation and control Work.
17. Interfaces with Owner-furnished equipment.
18. Other important Work for each major facility.
19. Equipment and system startup and test activities.
20. Project closeout and cleanup.
21. Demobilization.

1.05 PROGRESS OF THE WORK

A. Updated Progress Schedule shall reflect:

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

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

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

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

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

1.06 NARRATIVE PROGRESS REPORT

A. Format:

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

B. Contents:

1. Number of days worked over the period, work force on hand, construction equipment on hand (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks).
2. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved.
3. Contractor’s plan for management of Site (for example, lay down and staging areas, construction traffic), use of construction equipment, buildup of trade labor, and identification of potential Contract changes.
4. Identification of new activities and sequences as a result of executed Contract changes.
5. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.

7. Changes to activity logic.
8. Changes to the critical path.
9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
10. Steps taken to recover the schedule from Contractor-caused delays.

1.07 SCHEDULE ACCEPTANCE

A. Engineer's acceptance will demonstrate agreement that:

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

B. Unacceptable Preliminary Progress Schedule:

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

C. Unacceptable Detailed Progress Schedule:

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

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

1.08 ADJUSTMENT OF CONTRACT TIMES

A. Reference General Conditions and Section 01 26 00, Contract Modification Procedures.

B. Evaluation and reconciliation of Adjustments of Contract Times shall be based on the Updated Progress Schedule at the time of proposed adjustment or claimed delay.

C. Float:

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, and 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 (i) impacts Project's critical path, (ii) consumes available float or contingency time, and (iii) extends Work beyond contract completion date.

D. Claims Based on Contract Times:

1. Where Engineer has not yet rendered formal decision on Contractor's Claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Progress Schedule, reflect an interim adjustment in the Progress Schedule as acceptable to Engineer.
2. It is understood and agreed that such interim acceptance will not be binding on either Contractor or Owner, and will be made only for the purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the Contract Times.
3. Revise Progress Schedule prepared thereafter in accordance with Engineer's formal decision.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 DEFINITIONS

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

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

1.02 PROCEDURES

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

1. Jacobs
   Attn: Dustin Harris
   One Perimeter Park South
   Suite 315 North
   Birmingham, AL 35243
   Dustin.Harris@Jacobs.com

B. Electronic Submittals: Submittals shall, unless specifically accepted, be made in electronic format.

1. Each submittal shall be an electronic file in Adobe Acrobat Portable Document Format (PDF). Use the latest version available at time of execution of the Agreement.
2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.
3. PDF files shall be set to open "Bookmarks and Page" view.
4. Add general information to each PDF file, including title, subject, author, and keywords.
5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.
6. Submit new electronic files for each resubmittal.
7. Include a copy of the Transmittal of Contractor's Submittal form, located at end of section, with each electronic file.

8. Engineer will reject submittal that is not electronically submitted, unless specifically accepted.
9. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.
10. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.

C. Transmittal of Submittal:

1. Contractor shall:
   a. Review each submittal and check for compliance with Contract Documents.
   b. Stamp each submittal with uniform approval stamp before submitting to Engineer.
      1) Stamp to include Project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.
      2) Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal form attached at end of this section**.**
3. Identify each submittal with the following:
   a. Numbering and Tracking System:
      1) Sequentially number each submittal.
      2) Resubmission of submittal shall have original number with sequential alphabetic or numerical suffix.
   b. Specification section and paragraph to which submittal applies.
   c. Project title and Engineer's project number.
   d. Date of transmittal.
   e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.
4. Identify and describe each deviation or variation from Contract Documents.

D. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.
2. Package submittal information by individual specification section. Do not combine different specification sections together in submittal package, unless otherwise directed in specification.

3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
4. Index with labeled tab dividers in orderly manner.

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

F. Processing Time:

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

G. Resubmittals: Clearly identify each correction or change made. Itemize Engineer's comments and provide written response to each.

H. Incomplete Submittals:

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

I. Submittals not required by Contract Documents:

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

1.03 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Copies: Submitted electronically, unless otherwise indicated in individual Specification section. Engineer may require paper copy of the final approved submittal as needed.
2. Identify and Indicate:
    a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
    b. Equipment and Component Title: Identical to title shown on Drawings.
    c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
    d. Project-specific information drawn accurately to scale.
3. Manufacturer’s standard schematic drawings and diagrams as follows:
    a. Modify to delete information that is not applicable to the Work.
    b. Supplement standard information to provide information specifically applicable to the Work.
4. Product Data: Provide as specified in individual specifications.
5. Foreign Manufacturers: When proposed, include the following additional information:
    a. Names and addresses of at least two companies that maintain technical service representatives close to Project.
    b. Complete list of spare parts and accessories for each piece of equipment.

C. Samples:

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

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

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

1. Approved:
   a. Contractor may incorporate product(s) or implement Work covered by submittal.
2. Approved as Noted:
   a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
3. Partial Approval, Resubmit as Noted:
   a. Make corrections or obtain missing portions, and resubmit.
   b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
4. Revise and Resubmit:
   a. Contractor may not incorporate product(s) or implement Work covered by submittal.

1.04 INFORMATIONAL SUBMITTALS

A. General:

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

B. Certificates:

1. General:
   a. Provide notarized statement that includes signature of entity responsible for preparing certification.
   b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
2. Welding: In accordance with individual specification sections.
3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual specification section.
4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual specification sections.
6. Manufacturer's Certificate of Compliance: In accordance with Section 01 61 00, Common Product Requirements.
7. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 43 33, Manufacturers' Field Services.

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

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

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

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

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

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

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

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

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

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

K. Test, Evaluation, and Inspection Reports:

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

6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
8) Provide interpretation of test results, when requested by Engineer.
9) Other items as identified in individual specification sections.

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

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

1.05 SUPPLEMENTS

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

1. Forms: Transmittal of Contractor's Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

Jacobs

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: _____

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

SUBMITTAL TYPE:	☐ Shop Drawing	☐ Sample	☐ Informational
	☐ Deferred		

The following items are hereby submitted:

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

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

By: _____
Contractor (Authorized Signature)

SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

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

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

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

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

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

F. Copies of standards and specifications of technical societies:

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

1.02 ABBREVIATIONS

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

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

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

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

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

PART 1 GENERAL

1.01 DEFINITIONS

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

1.02 SUBMITTALS

A. Informational Submittals:

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

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

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

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

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

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

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

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

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

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

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

3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

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

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

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

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

3.03 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

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

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

3.04 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.
5. Furnish documents necessary for training to meet requirements for operator and maintenance personal continuing education credits. Each training session should provide one continuing education credit, or equivalent, for those in attendance. Manufacturer shall provide certificate of completion to each person in attendance.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
   a. Respective manufacturer.
   b. Estimated dates for installation completion.
   c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.

3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.
4. Coordinate with Section 01 32 00, Construction Progress Documentation, and Section 01 91 14, Equipment Testing and Facility Startup.

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

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

D. Prestartup Training:

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

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

3.05 SUPPLEMENTS

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

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

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

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

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

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

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

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

Date: _____, 20___

Manufacturer:_____

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

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

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

Date of Execution: _____, 20___

Manufacturer:_____

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

_____

(Authorized Signature)

SECTION 01 45 16.13
CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 REFERENCES

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

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

1.02 DEFINITIONS

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

1.03 SUBMITTALS

A. Informational Submittals:

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

1.04 OWNER'S QUALITY ASSURANCE

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

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

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

C. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.

D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.

E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.

B. Maintain complete inspection records and make them available at all times to Owner and Engineer.

C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the quality control system.

B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor’s management and control with the Owner’s Quality Assurance.

C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager:

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

B. CQC Staff:

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

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

3.04 QUALITY CONTROL PHASING

A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:

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

2. Initial Phase:
   a. Accomplish at the beginning of a definable feature of Work:
      1) Notify Owner at least 48 hours in advance of beginning the initial phase.
      2) Perform prior to beginning Work on each definable feature of Work:
         a) Review minutes of the preparatory meeting.
         b) Check preliminary Work to verify compliance with Contract requirements.
         c) Verify required control inspection and testing.
         d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
         e) Resolve all differences.
         f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
      3) Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
      4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
3. Follow-up Phase:
   a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
   b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
   c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 CONTRACTOR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. An interim plan for the first 30 days of operation will be considered.
3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

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

f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
h. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORT

A. As a minimum, prepare a CQC report for every 7 calendar days. Account for all days throughout the life of the Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.

B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.

C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:

1. Contractor/subcontractor and their areas of responsibility.
2. Operating plant/equipment with hours worked, idle, or down for repair.
3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
5. Material received with statement as to its acceptability and storage.

6. Identify submittals reviewed, with Contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. List instructions given/received and conflicts in Drawings and/or Specifications.
10. Contractor's verification statement.
11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
12. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

3.07 SUBMITTAL QUALITY CONTROL

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

3.08 TESTING QUALITY CONTROL

A. Testing Procedure:

1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Procure services of a licensed testing laboratory. Perform the following activities and record the following data:
    a. Verify testing procedures comply with contract requirements.
    b. Verify facilities and testing equipment are available and comply with testing standards.
    c. Check test instrument calibration data against certified standards.
    d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
    e. Documentation:
        1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
        2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.

3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

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

3.09 COMPLETION INSPECTION

A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.

B. Punchlist:

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

END OF SECTION

SECTION 01 45 33
SPECIAL INSPECTION, OBSERVATION, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for Special Inspection, Observation, and Testing required in accordance with Chapter 17 of the 2021 IBC and is in addition to and supplements requirements included in Statement of Special Inspections shown in supplement located at end of this section.

1.02 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
2. International Code Council (ICC):
   a. International Building Code (IBC).
   b. Evaluation Service (ICC-ES) Reports and Legacy Reports.

1.03 DEFINITIONS

A. Agencies and Personnel:

1. Agency Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.
2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
3. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which Project is to be constructed.
4. Special Inspector: Qualified person employed by Owner who will demonstrate competence to the satisfaction of AHJ for inspection of a particular type of construction or operation requiring Special Inspection.

B. Statement of Special Inspections: Detailed written procedure contained in supplement located at end of this section establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing, extent and duration of Special Inspection, and reports to be completed and distributed by Special Inspector.

C. Special Inspection:

1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.
2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in area where the Work is being performed.
3. Special Inspection, Periodic: Part-time or intermittent observation of the Work requiring Special Inspection by an approved Special Inspector who is present in area where the Work has been or is being performed, and at completion of the Work.

D. Structural Systems and Components:

1. Diaphragm: Component of structural lateral load resisting system consisting of roof, floor, or other membrane or bracing system acting to transfer lateral forces to vertical resisting elements of structure.
2. Drag Strut or Collector: Component of structural lateral load resisting system consisting of diaphragm or shear wall element that collects and transfers diaphragm shear forces to vertical force-resisting elements or distributes forces within diaphragm or shear wall.
3. Seismic Force-Resisting System: That part of structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces identified on Drawings.
4. Shear Wall: Component of structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to plane of the wall. Unless noted otherwise on Drawings, load-bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.
5. Wind Force-Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces identified on Drawings.

E. Nonstructural Components:

1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems or components to structure, including braces, frames, struts, and attachments.
2. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.
3. Mechanical and Plumbing Component Supports: Structural members or assemblies which transmit loads and forces from mechanical or plumbing equipment to structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

F. Professional Observation:

1. Does not include or waive responsibility for required Special Inspection or inspections by building official.
2. Requirements are indicated on Statement of Special Inspections provided in supplement located at the end of this section.
3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces and installation of deep foundation elements by a registered design professional for general conformance to Contract Documents.
4. Structural Observation: Visual observation of structural system(s) by a registered design professional for general conformance to Contract Documents.

1.04 SUBMITTALS

A. Informational Submittals:

1. Contractor’s Statement of Responsibility: Form shall be completed by entity responsible for construction of main wind force-resisting system, and main seismic force-resisting system, wind-resisting component, and seismic-resisting component listed in Statement of Special Inspections. Refer to Article Supplements located at end of section.

1.05 STATEMENT OF SPECIAL INSPECTIONS REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated and subject to Special Inspection under Section 1705: None required.
2. Wind force-resisting systems designated under IBC Section 1705: None required.
3. Architectural, Plumbing, Mechanical, and Electrical Components subject to Special Inspection under IBC Section 1705.13.5 and 1705.13.6 for Seismic Resistance: As listed in Section 01 45 36, Equipment Seismic Certification.

B. Statement of Special Inspections:

1. As included in supplement located at the end of this section and in support of building permit application, Project-specific requirements were prepared by Registered Design Professional in Responsible Charge. The following identifies elements of inspection, observation, and testing program to be followed in construction of the Work:
   a. Designated seismic systems and main seismic force and wind force-resisting systems and components that are subject to Special Inspection and Structural Observation for lateral load resistance.
   b. Special Inspection and testing required by IBC 1705 and other applicable sections and referenced standards therein.
   c. Type and frequency of Special Inspection required.
   d. Type and frequency of testing required.
   e. Required frequency and distribution of testing and Special Inspection reports to be distributed by Special Inspector to Engineer, Contractor, building official, and Owner.
   f. Geotechnical Observation to be Performed: Required frequency and distribution of Geotechnical Observation reports by registered design professional to Contractor, building official, and Owner.
   g. Structural Observations to be Performed: Required frequency and distribution of Structural Observation reports by registered design professional to Contractor, building official, and Owner.

C. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency or by Authority Having Jurisdiction’s (AHJ) approved, qualified inspection staff. Owner will secure and pay for services of agency to perform Special Inspection and associated testing.

D. Code required Special Inspection with associated testing and Professional Observation, as provided in Statement of Special Inspections in supplement located at the end of this section and further provided in this section, is for benefit of Owner and does not:

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

E. The presence or absence of code required Special Inspector and Professional Observer does not relieve Contractor from Contract requirements.

F. Contractor is responsible for additional costs associated with Special Inspection and Testing and Observation when Work is not ready at time identified by Contractor and Special Inspectors and Professional Observer are onsite, but not able to provide contracted services.

G. Contractor is responsible for associated costs for additional Special Inspection and Testing and Professional Observation by Special Inspectors and Professional Observers required because of rejection of materials of in place Work that cannot be made compliant to Contract Document without additional inspections and observation and testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Requirements of the Statement of Special Inspections are provided by the Owner. All other testing and inspections, unless noted otherwise, are provided by Contractor.

B. Provide access to shop or Site for Special Inspection and Testing and Professional Observation requirements.

C. Notify Engineer in advance of required Special Inspection and Professional Observation no later than 48 hours prior to date of Special Inspection and Professional Observation.

D. Provide access for Special Inspector to construction documents.

E. Retain special inspection records on-site to be readily available for review.

F. Cooperate with Special Inspector and provide safe access to the Work to be inspected.

G. Submit Fabricator's Certificates of Compliance for approved fabricators.

H. Provide reasonable auxiliary services as requested by the Special Inspector. Auxiliary services required include, but not limited to:

1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests to assist the Special Inspector in performing test/inspections.
2. Providing storage space for the Special Inspector’s exclusive use, such as for storing and curing concrete test samples and delivery of samples to testing laboratories.
3. Providing the Special Inspector with access to all approved submittals.
4. Providing security and protection of samples and test equipment at the Project Site.
5. Provide samples of materials to be tested in required quantities.

I. When required by Registered Design Professional in Responsible Charge, provide access for plumbing, mechanical and electrical component inspections for those items requiring certification.

J. Materials and systems shall be inspected during placement where Continuous Special Inspection is required.

K. Where Periodic Special Inspection is indicated in the Statement of Special Inspections:

1. Schedule inspections for either during or at completion of their placement or a combination or both.
2. Schedule periodically inspected Work (either inspected during or after its placement) so that corrections can be completed and re-inspected before Work is inaccessible.
3. Sampling a portion of the Work is not allowed. Schedules shall provide for inspection of all Work requiring periodic inspection.

3.02 SUPPLEMENTS

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

1. Contractor’s Statement of Responsibility.
2. Fabricator’s Certificate of Compliance.
3. Statement of Special Inspections.

END OF SECTION

CONTRACTOR'S STATEMENT OF RESPONSIBILITY

_____
(Project)

_____
(Name of Contracting Company)

_____
(Business Address)

(_____) _____ (_____) _____
(Telephone) (Fax)

I, (We) hereby certify that I am (we are) aware of the Special Inspection and Testing and Professional Observation and component certification requirements contained in Contract Documents for this Project for wind and seismic force-resisting systems**,** and for components including architectural, mechanical, and electrical components, as listed in Statement of Special Inspections in supplement located at the end of this section and Section 01 45 36, Equipment Seismic Certification, and that:

1. I, (We) aware of the systems and the requirements of the special inspection and acknowledge our responsibility in the implementation of the Statement of Special Inspections for the construction of the following systems:

Facility	**Specification**	**Lateral Force-Resisting System**
35-Finished Water Pump Station	04 22 00	Special Reinforced Masonry Shear Walls (R=5).

2. I, (We) are responsible for construction of the following components:

Facility	**Component**
09–Electrical Site Work	**Standby Engine Generators**
09–Electrical Site Work	**Switchgear**
09–Electrical Site Work	**Secondary Unit Substation**
31–Pump Station	**Fire Protection Equipment**
44–Operations Building	**Lab HVAC Distribution Systems for Hazardous Materials**

Facility	Component
44–Operations Building	**Lab Piping Distribution Systems for Hazardous Materials]**

3. Control of this Work will be exercised to obtain conformance with Contract Documents approved by building official.

4. Procedures within the Contractor's organization to be used for exercising control of the Work, method and frequency of reporting, and distribution of reports required under Statement of Special Inspections for Project are attached to this statement.

5. I, (We) will provide 48-hour notification to Engineer and approved inspection agency as required for structural tests and Special Inspection for Project.

6. The following person is hereby identified as exercising control over requirements of this section for the Work designated above:

Name: _____

Qualifications: _____

_____

_____

(Print name and official title of person signing this form)

Signed by: _____

Date: _____

Project Name: _____

FABRICATOR'S CERTIFICATE OF COMPLIANCE

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per IBC Section 1704.2.5 must submit Fabricator's Certificate of Compliance at the completion of fabrication.

_____
(Project)

_____
(Fabricator's Name)

_____
(Business Address)

_____
(Certification or Approval Agency)

_____
(Certification Number)

_____
(Date of Last Audit or Approval)

Description of structural members and assemblies that have been fabricated:

_____

_____

_____

_____

_____

I hereby certify that items described above were fabricated in strict accordance with approved construction documents.

_____
(Name and Title) type or print

_____
(Signature and Date)

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

STATEMENT OF SPECIAL INSPECTIONS

GENERAL NOTES

1. THE STATEMENT OF SPECIAL INSPECTIONS PROVIDE PROJECT COMPLIANCE WITH THE PROVISIONS OF THE **2021** INTERNATIONAL BUILDING CODE (IBC) CHAPTER 17 FOR SPECIAL INSPECTION, STRUCTURAL OBSERVATION, AND TESTING FOR WIND AND SEISMIC RESISTANCE AS APPLICABLE. EXCEPT WHERE OTHERWISE NOTED, THIS INSPECTION IS OWNER FURNISHED.
2. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 1.
3. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR STRUCTURAL COMPONENTS, REGARDLESS OF WIND OR SEISMIC DESIGN CATEGORIES, ARE CONTAINED IN TABLE 2. STANDARD TESTING REQUIREMENTS FOR STRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 3.
4. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES ASSIGNED TO SEISMIC DESIGN CATEGORIES C, D, E, OR F ARE CONTAINED IN TABLE 4. ADDITIONAL TESTING REQUIREMENTS FOR STRUCTURAL RESISTANCE ARE CONTAINED IN TABLE 6.
5. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES SUBJECT TO BASIC DESIGN WIND SPEED (V) IN EXCESS OF 140 MPH IN WIND EXPOSURE CATEGORY C OR D ARE CONTAINED IN TABLE 5.
6. FOR ADDITIONAL REQUIREMENTS, REFER TO SPECIFICATION SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION, AND TESTING. THESE INCLUDE:
   A. CONTRACTOR’S REQUIREMENTS TO PROVIDE ACCESS TO THE WORK FOR REQUIRED INSPECTIONS, AND TO PROVIDE NOTICE OF REQUIRED INSPECTIONS AND STRUCTURAL OBSERVATION.
   B. CONTRACTOR’S STATEMENT OF RESPONSIBILITY FOR WORK TO BE PERFORMED ON SYSTEMS DESIGNATED UNDER THE STATEMENT OF SPECIAL INSPECTIONS FOR WIND OR SEISMIC RESISTANCE.
   C. DEFINITIONS AND TERMINOLOGY USED IN THIS STATEMENT OF SPECIAL INSPECTIONS.

SPECIAL INSPECTION

1. SPECIAL INSPECTION WILL BE IN ACCORDANCE WITH IBC SECTIONS 1705 TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO THE FOLLOWING TABLES FOR PROJECT SPECIFIC INSPECTION TYPES AND FREQUENCIES.
2. SPECIAL INSPECTIONS WILL BE PROVIDED BY A CERTIFIED OR QUALIFIED INSPECTOR AND ASSOCIATED TESTING WILL BE PERFORMED BY AN APPROVED ACCREDITED INDEPENDENT AGENCY. THE **OWNER** WILL SECURE AND PAY FOR THE SERVICES OF THE AGENCY TO PERFORM ALL SPECIAL INSPECTION AND ASSOCIATED TESTS. INSPECTORS FOR EACH SYSTEM AND MATERIAL WILL BE INTERNATIONAL CODE COUNCIL (ICC) CERTIFIED OR OTHERWISE APPROVED BY THE BUILDING OFFICIAL.
3. THE SPECIAL INSPECTOR WILL OBSERVE THE INDICATED WORK FOR COMPLIANCE WITH THE APPROVED CONTRACT DOCUMENTS AND SUBMIT RECORDS OF INSPECTION. ALL DISCREPANCIES WILL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION.
4. SPECIAL INSPECTION AND ASSOCIATED TESTING REPORTS WILL BE SUBMITTED TO THE ENGINEER, CONTRACTOR, BUILDING OFFICIAL, AND OWNER WITHIN ONE WEEK OF INSPECTION OR WITHIN ONE WEEK OF TEST COMPLETION. INSPECTIONS FOR WHICH REPORTING WILL BE REQUIRED ARE NOTED IN THE FOLLOWING TABLES.
5. AT THE CONCLUSION OF CONSTRUCTION, A FINAL REPORT DOCUMENTING REQUIRED SPECIAL INSPECTIONS AND CORRECTION OF PREVIOUSLY NOTED DISCREPANCIES WILL BE SUBMITTED.

GEOTECHNICAL OBSERVATION

1. ALL FOUNDATION BEARING SURFACES SHALL BE INSPECTED BY GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF REINFORCING STEEL. ADDITIONAL SPECIAL INSPECTION REQUIREMENTS ARE LISTED IN TABLE 1.
2. GEOTECHNICAL TESTING REQUIREMENTS ARE LISTED IN TABLE 3.

STRUCTURAL OBSERVATION

1. STRUCTURAL OBSERVATION WILL BE IN ACCORDANCE WITH IBC SECTION 1704.6 TOGETHER WITH LOCAL AND STATE AMENDMENTS.
2. ONSITE STRUCTURAL OBSERVATION WILL BE PERFORMED FOR EACH IDENTIFIED SEISMIC FORCE- OR WIND FORCE-RESISTING SYSTEM, INCLUDING FOUNDATIONS AND CONNECTIONS. REFER TO THE GENERAL STRUCTURAL NOTES DRAWING FOR THE BASIC SEISMIC AND WIND

FORCE-RESISTING SYSTEMS FOR THE STRUCTURES INCLUDED IN THE WORK.

3. STRUCTURAL OBSERVATION WILL BE PERFORMED BY A REGISTERED PROJECT DESIGN PROFESSIONAL FOR GENERAL CONFORMANCE TO THE APPROVED CONSTRUCTION DOCUMENTS. STRUCTURAL OBSERVATION DOES NOT INCLUDE OR WAIVE THE RESPONSIBILITY FOR ANY REQUIRED SPECIAL INSPECTIONS OR INSPECTIONS BY THE BUILDING OFFICIAL.
4. STRUCTURAL OBSERVATION REPORTS, NOTING ANY DEFICIENCIES IN OBSERVED CONSTRUCTION, WILL BE DELIVERED TO THE CONTRACTOR, BUILDING OFFICIAL, AND OWNER FOLLOWING EACH OBSERVATION. THE CONTRACTOR WILL BE NOTIFIED ONSITE OR BY PHONE OR E-MAIL WITHIN 24 HOURS UPON FINDING DEFICIENCIES.
5. AT THE CONCLUSION OF CONSTRUCTION, A WRITTEN STATEMENT WILL BE PROVIDED TO VERIFY THAT THE STRUCTURAL OBSERVATION SITE VISITS WERE MADE AND WHETHER THERE REMAIN ANY STRUCTURAL DEFICIENCIES THAT HAVE NOT BEEN RESOLVED.
6. STRUCTURAL OBSERVATION WILL INCLUDE VISUAL OBSERVATION OF THE STRUCTURAL SYSTEM AT SIGNIFICANT CONSTRUCTION STAGES AND AT COMPLETION OF THE STRUCTURAL SYSTEM FOR EACH STRUCTURE CONTAINED IN THE WORK. THE CONTRACTOR SHALL SCHEDULE AND FACILITATE STRUCTURAL OBSERVATION, INCLUDING THE ELEMENTS DESCRIBED IN THE STRUCTURAL OBSERVATION TABLE (ATTACHED).

SPECIAL INSPECTIONS FOR WIND RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR WIND RESISTANCE IN ACCORDANCE WITH IBC SECTION 1705.12 ARE NOT APPLICABLE TO THIS PROJECT.

SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE IN ACCORDANCE WITH IBC SECTION 1705.13 AND 1705.14] ARE NOT APPLICABLE TO THIS PROJECT.
2. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE WILL BE IN ACCORDANCE WITH IBC SECTION 1705.13 AND 1705.14 TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO GENERAL STRUCTURAL NOTES DRAWING FOR BASIC SEISMIC-FORCE-RESISTING SYSTEMS FOR EACH STRUCTURE AND DESIGNATED SEISMIC DESIGN CATEGORY.

3. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE SHALL APPLY TO THE SYSTEMS AND COMPONENTS LISTED IN TABLE 4.
4. MAIN SYSTEMS REQUIRED TO BE COVERED UNDER PROJECT SPECIAL INSPECTION REQUIREMENTS INCLUDE THE FOLLOWING TOGETHER WITH THEIR CONNECTIONS. REFER TO SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION AND TESTING.

Statement of Special Inspections Prepared by:

_____
Type or Print Name

_____
Signature

_____
Date

TABLE 1

REQUIRED NON-STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM OR MATERIAL	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
GEOTECHNICAL						
1. SOILS:						
A. VERIFY MATERIALS BELOW SHALLOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY	1705.6, 1803.5.8, 1803.5.9, 1804.6, 1804.7	SECTION 31 23 13, SUBGRADE PREPARATION	X		PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	**SEE TABLE 3 FOR CLSM STRENGTH TEST REQUIREMENTS**
B. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL	1705.6	SECTION 31 23 16, EXCAVATION	X		PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	
C. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS	1705.6	SECTION 31 23 23, FILL AND BACKFILL	X			SEE TABLE 3 FOR GRADATION TEST REQUIREMENTS
D.DURING FILL PLACEMENT, VERIFY USE OF PROPER MATERIALS AND PROCEDURES IN ACCORDANCE WITH THE PROVISIONS OF THE APPROVED GEOTECHNICAL REPORT. VERIFY DENSITIES, AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL	1705.6, 1803.5.8	SECTION 31 23 23, FILL AND BACKFILL		X		SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS
E. PRIOR TO PLACEMENT OF COMPACTED FILL, INSPECT SUBGRADE AND VERIFY THAT SITE HAS BEEN PREPARED PROPERLY	1705.6	SECTION 31 23 13, SUBGRADE PREPARATION	X		PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	SEE TABLE 3 FOR DENSITY TEST **AND PROOF ROLLING** REQUIREMENTS
2. DRIVEN DEEP FOUNDATION ELEMENTS:						
A. VERIFY ELEMENT MATERIALS, SIZES, AND LENGTHS COMPLY WITH THE REQUIREMENTS	1705.7	**SECTION [31 62 16, STEEL PILES] [ ]**		X		

TABLE 1
REQUIRED NON-STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM OR MATERIAL	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
B. DETERMINE CAPACITIES OF TEST ELEMENTS AND CONDUCT ADDITIONAL LOAD TESTS, AS REQUIRED	1705.7	**SECTION [31 62 16, STEEL PILES] [ ]**		X	**[PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER]**	SEE TABLE 3 FOR DYNAMIC **[STATIC]** PILE TESTING
C. INSPECT DRIVING OPERATIONS AND MAINTAIN COMPLETE AND ACCURATE RECORDS FOR EACH ELEMENT	1705.7			X		
D. VERIFY PLACEMENT LOCATIONS AND PLUMBNESS, CONFIRM TYPE AND SIZE OF HAMMER, RECORD NUMBER OF BLOWS PER FOOT OF PENETRATION, DETERMINE REQUIRED PENETRATIONS TO ACHIEVE DESIGN CAPACITY, RECORD TIP AND BUTT ELEVATIONS, AND DOCUMENT ANY DAMAGE TO FOUNDATION ELEMENT	1705.7			X		
E. FOR STEEL ELEMENTS, PERFORM ADDITIONAL INSPECTIONS IN ACCORDANCE WITH SECTION 1705.2	1705.7				SEE TABLE 2 FOR REQUIRED INSPECTIONS FOR STRUCTURAL STEEL CONSTRUCTION	
F. FOR CONCRETE ELEMENTS AND CONCRETE-FILLED ELEMENTS, PERFORM TESTS AND ADDITIONAL INSPECTIONS IN ACCORDANCE WITH SECTION 1705.3	1705.7				SEE TABLE 2 FOR REQUIRED INSPECTIONS FOR CONCRETE CONSTRUCTION AND TABLE 3 FOR REQUIRED TESTING	

TABLE 1
REQUIRED NON-STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM OR MATERIAL	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
G. FOR SPECIALTY ELEMENTS, PERFORM ADDITIONAL INSPECTIONS AS DETERMINED BY THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE	1705.7	**SECTION [ ]**		X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	
3. CAST-IN-PLACE DEEP FOUNDATION ELEMENTS:						
A. INSPECT DRILLING OPERATIONS AND MAINTAIN COMPLETE AND ACCURATE RECORDS FOR EACH	1705.8			X		
B. VERIFY PLACEMENT LOCATIONS AND PLUMBNESS, CONFIRM ELEMENT DIAMETERS, BELL DIAMETERS (IF APPLICABLE), LENGTHS, EMBEDMENT INTO BEDROCK (IF APPLICABLE), AND ADEQUATE END-BEARING STRATA CAPACITY. RECORD CONCRETE OR GROUT VOLUMES.	1705.8			X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	SEE TABLE 3 FOR PILE INTEGRITY TESTING
C. FOR CONCRETE ELEMENTS, PERFORM TESTS AND ADDITIONAL SPECIAL INSPECTIONS IN ACCORDANCE WITH SECTION 1705.3	1705.8				SEE TABLE 2 FOR REQUIRED INSPECTIONS FOR CONCRETE CONSTRUCTION AND TABLE 3 FOR REQUIRED TESTING	
4. STRUCTURAL INTEGRITY OF DEEP FOUNDATION ELEMENTS						

TABLE 1
REQUIRED NON-STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM OR MATERIAL	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
A. WHERE REQUIRED WHEN INTEGRITY IS UNCERTAIN, RECORD PILE TYPE AND DIMENSIONS, LOCATION, VISUAL OBSERVATIONS AND NOTATIONS OF UNUSUAL OCCURRENCES DURING INSTALLATION OR EXCAVATION, EQUIPMENT USED FOR INTEGRITY TESTING, COMMENTS ON INTEGRITY, AND OTHER PERTINENT INFORMATION AS REQUIRED BY THE REGISTERED DESIGN PROFESSIONAL IN	1705.10	ASTM **[D4945] [ASTM D5882] [ASTM D6760] [D7949]**		X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	SEE TABLE 3 FOR PILE INTEGRITY TESTING
7. MECHANICALLY STABILIZED EARTH RETAINING WALLS:						
A. VERIFY MODULAR UNIT AND GEOSYNTHETIC REINFORCEMENT PRODUCT NAMES, TYPES, AND DIMENSIONS	1703.4.2, 1705.1.1 ITEM 3	GEOTECHNICAL AND ICC-ES EVALUATION REPORTS	X			
B. VERIFY MODULAR UNIT PLACEMENT INCLUDING ALIGNMENT AND INCLINATION	1703.4.2, 1705.1.1 ITEM 3	GEOTECHNICAL AND ICC-ES EVALUATION REPORTS	X			
C. VERIFY PLACEMENT OF REINFORCEMENT, BACKFILL PLACEMENT AND COMPACTION, AND DRAINAGE PROVISIONS	1703.4.2, 1705.1.1 ITEM 3	GEOTECHNICAL AND ICC-ES EVALUATION REPORTS		X		SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS
8. ROCK ANCHORS:						
A. VERIFY ANCHOR MATERIALS, SIZES, LENGTHS AND CORROSION PROTECTION COMPLY WITH THE	1705.1.1 ITEM 2	GEOTECHNICAL REPORT	X			

TABLE 1
REQUIRED NON-STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM OR MATERIAL	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
B. VERIFY PLACEMENT LOCATIONS, LENGTHS, EMBEDMENT INTO ROCK	1705.1.1 ITEM 2	GEOTECHNICAL REPORT		X		
C. DETERMINE CAPACITIES OF ANCHORS AND CONDUCT ADDITIONAL LOAD TESTS, AS REQUIRED	1705.1.1 ITEM 2			X		SEE TABLE 3 FOR PULLOUT TEST REQUIREMENTS
D. APPLICATION OF PRESTRESSING FORCES AND GROUTING OF BONDED TENDONS	1705.1.1 ITEM 2				SEE TABLE 2 FOR REQUIRED INSPECTIONS FOR CONCRETE CONSTRUCTION	SEE TABLE 3 FOR GROUT TEST AND TENDON PERFORMANCE AND PROOF TEST
E. PERFORM ADDITIONAL INSPECTIONS IN ACCORDANCE WITH SECTION 1705.3	1705.1.1 ITEM 2				SEE TABLE 2 FOR REQUIRED INSPECTIONS FOR CONCRETE CONSTRUCTION	
9. STONE COLUMNS:						
A.VERIFY USE OF PROPER AGGREGATE AND LIFT THICKNESSES DURING PLACEMENT	1705.1.1 ITEM 2	GEOTECHNICAL REPORT		X		SEE TABLE 3 FOR GRADATION TEST REQUIREMENTS
B. VERIFY HOLE SIZE AND DEPTH, INSTALLATION RAMMER ENERGY, AND TOP OF COLUMN ELEVATION	1705.1.1 ITEM 2	GEOTECHNICAL REPORT		X		
ARCHITECTURAL						
5. FIRE-RESISTANT PENETRATIONS AND JOINTS IN BUILDING ASSIGNED TO RISK CATEGORY III OR IV:						
A. PENETRATION FIRESTOPS	1705.18.1	ASTM E2174	X			
B. FIRE-RESISTANT JOINT SYSTEMS	1705.18.2	ASTM E2393	X			
BUILDING MECHANICAL						
1. INSTALLATION OF SMOKE CONTROL SYSTEMS:						

TABLE 1

REQUIRED NON-STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM OR MATERIAL	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
A. LEAKAGE TESTING AND RECORDING OF DEVICE LOCATIONS PRIOR TO CONCEALMENT	1705.19		X			
B. PRIOR TO OCCUPANCY AND AFTER SUFFICIENT COMPLETION, PRESSURE DIFFERENCE TESTING, FLOW MEASUREMENTS, AND DETECTION AND CONTROL VERIFICATION	1705.19		X			
GENERAL						
1. CONSTRUCTION MATERIALS AND SYSTEMS THAT ARE ALTERNATIVES TO MATERIALS AND SYSTEMS PRESCRIBED BY CODE	1705.1.1 ITEM 1		X			
2. UNUSUAL DESIGN APPLICATION OF CODE MATERIALS	1705.1.1 ITEM 2			X		
3. INSTALLATION OF MATERIALS THAT REQUIRE ADDITIONAL MANUFACTURER'S INSTRUCTIONS BEYOND CODE REQUIREMENTS	1703.4.2, 1705.1.1 ITEM 3	ICC-ES EVALUATION REPORTS		X		
STRUCTURAL						
SEE TABLE 2.						

NOTES:
1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING INSPECTED WORK.

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
CONCRETE						
1. INSPECT REINFORCEMENT, INCLUDING PRESTRESSING TENDONS, AND VERIFY PLACEMENT	1705.3	ACI 318: Ch. 20, 25.2, 25.3, 26.6.1-26.6.3	X			SEE TABLE 6 FOR REINFORCING STEEL TESTING
3. INSPECT ANCHORS CAST IN CONCRETE	1705.3	ACI 318: 26.13.3.3	X			
4. INSPECT ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS						
A. ADHESIVE ANCHORS INSTALLED IN HORIZONTALLY OR UPWARDLY INCLINED ORIENTATIONS TO RESIST SUSTAINED TENSION LOADS	1705.3	ACI 318: 26.13.3.2, ICC-ES EVALUATION REPORTS		X		
B. MECHANICAL ANCHORS AND ADHESIVE ANCHORS NOT DEFINED IN 4A.	1705.3	ACI 318: 26.13.3.3, ICC-ES EVALUATION REPORTS	X			
5. VERIFY USE OF REQUIRED DESIGN MIX	1705.3, 1904.1, 1904.2, 1908.1	ACI 318: Ch. 19, 26.4.3, 26.4.4	X			
6. PRIOR TO CONCRETE PLACEMENT, FABRICATE SPECIMENS FOR STRENGTH TESTS, PERFORM SLUMP AND AIR CONTENT TESTS, AND DETERMINE THE TEMPERATURE OF THE CONCRETE	1705.3, 1908.1	ASTM C 172, ASTM C 31, ACI 318: 26.5, 26.12		X		SEE TABLE 3 FOR CONCRETE TEST REQUIREMENTS
7. INSPECT CONCRETE AND SHOTCRETE PLACEMENT FOR PROPER APPLICATION TECHNIQUES	1705.3, 1908.1	ACI 318: 26.5.1.1, 26.5.2.1		X		
8. VERIFY MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES	1705.3, 1908.1	ACI 318: 26.5.3-26.5.5	X			
14. INSPECT FORMWORK FOR SHAPE, LOCATION AND DIMENSIONS OF THE CONCRETE MEMBER BEING FORMED	1705.3	ACI 318: 26.11.1.2(b)	X			
15. INSPECTION OF WATERSTOPS FOR PROPER SHAPE, LOCATION, JOINT QUALITY, AND SURROUNDING CONCRETE PLACEMENT		ACI: 26.5.6.2	X			
16. VERIFY PROPER INSTALLATION OF MECHANICAL REINFORCING SPLICES AND CONNECTIONS	1705.1.1 ITEM 3, 1705.3	ICC-ES EVALUATION REPORTS	X			
MASONRY VENEER LEVEL 2						
1. VERIFY COMPLIANCE OF THE APPROVED SUBMITTALS	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.5	X			
2. VERIFICATION OF f'_m AND f'_{AAC} PRIOR TO CONSTRUCTION EXCEPT WHERE SPECIFICALLY EXEMPTED BY CODE	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.4 B	X			

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
3. FOR SELF-CONSOLIDATING GROUT: VERIFICATION OF SLUMP FLOW AND VISUAL STABILITY INDEX (VSI) AS DELIVERED TO THE PROJECT SITE.	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.5 B.1.b.3	X			
4. AS MASONRY CONSTRUCTION BEGINS, THE FOLLOWING SHALL BE VERIFIED TO ENSURE COMPLIANCE:						
A. PROPORTIONS OF SITE-PREPARED MORTAR	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 2.1, 2.6 A	X			
C. GRADE, TYPE AND SIZE OF REINFORCEMENT, CONNECTORS, ANCHOR BOLTS, ANCHORAGES	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 3.4, 3.6 A	X			
F. SAMPLE PANEL CONSTRUCTION	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.6 D	X			
5. PRIOR TO GROUTING, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:						
A. GROUT SPACE	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 3.2 D, 3.2 F	X			
C. PLACEMENT OF REINFORCEMENT, CONNECTORS, AND ANCHOR BOLTS	1705.4	TMS 402: Sec. 3.1, 6.1, 6.3.1, 6.3.6, 6.3.7 TMS 602: Art. 3.2 E, 3.4	X			
6. VERIFY DURING CONSTRUCTION:						
A. MATERIALS AND PROCEDURES IN ACCORDANCE WITH THE APPROVED SUBMTITALS	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.5	X			
B. PLACEMENT OF MASONRY UNITS AND MORTAR JOINT CONSTRUCTION	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 3.3 B	X			
C. SIZE AND LOCATION OF STRUCTURAL MEMBERS	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 3.3 F	X			
D. TYPE, SIZE AND LOCATION OF ANCHORS, INCLUDING OTHER DETAILS OF ANCHORAGE OF MASONRY TO STRUCTURAL MEMBERS, FRAMES, OR OTHER CONSTRUCTION	1705.4	TMS 402: Sec. 1.2.1(e), 3.1, 6.2.1, 6.3.1	X			
E. WELDING OF REINFORCEMENT	1705.4	TMS 402: Sec. 3.1, 6.1.6.1.2		X	SEE STRUCTURAL STEEL (IN THIS TABLE) FOR WELDING INSPECTION REQUIREMENTS	
F. PREPARATION, CONSTRUCTION, AND PROTECTION OF MASONRY DURING COLD WEATHER (TEMPERATURE BELOW 40 DEGREES F) OR HOT WEATHER (TEMPERATURE ABOVE 90 DEGREES F)	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.8 C, 1.8 D	X			

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
7. OBSERVE PREPARATION OF GROUT SPECIMENS, MORTAR SPECIMENS, AND/OR PRISMS	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. **[1.4 B.2.a.3)] [1.4 B.2.b.3)] [1.4 B.2.c.3)] [1.4 B.3] [1.4 B.4]**	X			SEE TABLE 3 FOR **[UNIT STRENGTH TESTS] [AND] [PRISM TESTS]** FOR MASONRY
MASONRY LEVEL 3						
1. VERIFY COMPLIANCE OF THE APPROVED SUBMITTALS	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.5	X			
2. VERIFICATION OF f'_m AND f'_{AAC} PRIOR TO CONSTRUCTION AND FOR EVERY 5,000 SQUARE FEET DURING CONSTRUCTION	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.4 B	X			SEE TABLE 3 FOR MASONRY TEST REQUIREMENTS
3. FOR SELF-CONSOLIDATING GROUT: VERIFICATION OF SLUMP FLOW AND VSI AS DELIVERED TO THE PROJECT SITE.	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.5 B.1.b.3	X			
4. VERIFICATION OF PROPORTIONS OF MATERIALS IN PREMIXED OR PREBLENDED MORTAR, PRESTRESSING GROUT, AND GROUT OTHER THAN SELF-CONSOLIDATING GROUT, AS DELIVERED TO THE PROJECT SITE	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.5 B	X			
5. AS MASONRY CONSTRUCTION BEGINS, THE FOLLOWING SHALL BE VERIFIED TO ENSURE COMPLIANCE:						
A. PROPORTIONS OF SITE-PREPARED MORTAR	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 2.1, 2.6 A	X			
C. GRADE, TYPE AND SIZE OF REINFORCEMENT, CONNECTORS, ANCHOR BOLTS, AND ANCHORAGES	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 3.4, 3.6 A	X			
F. SAMPLE PANEL CONSTRUCTION	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.6 D		X		
5. PRIOR TO GROUTING, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:						
A. GROUT SPACE	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 3.2 D, 3.2 F		X		
C. PLACEMENT OF REINFORCEMENT, CONNECTORS, AND ANCHOR BOLTS	1705.4	TMS 402: Sec. 3.1, 6.1, 6.3.1, 6.3.6, 6.3.7 TMS 602: Art. 3.2 E, 3.4		X		
6. VERIFY DURING CONSTRUCTION:						
A. MATERIALS AND PROCEDURES IN ACCORDANCE WITH THE APPROVED SUBMTITALS	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.5	X			
B. PLACEMENT OF MASONRY UNITS AND MORTAR JOINT CONSTRUCTION	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 3.3 B	X			
C. SIZE AND LOCATION OF STRUCTURAL MEMBERS	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 3.3 F	X			

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
D. TYPE, SIZE AND LOCATION OF ANCHORS, INCLUDING OTHER DETAILS OF ANCHORAGE OF MASONRY TO STRUCTURAL MEMBERS, FRAMES, OR OTHER CONSTRUCTION	1705.4	TMS 402: Sec. 1.2.1(e), 3.1, 6.2.1, 6.3.1		X		
E. WELDING OF REINFORCEMENT	1705.4	TMS 402: Sec. 3.1, 6.1.6.1.2		X		
F. PREPARATION, CONSTRUCTION, AND PROTECTION OF MASONRY DURING COLD WEATHER (TEMPERATURE BELOW 40 DEGREES F) OR HOT WEATHER (TEMPERATURE ABOVE 90 DEGREES F)	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. 1.8 C, 1.8 D	X			
7. OBSERVE PREPARATION OF GROUT SPECIMENS, MORTAR SPECIMENS, AND/OR PRISMS	1705.4	TMS 402: Sec. 3.1 TMS 602: Art. **[1.4 B.2.a.3)] [1.4 B.2.b.3)] [1.4 B.2.c.3)] [1.4 B.3] [1.4 B.4]**		X		SEE TABLE 3 FOR **[UNIT STRENGTH TESTS] [AND] [PRISM TESTS]** FOR MASONRY
STRUCTURAL STEEL						
1. MATERIAL VERIFICATION OF STRUCTURAL STEEL:						
A. IDENTIFICATION MARKINGS TO CONFORM TO AISC 360	1705.2.1, 2202.1	Applicable ASTM Material Standards	X			
B. MANUFACTURER'S CERTIFIED TEST REPORTS	1705.2.1	AISC 360: Sec. N3.2, N5.2	X			
2. PRIOR TO BOLTING, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:						
A. MANUFACTURER'S CERTIFICATIONS AVAILABLE FOR FASTENER MATERIALS	1705.2.1	AISC 360: Sec. N3.2, N5.2, N5.6 RCSC: Sec. 2.1, 9.1		X		
B. FASTENERS MARKED IN ACCORDANCE WITH ASTM REQUIREMENTS	1705.2.1	AISC 360: Sec. N3.2, N5.2, N5.6 Applicable ASTM Material Standards	X			
C. CORRECT FASTENERS SELECTED FOR THE JOINT DETAIL (GRADE, TYPE, BOLT LENGTH IF THREADS ARE TO BE EXCLUDED FROM THE SHEAR PLANE)	1705.2.1	AISC 360: Sec. N3.2, N5.2, N5.6	X			
D. CORRECT BOLTING PROCEDURE SELECTED FOR JOINT DETAIL	1705.2.1	AISC 360: Sec. N5.6 RCSC: Sec. 4	X			
E. CONNECTING ELEMENTS, INCLUDING THE APPROPRIATE FAYING SURFACE CONDITION AND HOLE PREPARATION, IF SPECIFIED, MEET APPLICABLE REQUIREMENTS	1705.2.1	AISC 360: Sec. N5.6 RCSC: Sec. 3.2, 4	X			

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
F. PRE-INSTALLATION VERIFICATION TESTING BY INSTALLATION PERSONNEL OBSERVED AND DOCUMENTED FOR FASTENER ASSEMBLIES AND	1705.2.1	AISC 360: Sec. N5.6 RCSC: Sec. 7	X			
G. PROTECTED STORAGE PROVIDED FOR BOLTS, NUTS, WASHERS AND OTHER FASTENER COMPONENTS	1705.2.1	AISC 360: Sec. N5.6 RCSC: Sec. 2.2	X			
3. VERIFY DURING BOLTING:						
A. FASTENER ASSEMBLIES PLACED IN ALL HOLES AND WASHERS (IF REQUIRED) AND NUTS ARE POSITIONED AS REQUIRED	1705.2.1	AISC 360: Sec. N5.6	X			
B. JOINT BROUGHT TO SNUG-TIGHT CONDITION PRIOR TO THE PRETENSIONING OPERATION	1705.2.1	AISC 360: Sec. N5.6	X			
C. FASTENER COMPONENT NOT TURNED BY THE WRENCH PREVENTED FROM ROTATING	1705.2.1	AISC 360: Sec. N5.6	X			
D. FASTENERS ARE PRETENSIONED IN ACCORDANCE WITH THE RCSC SPECIFICATION, PROGRESSING SYSTEMATICALLY FROM THE MOST RIGID POINT TOWARD THE FREE EDGES	1705.2.1	AISC 360: Sec. N5.6	X			SEE TABLE 3 FOR TESTING OF HIGH-STRENGTH BOLTING
4. PRIOR TO WELDING, VERIFY THAT THE FOLLOWING ARE IN COMPLIANCE:						
A. APPROVED WELDER QUALIFICATION RECORDS AND CONTINUITY RECORDS	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
B. APPROVED WELDING PROCEDURE SPECIFICATIONS (WPS) AVAILABLE TO WELDERS AND WELDING INSPECTOR(S)	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1		X		
C. MANUFACTURER CERTIFICATIONS FOR WELDING CONSUMABLES AVAILABLE	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1		X		
D. MATERIAL IDENTIFICATION (TYPE/GRADE)	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
E. WELDER IDENTIFICATION SYSTEM	1705.2.1	AISC 360: Sec. N5.4	X			
F. FIT-UP OF WELDS (INCLUDING JOINT GEOMETRY)	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23
G. CONFIGURATION AND FINISH OF ACCESS HOLES	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
5. VERIFY DURING WELDING:						
A. CONTROL AND HANDLING OF WELDING	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
B. NO WELDING OVER CRACKED TACK WELDS	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X		NOTE 2	
C. ENVIRONMENTAL CONDITIONS	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
D. COMPLIANCE WITH WPS REQUIREMENTS	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23 AND TABLE 3 FOR STRUCTURAL STEEL TEST REQUIREMENT
E. WELDING TECHNIQUES	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
F. PLACEMENT AND INSTALLATION OF STEEL HEADED STUD ANCHORS	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1		X		
6. AFTER WELDING, VERIFY THE FOLLOWING:						
A. WELDS CLEANED	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
B. SIZE, LENGTH AND LOCATION OF WELDS	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X		NOTE 2	
C. WELDS MEET VISUAL ACCEPTANCE CRITERIA	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23
D. ARC STRIKES	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
E. K-AREA	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
F. BACKING REMOVED AND WELD TABS REMOVED (IF REQUIRED)	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
G. REPAIR ACTIVITIES	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
H. NO PROHIBITED WELDS HAVE BEEN ADDED WITHOUT THE APPROVAL OF THE EOR	1705.2.1	AISC 360: Sec. N5.4 AWS D1.1	X			
I. NONDESTRUCTIVE WELDING INSPECTION	1705.2	AISC 360: Sec. N5.5 AWS D1.1	X		NOTE 2	ALSO SEE REQUIREMENTS OF SPEC. SECTION 05 05 23
7. INSPECTION OF GALVANIZED STRUCTURAL STEEL MAIN MEMBERS FOR CRACKS SUBSEQUENT TO GALVANIZING	1705.2.1	AISC 360: Sec. N5.7	X			
COLD-FORMED STEEL DECK						
1. PRIOR TO DECK PLACEMENT, VERIFY COMPLIANCE OF MATERIALS (DECK AND ALL ACCESSORIES) WITH CONTRACT DOCUMENTS, INCLUDING PROFILES, MATERIAL PROPERTIES, AND BASE METAL THICKNESS	1705.2.2	SDI QA/QC	X			

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
2. VERIFY AFTER DECK PLACEMENT:						
A. COMPLIANCE OF INSTALLATION OF DECK AND ALL DECK ACCESSORIES WITH CONTRACT DOCUMENTS	1705.2.2	SDI QA/QC	X			
B. VERIFY DECK MATERIALS ARE REPRESENTED BY THE MILL CERTIFICATIONS THAT COMPLY WITH THE CONSTRUCTION DOCUMENTS	1705.2.2	SDI QA/QC	X			
3. VERIFY PRIOR TO WELDING:						
A. WELDING PROCEDURE SPECIFICATIONS AND MANUFACTURER CERTIFICATIONS FOR WELDING CONSUMABLES AVAILABLE	1705.2.2	SDI QA/QC AWS D1.3	X		NOTE 3	
B. MATERIAL IDENTIFICATION (TYPE/GRADE)	1705.2.2	SDI QA/QC	X		NOTE 3	
C. WELDING EQUIPMENT CHECKED	1705.2.2	SDI QA/QC	X		NOTE 3	
4. VERIFY DURING WELDING:						
A. USE OF QUALIFIED WELDERS	1705.2.2	SDI QA/QC	X		NOTE 3	
B. CONTROL AND HANDLING OF WELDING	1705.2.2	SDI QA/QC	X		NOTE 3	
C. ENVIRONMENTAL CONDITIONS	1705.2.2	SDI QA/QC	X		NOTE 3	
D. WELDING CONFORMS TO THE WPS	1705.2.2	SDI QA/QC	X		NOTE 3	
5. VERIFY AFTER WELDING:						
A. SIZE AND LOCATION OF WELDS, INCLUDING SUPPORT, SIDELAP, AND PERIMETER WELDS	1705.2.2	SDI QA/QC	X			
B. VISUAL ACCEPTANCE CRITERIA MET	1705.2.2	SDI QA/QC	X			
C. REPAIR ACTIVITIES	1705.2.2	SDI QA/QC	X			
6. VERIFY PRIOR TO MECHANICAL FASTENING:						
A. MANUFACTURERS' INSTALLATION INSTRUCTIONS AVAILABLE FOR MECHANICAL FASTENERS	1705.2.2	SDI QA/QC	X		NOTE 3	
B. PROPER TOOLS AVAILABLE FOR FASTENER INSTALLATION	1705.2.2	SDI QA/QC	X		NOTE 3	
C. MECHANICAL FASTENERS PROPERLY STORED	1705.2.2	SDI QA/QC	X		NOTE 3	
7. VERIFY DURING MECHANICAL FASTENING						
A. FASTENERS ARE POSITIONED AS REQUIRED	1705.2.2	SDI QA/QC	X		NOTE 3	

TABLE 2
REQUIRED STRUCTURAL SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

SYSTEM	2021 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
B. FASTENERS ARE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS	1705.2.2	SDI QA/QC	X		NOTE 3	
8. VERIFY AFTER MECHANICAL FASTENING:						
A. SPACING, TYPE, AND INSTALLATION OF SUPPORT FASTENERS	1705.2.2	SDI QA/QC	X			
B. SPACING, TYPE, AND INSTALLATION OF SIDELAP FASTENERS	1705.2.2	SDI QA/QC	X			
C. SPACING, TYPE, AND INSTALLATION OF PERIMETER FASTENERS	1705.2.2	SDI QA/QC	X			
D. REPAIR ACTIVITIES	1705.2.2	SDI QA/QC	X			
OPEN-WEB STEEL JOISTS AND JOIST GIRDERS						
1. INSTALLATION OF OPEN-WEB STEEL JOISTS AND JOIST GIRDERS						
A. END CONNECTIONS--WELDED OR BOLTED	1705.2.3, 2207.1		X			
B. BRIDGING--HORIZONTAL OR DIAGONAL						
1. STANDARD BRIDGING	1705.2.3, 2207.1		X			
2. BRIDGING THAT DIFFERS FROM SECTION 2207.1	1705.2.3		X			

NOTES:
1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING INSPECTED WORK.

2. VISUAL INSPECTION IS THE RESPONSIBILITY OF THE CONTRACTOR'S WELDING INSPECTOR(S) AND IS NOT CONSIDERED SPECIAL INSPECTION. CONTRACTOR MUST PROVIDE A QUALIFIED WELDING INSPECTOR TO OVERSEE CONTRACTOR'S WELDING OPERATIONS, AS REQUIRED BY SPECIFICATION SECTION 05 05 23 AND REFERENCED WELDING CODES.

3. SPECIAL INSPECTOR TO OBSERVE ON AN INTERMITTENT BASIS SUFFICIENT TO CONFIRM THAT THE WORK HAS BEEN PERFORMED IN ACCORDANCE WITH THE APPLICABLE DOCUMENTS. OPERATIONS NEED NOT BE DELAYED PENDING THESE INSPECTIONS.

TABLE 3

TESTING FOR REQUIRED SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

MATERIAL	TYPE OR SCOPE	STANDARD	2021 IBC CODE REFERENCE	FREQUENCY	BY WHOM	COMMENTS
GEOTECHNICAL						
COMPACTED FILL	GRADATION	ASTM C117, C136	1705.6	SECTION 31 23 23, FILL AND BACKFILL	OWNER'S TESTING AGENCY	
COMPACTED FILL	COMPACTION	ASTM **D698**	1705.6	SECTION 31 23 23, FILL AND BACKFILL	OWNER'S TESTING AGENCY	
COMPACTED FILL	DENSITY	ASTM **D698**	1705.6	SECTION 31 23 23, FILL AND BACKFILL	OWNER'S TESTING AGENCY	
PREPARED SUBGRADE	DENSITY	ASTM **D698**	1705.6	SECTION 31 23 13, SUBGRADE PREPARATION	OWNER'S TESTING AGENCY	
DRIVEN DEEP FOUNDATIONS	DYNAMIC PILE TESTING	ASTM D4945	1705.7	SECTION 31 09 17, DYNAMIC PILE TESTING	OWNER'S TESTING AGENCY	
DRIVEN DEEP FOUNDATIONS	STATIC PILE TESTING	ASTM D1143	1705.7	SECTION 31 09 18, STATIC PILE TESTING	OWNER'S TESTING AGENCY	
CAST-IN-PLACE DEEP FOUNDATIONS	PILE INTEGRITY TESTING	ASTM D5882	1705.8	SECTION 31 09 17, DYNAMIC PILE TESTING	OWNER'S TESTING AGENCY	
NONPRESTRESSED ROCK ANCHORS	PULLOUT TEST	ASTM D4435	1705.1.1- ITEM 2	SECTION 31 68 16, NONPRESTRESSED ROCK ANCHORS	CONTRACTOR'S APPROVED TESTING AGENCY	
PRESTRESSED ROCK ANCHORS	GROUT TEST	ASTM C942	1705.1.1- ITEM 2	SECTION 31 68 13, PRESTRESSED ROCK ANCHORS	CONTRACTOR'S APPROVED TESTING AGENCY	
PRESTRESSED ROCK ANCHORS	TENDON PERFORMANCE TEST		1705.1.1- ITEM 2	SECTION 31 68 13, PRESTRESSED ROCK ANCHORS	CONTRACTOR'S APPROVED TESTING AGENCY	
PRESTRESSED ROCK ANCHORS	TENDON PROOF TEST		1705.1.1- ITEM 2	SECTION 31 68 13, PRESTRESSED ROCK ANCHORS	CONTRACTOR'S APPROVED TESTING AGENCY	
CONCRETE						
CONCRETE	STRENGTH	ASTM C39	1705.3, 1904.1	ONCE EACH DAY, BUT NOT LESS THAN ONE SAMPLE FOR EACH 150 CUBIC YARDS OR 5,000 SFT OF WALLS OR SLABS PLACED	OWNER'S TESTING AGENCY	

TABLE 3
TESTING FOR REQUIRED SPECIAL INSPECTION
REFER TO SPECIFICATION SECTION 01 45 33

MATERIAL	TYPE OR SCOPE	STANDARD	2021 IBC CODE REFERENCE	FREQUENCY	BY WHOM	COMMENTS
SHOTCRETE	STRENGTH	ASTM C42	1705.3, 1908.1	ONCE EACH SHIFT, BUT NOT LESS THAN ONE SAMPLE FOR EACH 50 CUBIC YARDS PLACED	OWNER'S TESTING AGENCY	
CONCRETE	SLUMP	ASTM C143, C94	1705.3, 1904.1	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	
CONCRETE	AIR CONTENT	ASTM C231, C94	1705.3, 1904.1	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	
CONCRETE	TEMPERATURE	ASTM C1064	1705.3, 1904.1	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	
MASONRY						
CONCRETE MASONRY	UNIT STRENGTH	ASTM C140	1705.4, 2105.1	ONE SAMPLE SET (6 FULL SIZE UNITS) PER 5,000 SQ. FT. DURING CONSTRUCTION	APPROVED TESTING AGENCY	
MASONRY	COMPRESSIVE STRENGTH OF GROUT	ASTM C1019	1705.4, 2105.1	THREE SAMPLES PRIOR TO CONSTRUCTION	APPROVED TESTING AGENCY	
MASONRY	PRISM	ASTM C1314	1705.4, 2105.1	TEST THREE PRISMS PRIOR TO CONSTRUCTION	OWNER'S TESTING AGENCY	
STEEL						
STEEL STUD WELDING	PRE-PRODUCTION TESTING	AWS D1.1 Sec. 9.7.1	1705.2	PRIOR TO CONSTRUCTION FOR EACH SIZE AND TYPE AND FIRST 2 STUDS EACH SHIFT	CONTRACTOR'S WELDING INSPECTOR	
HIGH-STRENGTH BOLTING	PRE-INSTALLATION VERIFICATION TESTING OF PRETENSIONED BOLTS	RCSC SPECIFICATION FOR STRUCTURAL JOINTS USING HIGH STRENGTH BOLTS, Sec. 7	1705.2	3 FASTENER ASSEMBLIES OF EACH COMBINATION OF DIAMETER, LENGTH, GRADE AND LOT	OWNER'S TESTING AGENCY	

TABLE 4

REQUIRED SPECIAL INSPECTION FOR SEISMIC RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO TABLE 2 FOR STANDARD STRUCTURAL SPECIAL INSPECTION REQUIREMENTS
REFER TO SPECIFICATION SECTION 01 45 33

The Seismic Design Category (SDC) for this Project is 'D'.

SYSTEM	INSPECTION REQUIRED FOR FOLLOWING SEISMIC DESIGN CATEGORIES	2021 IBC CODE REFERENCE	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
ARCHITECTURAL						
INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED ARCHITECTURAL SYSTEMS AND THEIR COMPONENTS	"D" AND ABOVE	1705.13.5	X			SEE TABLE 6
ELECTRICAL						
INSTALLATION OF ANCHORAGE OF ELECTRICAL EQUIPMENT FOR EMERGENCY OR STANDBY POWER SYSTEMS	"C" AND ABOVE	1705.13.6 ITEM 1	X		NOTES 2 & 3	
INSTALLATION OF EQUIPMENT USING COMBUSTIBLE ENERGY SOURCES AND PIPING SYSTEMS PROVIDING SUPPLY	"C" AND ABOVE	1705.13.6 ITEM 3	X		NOTES 2 & 3	
INSTALLATION OF ANCHORAGE OF ALL OTHER ELECTRICAL EQUIPMENT	"E" AND ABOVE	1705.13.6 ITEM 2	X		NOTES 2 & 3	
INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED ELECTRICAL SYSTEMS AND THEIR COMPONENTS	"B" AND ABOVE	1705.14.2	X		NOTES 2 & 3	SEE TABLE 6
PROCESS MECHANICAL						
INSTALLATION OF PIPING SYSTEMS MEANT TO CARRY HAZARDOUS MATERIALS AND ITS ASSOCIATED MECHANICAL UNITS	"C" AND ABOVE	1705.13.6 ITEM 3	X			

TABLE 4

REQUIRED SPECIAL INSPECTION FOR SEISMIC RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO TABLE 2 FOR STANDARD STRUCTURAL SPECIAL INSPECTION REQUIREMENTS
REFER TO SPECIFICATION SECTION 01 45 33

INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED MECHANICAL SYSTEMS AND THEIR COMPONENTS	"B" AND ABOVE	1705.14.2	X		NOTES 2 & 3	SEE TABLE 6
BUILDING MECHANICAL AND PLUMBING						
INSTALLATION OF PIPING SYSTEMS MEANT TO CARRY HAZARDOUS MATERIALS AND ITS ASSOCIATED MECHANICAL UNITS	"C" AND ABOVE	1705.13.6 ITEM 3	X			
INSTALLATION AND ANCHORAGE OF HVAC DUCTWORK THAT WILL CONTAIN HAZARDOUS MATERIALS	"C" AND ABOVE	1705.13.6 ITEM 4	X			
INSTALLATION OF VIBRATION ISOLATION SYSTEMS WHERE THE CONSTRUCTION DOCUMENTS REQUIRE A NOMINAL CLEARANCE OF 0.25 INCHES OR LESS BETWEEN THE EQUIPMENT SUPPORT FRAME AND RESTRAINT	"C" AND ABOVE	1705.13.6 ITEM 5	X		NOTES 2 & 3	
INSTALLATION OF FIRE PROTECTION SPRINKLER SYSTEM	"C" AND ABOVE	1705.13.6 ITEM 6	X		NOTE 5	
INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED MECHANICAL SYSTEMS AND THEIR COMPONENTS	"B" AND ABOVE	1705.14.2	X		NOTES 2 & 3	SEE TABLE 6
STRUCTURAL						
INSPECTION OF STRUCTURAL STEEL ELEMENTS INCLUDING STRUTS, COLLECTORS, CHORDS AND FOUNDATION ELEMENTS	"B" AND ABOVE	1705.13.1.2, AISC 341		X		SEE TABLE 6 FOR STRUCTURAL STEEL TESTING

TABLE 4

REQUIRED SPECIAL INSPECTION FOR SEISMIC RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO TABLE 2 FOR STANDARD STRUCTURAL SPECIAL INSPECTION REQUIREMENTS
REFER TO SPECIFICATION SECTION 01 45 33

INSPECT AND VERIFY THAT THE DESIGNATED SEISMIC SYSTEM COMPONENTS ARE LABELED AND ANCHORAGE OR MOUNTING CONFORMS TO THE CERTIFICATE OF COMPLIANCE	"C" AND ABOVE	1705.13.4	X			

NOTES:
1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING THE INSPECTED WORK
2. TESTING OF SYSTEMS AND THEIR ANCHORAGE SHALL BE IN CONFORMANCE WITH 2021 IBC SECTION 1705.14.2.
3. CERTIFICATION OF SYSTEMS AND THEIR ANCHORAGE SHALL BE IN CONFORMANCE WITH 2021 IBC SECTION 1705.14.3.
4. NOT REQUIRED IF SHEATHING IS GYPSUM BOARD OR FIBERBOARD OR IF SHEATHING IS WOOD STRUCTURAL PANEL OR STEEL SHEETS ON ONE SIDE OF PANEL OR DIAPHRAGM ONLY AND THE FASTENER SPACING IS MORE THAN 4 INCHES.
5. SPECIAL INSPECTOR TO VERIFY THAT CLEARANCES AROUND AUTOMATIC FIRE SPRINKLER SYSTEMS ARE SUFFICIENT SUCH THAT FAILURE OF AN ARCHITECTURAL, MECHANICAL, OR ELECTRICAL COMPONENT WILL NOT CAUSE FAILURE OF THE SPRINKLER SYSTEM AND THAT CLEARANCES ARE NOT LESS THAN 3 INCHES, INCLUDING TO STRUCTURAL MEMBERS NOT SUPPORTING THE SYSTEM. NOT REQUIRED WHERE FLEXIBLE SPRINKLER HOSE FITTINGS ARE USED.

TABLE 5

REQUIRED SPECIAL INSPECTION FOR WIND RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO SPECIFICATION SECTION 01 45 33

The Basic Wind Speed (3-second-gust) for this Project is 119 mph.
The Wind Exposure is Category C.

NOT REQUIRED

TABLE 6
TESTING FOR SEISMIC RESISTANCE
REFER TO SPECIFICATION SECTION 01 45 33

MATERIAL	TYPE OR SCOPE	STANDARD	2021 IBC CODE REFERENCE	FREQUENCY	BY WHOM	COMMENTS
OTHER						
NONSTRUCTURAL COMPONENTS (AND ASSOCIATED ANCHORAGES) SUBJECT TO CERTIFICATION PROVISIONS OF ASCE 7 SECTION 13.2.1	CERTIFICATE OF COMPLIANCE	ASCE 7 SECTION 13.2.1	1705.14.2	EACH SYSTEM OR COMPONENT	MANUFACTURER	NOTE 2
DESIGNATED SEISMIC SYSTEM COMPONENTS (AND ASSOCIATED ANCHORAGES) SUBJECT TO PROVISIONS OF ASCE 7 SECTION 13.2.2	CERTIFICATE OF COMPLIANCE	ASCE 7 SECTION 13.2.2	1705.14.3	EACH SYSTEM OR COMPONENT	MANUFACTURER	NOTE 2
SEISMICALLY ISOLATED STRUCTURES	NONDESTRUCTIVE TESTING	ASCE 7 SECTION 17.8	1705.14.4	CONTINUOUS	MANUFACTURER	

NOTES:
1. TESTING AND QUALIFICATION FOR SEISMIC RESISTANCE ARE REQUIRED FOR SEISMIC-FORCE-RESISTING SYSTEMS IN STRUCTURES ASSIGNED TO SEISMIC DESIGN CATEGORY B, C, D, E, OR F,UNLESS OTHERWISE NOTED.
2. BASED ON ACTUAL TEST ON SHAKE TABLE, BY AN ANALYTICAL METHOD USING DYNAMIC CHARACTARISTICS AND FORCES, BY THE USE OF EXPERIENCE DATA, OR BY MORE RIGOROUS ANALYSIS PROVIDING FOR EQUIVALENT SAFETY.

SECTION 01 45 36
EQUIPMENT SEISMIC CERTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. This section covers the code required seismic certification of mechanical and electrical equipment in accordance with 2021 IBC, Chapter 17.

1.02 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 344, Standard for Seismic Qualification of Equipment for Nuclear Power Generating Stations.
   b. 693, Recommended Practice for Seismic Design of Substations.
3. International Code Council (ICC):
   a. International Building Code (IBC).
   b. Evaluation Service (ICC-ES) Reports and Legacy Reports.
4. National Fire Protection Association (NFPA): 13, Standard for the Installation of Sprinkler Systems.

1.03 DEFINITIONS

A. Agencies and Personnel:

1. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.

B. Component Supports:

1. Electrical: Structural members or assemblies which transmit loads and forces from electrical equipment to the structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.
2. Mechanical: Structural members or assemblies which transmit loads and forces from mechanical equipment to the structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

1.04 SUBMITTALS

A. Informational Submittals:

1. Seismic Qualification of Mechanical and Electrical Equipment Certification of Compliance: Submit for mechanical and electrical components having a component importance factor of 1.5 as designated herein. Submit for other components having component importance factor of 1.0 where test results are submitted as an alternate to required calculations under 13.2.5 of ASCE 7-16. Refer to Article Supplements located at end of section.
2. If required by Engineer, submit documentation of testing results or analytical data.

1.05 STATEMENT OF SPECIAL INSPECTIONS (PLAN) REQUIREMENTS

A. Complete special inspection and testing in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.

B. Architectural, mechanical, and electrical components subject to special inspection and testing under IBC Section 1705.13 for seismic resistance, as listed in table in Article Mechanical and Electrical Component Certification are in addition to requirements of Section 01 45 33, Special Inspection, Observation, and Testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MECHANICAL AND ELECTRICAL COMPONENT CERTIFICATION

A. Provide certificate of compliance for mechanical and electrical component testing and certification on form located at end of section. Provide certificates for equipment and components listed in the following table:

Mechanical and Electrical Components Requiring Certification of Compliance for Seismic Testing or Analysis under IBC Section 1705.14.2			
Facility	**Component**	**Component Importance Factor, I_p**	**Component to Remain Operable?**
35–Electrical Site Work	Standby Engine Generators	1.5	Yes
35–Electrical Site Work	Switchgear	1.5	Yes

Mechanical and Electrical Components Requiring Certification of Compliance for Seismic Testing or Analysis under IBC Section 1705.14.2			
Facility	**Component**	**Component Importance Factor, I_p**	**Component to Remain Operable?**
35–Electrical Site Work	MCC's/ Motor Starter Panels	1.5	Yes
35–Finished Water Pump Station	Finished Water Pumps	1.5	Yes
25 – Air Stripping Towers	Air Stripping Towers	1.5	Yes

B. Certify mechanical and electrical components listed in table above on basis of tests on a shaking table, by three-dimensional shock tests, by an analytical method using dynamic characteristics, and forces as provided in Section 01 88 15, Anchorage and Bracing, experience data demonstrating acceptable seismic performance, or by more rigorous analysis. Submitted testing and experience data shall meet requirements of ASCE 7 -16 Section 13.2.5 and Section 13.2.6, respectively.

C. Component and attachment testing and certification shall be in accordance with applicable provisions of IBC Section 1705.14.2. Seismic testing and certification is in addition to functional and performance testing required for new equipment for field quality control or start-up testing as indicated in technical specification.

D. Where equipment is required to remain operable following the design earthquake ground motion, active parts or energized components shall be certified on basis of approved shake table testing or experience only unless demonstrably similar to other equipment so qualified.

E. Components with hazardous contents shall be certified to contain materials under the design earthquake.

3.02 SUPPLEMENTS

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

1. Seismic Qualification of Mechanical and Electrical Equipment Certificate of Compliance.

END OF SECTION

SEISMIC QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT CERTIFICATE OF COMPLIANCE

(Component under Certification)	(Name of Manufacturer)
(Tag Number or Equipment ID)	(Business Address)
(Drawing/Detail Number)	(_____)_____ (Telephone)

This is to certify that above-referenced component meets or exceeds requirements of Section **1705.14.2** of **2021** IBC for seismic qualification of equipment. Basis of qualification is by:

(Check Applicable)

☐ Shake-table Test

☐ Three-dimensional Shock Test

☐ Analytical Method

Qualification shall be based on the modified forces of Section 13.2.2 of ASCE 7-16.

☐ Experience Data

☐ Other _____

under acceptance criteria of:

☐ ICC-ES AC156, Acceptance Criteria for Seismic Qualification by Shake-table Testing of Nonstructural Components

☐ IEEE 693, IEEE Recommended Practice for Seismic Design of Substations

☐ IEEE 344, IEEE Standard for Seismic Qualification of Equipment for Nuclear Power Generating Stations for experience data

☐ ASCE 7 -16 Chapter 13 for analytical methods

☐ Other _____

for the following earthquake hazard rating:

IEEE Seismic Qualification Level:_____

Mapped MCE, 5 Percent Damped, Short Period Spectral Response Acceleration, S_S:_____

Design, 5 Percent Damped, Short Period Spectral Response Acceleration, S_{DS}:_____

Component Importance Factor, I_p:_____

Component Response Modification Factor, R_p:_____

Height of Point of Attachment as Factor of Average Roof Height, z/h:_____

This certification covers both the integrity of the equipment and anchorage of equipment. Required mounting and anchorage details are shown on attached Seismic Outline Drawing for the most seismically vulnerable component covered by this certification.

Manufacturer's Representative Signature: _____

Address: _____

Date: _____

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 REFERENCES

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

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

1.02 SUBMITTALS

A. Informational Submittals: Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.

1.03 MOBILIZATION

A. Mobilization includes, but is not limited to, these principal items:

1. Obtaining required permits.
2. Moving Contractor’s field office and equipment required for first month operations onto Site.
3. Installing temporary construction power, wiring, and lighting facilities.
4. Providing onsite Internet service.
5. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
6. Arranging for and erection of Contractor’s work and storage yard.
7. Posting OSHA required notices and establishing safety programs and procedures.
8. Having Contractor’s superintendent at Site full time.

1.04 PROTECTION OF WORK AND PROPERTY

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

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

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

A. Power:

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

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

C. Heating, Cooling, and Ventilating:

1. Provide as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for installation of materials, and to protect materials, equipment, and finished from damage because of temperature or humidity.
2. Provide adequate forced air ventilation of enclosed areas to cure installed materials, to dispense humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
3. Pay costs of installation, maintenance, operation, removal, and fuel consumed.
4. Provide portable unit heaters, complete with controls, oil- or gas-fired, and suitably vented to outside as required for protection of health and property.
5. If permanent natural gas piping is used for temporary heating units, do not modify or reroute gas piping without approval of utility company. Provide separate gas metering as required by utility.

D. Water:

1. Owner will provide a place of temporary connection for construction and drinking water at Site. Provide temporary facilities and piping required to bring water to point of use and remove when no longer needed. Install an acceptable metering device and pay for water used at Owner's current rate.
2. Owner will furnish construction and drinking water required at no cost to Contractor on Site. Furnish and install temporary piping and facilities to transport water to the Work.
3. Provide and bear costs of necessary water required for testing equipment, tanks or basins, and piping prior to Substantial Completion, unless otherwise specifically stated in Specifications for equipment, systems, or facilities to be tested.
4. Provide means to prevent water used for testing from flowing back into source pipeline.

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

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

3.02 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
3. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate activities with owner of said utility and perform work to their satisfaction.
4. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.

5. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
6. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
7. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance: Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
8. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
9. Maintain original Site drainage wherever possible.

B. Site Security: Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.

C. Barricades and Lights:

1. Provide as necessary to prevent unauthorized entry to construction areas and affected roads, streets, and alleyways, inside and outside of fenced area, and as required to ensure public safety and the safety of Contractor's employees, other employer's employees, and others who may be affected by the Work.
2. Provide to protect existing facilities and adjacent properties from potential damage.
3. Locate to enable access by facility operators and property owners.
4. Protect streets, roads, highways, and other public thoroughfares that are closed to traffic by effective barricades with acceptable warning signs.
5. Locate barricades at the nearest intersecting public thoroughfare on each side of blocked section.
6. Illuminate barricades and obstructions with warning lights from sunset to sunrise.

D. Trees and Plantings:

1. Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on Drawings to remain undisturbed.
    a. Where practical, tunnel beneath trees when on or near line of trench.
    b. Employ hand excavation as necessary to prevent tree injury.
    c. Do not stockpile materials or permit traffic within drip lines of trees.
    d. Provide and maintain temporary barricades around trees.
    e. Water vegetation as necessary to maintain health.
    f. Cover temporarily exposed roots with wet burlap, and keep burlap moist until soil is replaced around roots.
    g. No trees, except those specifically shown on Drawings to be removed, shall be removed without written approval of Engineer.
    h. Dispose of removed trees in a legal manner off the Site.
2. Balling and burlapping of trees indicated for replacement shall conform to recommended specifications set forth in the American Standards for Nursery Stock, published by American Nursery and Landscape Association. Balls shall be firm and intact and made balls will not be accepted. Handle ball and burlap trees by ball and not by top.
3. In event of damage to bark, trunks, limbs, or roots of plants that are not designated for removal, treat damage by corrective pruning, bark tracing, application of a heavy coating of tree paint, and other accepted horticultural and tree surgery practices.
4. Replace each plant that dies as a result of construction activities.

E. Existing Structures:

1. Where Contractor contemplates removal of small structures such as signposts and culverts that interfere with Contractor’s operations, obtain approval of Engineer.
2. Replace items removed in their original location and a condition equal to or better than original.

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

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

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

I. Endangered and Threatened Species:

1. Take precautions necessary and prudent to protect native endangered and threatened flora and fauna.
2. Notify Engineer of construction activities that might threaten endangered and threatened species or their habitats.
3. Engineer will mark areas known as habitats of endangered and threatened species prior to commencement of onsite activities.
4. Additional areas will be marked by Engineer as other habitats of endangered and threatened species become known during construction.
5. The Pygmy Sculpin are considered a threatened species and are inhabitants of the Coldwater Spring located on the project site. Special care should be taken to prevent disturbance of the habitat.

3.03 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning: Of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.

B. Noise Control:

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

C. Water Pollution Control:

1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain Engineer's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and dewater pump discharges.
3. Comply with Section 01 57 13, Temporary Erosion and Sedimentation Control, for stormwater flow and surface runoff.
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

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

3.04 STORAGE YARDS AND BUILDINGS

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

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

C. Temporary Storage Buildings:

1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standard.

3.05 PARKING AREAS

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

B. Provide parking facilities for personnel working on Project. No employee or equipment parking will be permitted on Owner's existing paved areas.

3.06 VEHICULAR TRAFFIC

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

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

C. Maintenance of traffic is not required if Contractor obtains written permission from Owner. In making street crossings, do not block more than one-half the street at a time. Whenever possible, widen shoulder on opposite side to facilitate traffic flow. Provide temporary surfacing on shoulders as necessary.

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

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

3.07 CLEANING DURING CONSTRUCTION

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

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

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

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

END OF SECTION

SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This section covers Work to implement structural and nonstructural Best Management Practices (BMP) to control soil erosion by wind or water and keep eroded sediments and other construction-generated pollutants from moving off project sites. Requirements described in this specification and shown on the Drawings are part of the project Temporary Erosion and Sediment Control Plan (TESC Plan) and are the minimum for all project construction sites and conditions. This specification covers all project activities, including material sources, disposal sites, and offsite mitigation areas unless specific project activities are excluded elsewhere in this specification or in other Contract Documents controlling the Work.

B. National Pollutant Discharge Elimination System: Comply with Federal, State, and Local laws, rules and regulations, and the National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Discharge Permit or Permits applicable to the project. NPDES General Construction permits are required on projects that involve disturbance of 1 acre or more with potential to discharge stormwater to surface waters. This project involves disturbance of >1 acre. If an NPDES General Construction permit is to be required, Contractor is responsible for obtaining the permit. A copy of the Project's General Construction Permit, if applicable to the project, is available from Owner.

C. Other Regulations: A local government erosion and sediment control permit may apply and some local agency requirements may be more stringent than this specification. Adequate erosion and sediment control is essential for complying with the federal Endangered Species Act where construction runoff enters waters inhabited by protected species.

1.02 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.

2. ASTM International (ASTM):
    a. D638, Standard Test Method for Tensile Properties of Plastics.
    b. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
    c. D3776/D3776M, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
    d. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
    e. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
    f. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
    g. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
    h. D4632/D4632M, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
    i. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
    j. D6241, Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
    k. D6459, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion.
    l. D6460, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion.
    m. D6475, Standard Test Method for Measuring Mass Per Unit Area of Erosion Control Blankets.
    n. D7322, Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Ability to Encourage Seed Germination and Plant Growth Under Bench-Scale Conditions.
    o. D7367, Standard Test Method for Determining Water Holding Capacity of Fiber Mulches for Hydraulic Planting.
3. National Weather Service:
    a. Precipitation-Frequency of the United States by State/Territory, 2012.
    b. Precipitation Frequency Data Server, 2012.
4. North American Weed Management Association (NAWMA).
5. U.S. Department of Agriculture, Natural Resources Conservation Service: *Urban Hydrology for Small Watersheds*; 1986. Technical Release 55.

6. U.S. Environmental Protection Agency:
   a. Developing Your Stormwater Pollution Prevention Plan: A Guide for Construction Sites, 2007. EPA-833-R-06-004.
   b. National Menu of BMPs, 2012.
7. The sections of the standards referenced above which apply to this Project include, but are not limited to:

Specification or Detail No.	Symbol	Title
3125-187	CD	Check Dam
3125-165	SF	Silt (Sediment) Fence
3125-160	W	Wattles

1.03 SYSTEM DESCRIPTION

A. Erosion and Sediment Control:

1. Provide, maintain, and operate temporary facilities to control erosion and sediment releases during construction period.
2. Design erosion and sediment controls to handle peak runoff resulting from 25-year, 24-hour storm event based on National Weather Service: Precipitation Frequency Data Server.
3. Size temporary stormwater conveyances based on procedures presented in U.S. Department of Agriculture, Natural Resources Conservation Service: Urban Hydrology for Small Watersheds, 1986. Technical Release 55**.**

B. Erosion and Sediment Control (ESC) Lead:

1. Identify the ESC Lead at the preconstruction discussions and in the TESC Plan. The ESC Lead shall have certification in construction site erosion and sediment control from a course approved by Owner.
2. The ESC Lead shall implement the TESC Plan, including, but not limited to:
   a. Installing and maintaining all temporary erosion and sediment control Best Management Practices (BMPs) included in the TESC Plan to assure continued performance of their intended function. Damaged or inadequate TESC BMPs shall be corrected immediately.
   b. Updating TESC Plan to reflect current field conditions.
   c. Terminating TESC Plan.

3. When a TESC Plan is included in the Contract Plans, ESC Lead shall also inspect all areas disturbed by construction activities, all onsite erosion and sediment control BMPs, all stormwater discharge points, and all temporarily stabilized inactive sites per schedule in the Construction Stormwater Discharge Permit(s) or as directed by Engineer. Complete erosion and sediment control inspection form provided by water resource agency or Owner for each inspection and submit a copy to Engineer no later than end of the next working day following inspection.

C. Personnel Training: Prior to commencement of construction, applicable personnel must have an understanding of the Construction Stormwater Discharge Permit's requirements and their specific responsibilities under the permit. At a minimum, personnel must be trained to understand the following as it relates to the scope of their job duties:

1. The location of all stormwater controls and how to maintain them.
2. Procedures for complying with the pollution prevention requirements.
3. Procedures for conducting inspections, recording findings, and taking corrective action.

D. Temporary Erosion and Sediment Control Plan (Stormwater Pollution Prevention Plan):

1. A TESC Plan is furnished as part of the Drawings, which helps fulfill part of the plan requirement of the NPDES Permit. This initial TESC Plan, when adopted by Contractor, may be used as the basis of the construction TESC Plan. Additional or revised erosion and sediment control features, not shown on the initial TESC Plan, may be required depending on Contractor's methods of operation and schedule.
2. For each phase of the scheduled work, indicate on the TESC Plan all the BMPs proposed and installed for erosion and sediment control to minimize clearing, stabilize exposed soil, divert or temporarily store flows, limit runoff from exposed areas, and filter transported sediment. Include all temporary slopes, constructed for staging or other reasons, which may not have been identified in the original Contract plans. Refer to the current local jurisdiction's erosion and sediment control manual.
3. Some TESC Plan required elements typically required by NPDES permits:
    a. Narrative Site Description:
        1) Nature of construction activity planned for the Site.
        2) Estimates of total site area and the areas of the Site expected to be disturbed.

3) Soil types found onsite and their erosion potential.
4) The types of fill materials to be used.
5) Timetable for sequence of major construction events.

b. Site Map:
1) All areas of development.
2) Drainage patterns.
3) Areas of soil disturbance, including pre-development and post-development elevation contours.
4) Areas used for storage of soils or wastes.
5) Areas where vegetative practices are to be implemented.
6) Location of all erosion and sediment control BMP or structures.
7) Location of all impervious structures and surfaces after project is completed.
8) Springs, wetlands, and other surface waters located onsite.
9) Boundaries of the 100-year floodplain, if determined.
10) Ordinary High Water line, if determined.
11) Location of storm drainage outfalls to receiving waters, if applicable.
12) Details of sediment and erosion controls.
13) Details of detention ponds, storm drain piping, inflow and outflow details.

c. Required BMPs and Procedures for Erosion Prevention, Runoff Control, and Sediment Control:
1) Construction entrances and parking areas.
2) Unpaved site roads such as haul roads.
3) Hauling saturated soils from the Site.
4) Water washed from concrete trucks.
5) Correct installation of erosion and sediment control BMPs.
6) Prompt maintenance and repair of BMPs.
7) Clearing and grading practices to minimize area of exposed soil throughout life of the Project.
8) Schedule of phased clearing operations to limit soils to what can be stabilized.
9) Vegetative practices, including preservation of existing vegetation, seeding, mulching, and buffer strips.
10) Preventing erosion of exposed areas.
11) Diverting flows from exposed slopes.
12) Limiting runoff from exposed areas.
13) Limiting sediment transport within work sites and keeping it from moving off of project areas.
14) Perimeter controls for all clearing and grubbing, both planned and installed.

15) Additional controls for wet season work and temporary work suspensions.
16) Sensitive areas such as wetlands.
17) Offsite material source and waste areas.
18) Dust.
19) Emergency materials stockpiled onsite.
20) Storing flows and filtering sediment.
21) Soil stockpiles.

4. Contractor's construction TESC Plan and implementation schedules must be prepared by a competent individual. Furnish a signed copy of the TESC Plan with individual's name, title, state certifications, and employing firm if different than Contractor's firm.
5. Do not begin any Site activities that have potential to cause erosion or sediment movement until the TESC Plan and implementation schedules are approved by Engineer.
6. Keep a copy of the approved TESC Plan with updated changes onsite during all construction activities. During inactive periods longer than 7 calendar days, keep the TESC Plan onsite or provide a copy to Engineer to retain.
7. Continually update the TESC Plan and schedules as needed for unexpected storm or other events to ensure that sediment-laden water does not leave the construction site. Add approved changes to the TESC Plan no later than 24 hours after implementation.

E. Preventing erosion, and controlling runoff, sedimentation, and non-stormwater pollution, requires Contractor to perform temporary Work items including, but not limited to:

1. Providing ditches, berms, culverts, and other measures to control surface water.
2. Building dams, settling basins, energy dissipaters, and other measures, to control downstream flows.
3. Controlling underground water found during construction.
4. Covering or otherwise protecting slopes until permanent erosion control measures are working.

F. To the degree possible, coordinate this temporary Work with permanent drainage and erosion control work the Contract requires.

G. Engineer may require additional temporary control measures if it appears pollution or erosion may result from weather, nature of materials, or progress on the Work.

H. When natural elements rut or erode the slope, restore and repair damage with eroded material where possible, and remove and dispose of any remaining material found in ditches and culverts. When Engineer orders replacement with additional or other materials, unit Contract prices will cover quantities needed.

I. Install all sediment control devices including, but not limited to, sediment ponds, perimeter silt fencing, or other sediment trapping BMPs prior to any ground disturbing activity. Do not expose more erodible earth than necessary during clearing, grubbing, excavation, borrow, or fill activities without written approval by Engineer. Engineer may increase or decrease the limits based on project conditions. Erodible earth is defined as any surface where soils, grindings, or other materials may be capable of being displaced and transported by rain, wind, or surface water runoff. Cover inactive areas of erodible earth, whether at final grade or not, within specified time period (see NPDES Erosion and Sediment Control Permit), using an approved soil covering practice. Phase clearing and grading to maximum extent practical to prevent exposed inactive areas from becoming a source of erosion.

J. Water Management:

1. Manage site water in accordance with the conditions of the waste discharge permit from a local permitting authority. If site water management is not subject to permit, manage as follows:
    a. Groundwater: When groundwater is encountered in an exaction, treat and discharge as follows:
        1) When groundwater conforms to jurisdiction Water Quality Standards, it may bypass detention and treatment facilities and be routed directly to its normal discharge point at a rate and method that will not cause erosion.
        2) When turbidity of groundwater is similar to turbidity of side runoff, groundwater may be treated using same detention and treatment facilities being used to treat the site runoff and then discharged at a rate that will not cause erosion.
        3) When groundwater turbidity is greater than turbidity of site runoff, treat groundwater separately until turbidity is similar to or better than site runoff, and then it may be combined with site runoff and treated as described above.

b. Process Water:
   1) Do not discharge high pH process water or wastewater (non-stormwater) that is generated onsite, including water generated during concrete grinding, rubblizing, washout, and hydrodemolition activities, to waters of the jurisdiction, including wetlands. Water may be infiltrated upon approval of Engineer. Offsite disposal of concrete process water is subject to approval of Engineer.
   2) Treat all water generated onsite from construction or washing activities that is more turbid than site runoff separately until turbidity is the same or less than site runoff, and then it may be combined with site runoff and treated as described above. Water may be infiltrated upon approval of Engineer.

c. Offsite Water: Prior to disruption of normal watercourse, intercept offsite stormwater and pipe it either through or around the Project Site. This water shall not be combined with onsite stormwater. Discharge offsite water at its preconstruction outfall point preventing an increase in erosion below the site. Submit proposed method for performing this Work for Engineer's approval.

K. Dispersion/Infiltration: Convey water only to dispersion or infiltration areas designated in the TESC Plan or to sites approved by Engineer. Water shall be conveyed to designated dispersion areas at a rate such that, when runoff leaves the area and enters waters of the jurisdiction, turbidity standards are achieved. Convey water to designated infiltration areas at a rate that does not produce surface runoff.

L. Detention/Retention Pond Construction: Whether permanent or temporary, construct before beginning other grading and excavation Work in the area that drains into that pond. Install temporary conveyances concurrently with grading in accordance with the TESC Plan so that newly graded areas drain to the pond as they are exposed.

M. Pollution Control: Use BMPs to prevent or minimize stormwater exposure to pollutants from spills; vehicle and equipment fueling, maintenance, and storage; other cleaning and maintenance activities; and waste handling activities. These pollutants include fuel, hydraulic fluid, and other oils from vehicles and machinery, as well as debris, leftover paints, solvents, and glues from construction operations. Implement the following BMPs when applicable:

1. Written spill prevention and response procedures.
2. Employee training on spill prevention and proper disposal procedures.
3. Spill kits in all vehicles.
4. Regular maintenance schedule for vehicles and machinery.
5. Material delivery and storage controls.
6. Training and signage.
7. Covered storage areas for waste and supplies.

N. If Engineer orders the Work suspended, continue to control erosion, pollution, and runoff during the shutdown.

O. Nothing in this section shall relieve Contractor from complying with other Contract requirements.

1.04 SUBMITTALS

A. Informational Submittals:

1. When a TESC Plan is included in the Drawings, either adopt or modify the TESC Plan. Provide a schedule for TESC Plan implementation and incorporate it into Contractor’s progress schedule. Obtain Engineer’s approval of the TESC Plan and schedule before any Work begins.
2. Modified TESC Plans shall meet all requirements of the applicable jurisdictions.
3. The TESC Plan shall cover all areas that may be affected inside and outside the limits of the Project (including all Owner-provided sources, disposal sites, and haul roads, and all nearby land, streams, and other bodies of water).
4. Allow at least 5 working days for Engineer to review any original or revised TESC Plan. Failure to approve all or part of any such Plan shall not make Owner liable to Contractor for any Work delays.

PART 2 PRODUCTS

2.01 CHECK DAMS

A. Specified by Contractor with approval of Engineer.

2.02 COIR LOG

A. Logs made of 100 percent durable coconut (coir) fiber uniformly compacted within woven netting.

B. Netting: Made of bristle coir twine with minimum strength of 80 pounds tensile strength. Nominal 2-inch by 2-inch openings.

C. Log Segments: Maximum length of 20 feet, with a minimum diameter as shown on the Drawings.

D. Log Minimum Density: 7 lbs/cf.

E. Stakes: Untreated softwood species with a notch to secure rope ties.

F. Rope Ties: 1/4-inch diameter commercially available hemp rope.

2.03 EROSION CONTROL BLANKET (MATTING), BIODEGRADABLE

A. Temporary erosion control blanket shall be made of natural plant fibers. Supply independent test results meeting the following:

Properties	ASTM Test Method	Requirements
Protecting Slopes from Rainfall-Induced Erosion	D6459: Test in one soil type. Soil tested shall be sandy loam as defined by the NRCS Soil Texture Triangle.	Maximum C factor of 0.15 using Revised Universal Soil Loss Equation (RUSLE)
Dry Weight per Unit Area	D6475	0.36 lb/sq. yd. minimum
Performance in Protecting Earthen Channels from Stormwater-Induced Erosion	D6460: Test in one soil type. Soil tested shall be loam as defined by the NRCS Soil Texture Triangle.	1.0 lb/sq. ft. minimum
Seed Germination Enhancement	D7322	200 percent minimum
Netting, if present, shall be biodegradable with a life span not to exceed 1 year.		

B. For permanent erosion control blanket, see Section 31 32 00, Soil Stabilization.

2.04 GEOTEXTILE

A. Geotextiles shall consist only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. Geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. Geotextile properties shall be as described in Table 1 through Table 3.

Table 1
Geotextile for Permanent Erosion Control

Geotextile Property	ASTM Test Method	Geotextile Property Requirements					
		Permanent Erosion Control				Ditch Lining	
		Moderate Survivability		High Survivability			
		Woven	Nonwoven	Woven	Nonwoven	Woven	Nonwoven
AOS	D4751	See Table 2		See Table 2		U.S. No. 30 max.	
Water Permittivity	D4491	See Table 2		See Table 2		0.02 sec^{-1} min.	
Grab Tensile Strength, in machine and x-machine direction	D4632/ D4632M	250 lb min.	160 1b min.	315 lb min.	200 lb min.	250 lb min.	160 lb min.
Grab Failure Strain, in machine and x-machine direction	D4632/ D4632M	15% -50%	≥50%	15% -50%	≥50%	<50%	≥50%
Seam Breaking Strength	D4632/ D4632M	220 lb min.	140 lb min.	270 lb min.	180 lb min.	220 lb min.	140 lb min.
Puncture Resistance	D6241	495 lb min.	310 lb min.	620 lb min.	430 lb min.	495 lb min.	310 lb min.
Tear Strength, in machine and x-machine direction	D4533	80 lb min.	50 lb min.	112 lb min.	79 lb min.	80 lb min.	50 lb min.
Ultraviolet (UV) Radiation Stability	D4355	70% strength retained min., after 500 hours in xenon arc device					

Table 2 Filtration Properties for Geotextile for Permanent Erosion Control				
Geotextile Property	**ASTM Test Method**	**Geotextile Property Requirements**		
		Class A	**Class B**	**Class C**
AOS	D4751	U.S. No. 40 max.	U.S. No. 60 max.	U.S. No. 70 max.
Water Permittivity	D4491	0.7 sec^{-1} min.	0.4 sec^{-1} min.	0.2 sec^{-1} min.

Table 3 Geotextile for Temporary Silt Fence				
Geotextile Property	**ASTM Test Method**	**Geotextile Property Requirements**		
		Unsupported Between Posts		**Supported Between Posts with Wire or Polymeric Mesh**
AOS	D4751	U.S. No. 40 max.	U.S. No. 60 max.	U.S. No. 70 max.
Water Permittivity	D4491	0.2 sec-1 min.		
Grab Tensile Strength, in machine and x-machine direction	D4632/ D4632M	180 lb. min. in machine direction, 100 lb. min. in x-machine direction		100 lb .min.
Grab Failure Strain, in machine and x-machine direction	D4632/ D4632M	30% max. at 180 lb. or more		
Ultraviolet (UV) Radiation Stability	D4355	70% strength retained min., after 500 hours in xenon arc device		

2.05 INLET PROTECTION

A. As specified under Article Geotextile.

2.06 MULCH

A. Short-Term: Provide independent test results documenting that the mulch meets the requirements in Table 4, Short-Term Mulch Test Requirements.

Table 4
Short-Term Mulch Test Requirements

Properties	Test Method	Requirements
Performance in Protecting Slopes from Rainfall-Induced Erosion.	ASTM D6459. Test in one soil type. Soil tested shall be sandy loam as defined by the National Resources Conservation Service (NRCS) Soil Texture Triangle.	C Factor = 0.15 maximum using Revised Universal Soil Loss Equation (RUSLE)

B. Moderate-Term: Within 48 hours of application, the Moderate-Term Mulch shall bond with soil surface to create a continuous, absorbent, flexible, erosion-resistant blanket that allows for seed germination and plant growth and conforms to the requirements in Table 5, Moderate-Term Mulch Test Requirements. Provide test results documenting that the mulch meets the requirements in Table 5, Moderate-Term Mulch Test Requirements. Supply independent test results.

Table 5
Moderate-Term Mulch Test Requirements

Properties	Test Method	Requirements
Performance in Protecting Slopes from Rainfall-Induced Erosion.	ASTM D6459. Test in one soil type. Soil tested shall be sandy loam as defined by the NRCS Soil Texture Triangle.	C Factor = 0.05 maximum using Revised Universal Soil Loss Equation (RUSLE)

C. Long-Term:

1. Provide Long-Term Mulch with demonstrated ability:
   a. To adhere to soil and create a blanket-like mass within 2 hours of application.
   b. To bond with the soil surface to create a continuous, porous, absorbent, and flexible erosion-resistant blanket that allows for seed germination and plant growth.
   c. To conform to the requirements in Table 6, Long-Term Mulch Test Requirements.

d. Provide test results documenting that mulch meets requirements in Table 6, Long-Term Mulch Test Requirements. Supply independent test results.

Table 6
Long-Term Mulch Test Requirements

Properties	Test Method	Requirements
Performance in Protecting Slopes from Rainfall-Induced Erosion.	ASTM D6459. Test in one soil type. Soil tested shall be sandy loam as defined by the NRCS Soil Texture Triangle.	C Factor = 0.01 maximum using Revised Universal Soil Loss Equation (RUSLE)

2.07 OUTLET PROTECTION

A. Size riprap or quarry spall to resist movement under design flows. Install at least 8 inches deep. Provide riprap or quarry spall material free of extraneous material.

2.08 SEDIMENT CONTROL BARRIERS

A. Specified by Contractor with approval of Engineer. May include Compost Filter Sock or Compost Filter Berm.

2.09 SEEDING

A. See Section 32 92 00, Turf and Grasses.

2.10 SILT (SEDIMENT) FENCE

A. Geotextile: As specified in Article Geotextile.

B. Reinforcing: Welded wire fabric, 14-guage minimum with 2-inch by 4-inch mesh.

C. Support Posts: As recommended by manufacturer of geotextile.

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

2.11 STABILIZED CONSTRUCTION ENTRANCE

A. Construct a pad from stone 3 inches to 6 inches in size, placed at least 8 inches deep and not less than 50 feet long.

B. Provide aggregate free of extraneous materials that may cause or contribute to track out.

C. Place separation geotextile under the rock to prevent fine sediment from pumping up into the rock pad. See Article Geotextile for required geotextile properties.

D. Use of constructed or constructed/manufactured steel plates with ribs (such as, shaker/rumble plates or corrugated steel plates) for entrance/exit access is allowable.

2.12 STRAW BALE BARRIER

A. Straw:

1. Air dried condition free of noxious weeds, seeds, and other materials detrimental to plant life. Hay is not acceptable. Provide weed-free documentation:
   a. Certified Weed Free Straw using North American Weed Management Association (NAWMA) standards.
   b. Provide documentation that material is steam or heat treated to kill seeds.
   c. Provide U.S. or state’s Department of Agriculture laboratory test reports, dated within 90 days prior to date of application, showing there are no viable seeds in the straw.

B. Straw Mulch: Suitable for spreading with mulch blower equipment.

C. Posts for Straw Bales: 2-inch by 2-inch untreated wood or commercially manufactured metal posts.

2.13 WATTLES

A. Cylinders of biodegradable plant material such as weed-free straw, coir, compost, wood chips, excelsior, or wood fiber or shavings encased within biodegradable netting.

B. Diameter: 5 inches minimum.

C. Netting Material: Clean, evenly woven, and free of encrusted concrete or other contaminating materials such as preservatives. Also free from cuts, tears, or weak places with a minimum lifespan of 6 months.

D. Compost Filler: Coarse compost, wood chips, or wood shavings.

E. Wood Stakes: Untreated softwood species, 2-inch by 2-inch nominal dimension and 36 inches in length.

PART 3 EXECUTION

3.01 PREPARATION

A. Engineer's acceptance of the TESC Plan is required prior to starting earth disturbing activities.

B. Include proposed stockpile areas and installation of temporary erosion control devices, ditches, or other facilities in Work phasing plans.

C. Areas designated for Contractor's use during Project may be temporarily developed as specified to provide working, staging, and administrative areas. Include control of sediment from these areas in the TESC Plan.

D. Check Dams: Install check dams as soon as construction will allow, or when designated by Engineer. Contractor may substitute a different check dam, in lieu of what is specified in the Contract, with approval of Engineer. Check dam is a temporary or permanent structure, built across a minor channel. Water shall not flow through check dam structure. Construct check dams to create a ponding area upstream of dam to allow pollutants to settle, with water from increased flows channeled over a spillway in check dam. Construct check dam to prevent erosion in area below spillway. Place check dams perpendicular to flow of water and install in accordance with the Drawings. Extend outer edges up sides of conveyance to prevent water from going around check dam. Provide check dams of sufficient height to maximize detention, without causing water to leave ditch. Place sandbags so that initial row makes tight contact with ditch line for length of dam. Stagger subsequent rows so center of bag is placed over space between bags on previous lift.

E. Erosion Control Blanket (Matting), Biodegradable: Temporary Erosion Control Blankets are used as an erosion prevention device and to enhance establishment of vegetation. Install erosion control blankets according to manufacturer's recommendations.

1. Erosion control blankets with an open area of 60 percent or greater may be installed prior to seeding and fertilizing. Install blankets with less than 60 percent open space immediately following seeding and fertilizing operation.
2. Select erosion control blanket material for an area based on the intended function; slope or ditch stabilization and Site-specific factors including soil, slope gradient, rainfall, and flow exposure. Do not use erosion Control Blankets on slopes or in ditches that exceed manufacturer's recommendations.
3. For permanent erosion control blanket, see Section 31 32 00, Soil Stabilization.

F. Mulch: Furnish, haul, and evenly apply at rates indicated and spread on seeded areas within 48 hours after seeding unless otherwise specified.

1. Distribute straw mulch material with an approved mulch spreader that uses forced air to blow mulch material on seeded areas.
2. Apply wood strand mulch by hand or by straw blower on seeded areas.
3. Hydraulically apply Short-Term Mulch at the rate of 2,500 pounds per acre. May be applied in one lift.
4. Hydraulically apply Moderate-Term Mulch and Long-Term Mulch at the rate of 3,500 pounds per acre with no more than 2,000 pounds applied in any single lift. Mulch may be applied with seed and fertilizer in moist climates. In dry climates, apply seed and fertilizer in a single application followed by mulch application. Provide mulch suitable for application with a hydroseeder.
5. Cover temporary seed applied outside application windows established in Section 32 92 00, Turf and Grasses, with a mulch containing either Moderate-Term Mulch or Long-Term Mulch, as designated by Engineer.
6. Mulch areas not accessible by mulching equipment by approved hand methods.

G. Outlet Protection: Provide outlet protection to prevent scour at outlets of ponds, pipes, ditches, or other conveyances.

H. Sediment Control Barriers: Install sediment control barriers in accordance with TESC Plan or manufacturer's recommendations in the areas of clearing, grubbing, earthwork, or drainage prior to starting those activities. Maintain sediment control barriers until soils are stabilized.

I. Seeding: See Section 32 92 00, Turf and Grasses.

J. Silt (Sediment) Fence:

1. Silt fence shall be installed in accordance with the Drawings. When backup support is used, use steel wire with a maximum mesh spacing of 2 inches by 4 inches, or plastic mesh as resistant to ultraviolet radiation as the geotextile it supports. Provide wire or plastic mesh with strength equivalent to or greater than as required for unsupported geotextile (for example, 180 pounds grab tensile strength in the machine direction).
2. Attach geotextile to posts and support system using staples, wire, or in accordance with manufacturer's recommendations. Geotextile shall be sewn together at the point of manufacture, or at a location approved by Engineer, to form geotextile lengths as required.
3. Provide wood or steel support posts at sewn seams and overlaps and as shown on the Drawings and necessary to support fence.
4. Wood Posts: Minimum dimensions of 1-1/4-inch by 1-1/4-inch by the minimum length shown on the Drawings.
5. Steel Posts: Minimum weight of 0.90 lb/ft.
6. When sediment deposits reach approximately one-third the height of the silt fence, remove and stabilize deposits.

K. Stabilized Construction Entrance: Construct temporary stabilized construction

L. Wattles: Install wattles as soon as construction will allow or when designated by Engineer. Begin trench construction and wattle installation at base of slope and work uphill. Spread excavated material evenly along the uphill slope and compact using hand tamping or other method approved by Engineer. On gradually sloped or clay-type soils, provide trenches 2 inches to 3 inches deep. On loose soils, in high rainfall areas, or on steep slopes, provide trenches 3 inches to 5 inches deep, or half the thickness of the wattle. Exercise care when installing wattles to minimize disturbance of waterways and prevent sediment or pollutant discharge into waterbodies.

3.02 ADDITIONAL REQUIREMENTS

A. Natural Buffer or Equivalent:

1. Unless natural buffer between the Project Site and receiving waters has previously been eliminated by pre-existing development disturbances, comply with one of the following alternatives if stormwater from construction will discharge to surface water:
   a. Provide a 50-foot, undisturbed natural buffer between construction disturbances and surface water.
   b. Provide an undisturbed natural buffer that is less than 50 feet supplemented by additional erosion and sediment controls, which in combination, achieve a sediment load reduction that is equivalent to a 50-foot buffer.
   c. If it is infeasible to provide an undisturbed natural buffer of any size, implement erosion and sediment controls that achieve a sediment load reduction that is equivalent to a 50-foot buffer.

3.03 MAINTENANCE

A. The ESCP measures described in this specification are minimum requirements for anticipated Site conditions. During the construction period, upgrade these measures as needed to comply with all applicable local, state, and federal erosion and sediment control regulations.

B. Maintain erosion and sediment control BMPs so they properly perform their function until Engineer determines they are no longer needed.

C. Construction activities must avoid or minimize excavation and creation of bare ground during wet weather.

D. The intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.

E. Inspect BMPs in accordance with the schedule in the Construction Stormwater Discharge Permit(s) or as directed by Engineer.

F. Complete an inspection report within 24 hours of an inspection. Each inspection report shall be signed and identify corrective actions. Document that corrective actions are performed within 7 days of identification. Keep a copy of all inspection reports at the Site or at an easily accessible location.

G. Unless otherwise specified, remove deposits before the depth of accumulated sediment and debris reaches approximately height of BMP. Dispose of debris or contaminated sediment at approved locations. Clean sediments may be stabilized onsite using BMPs as approved by Engineer.

H. Sediment Fence: Remove trapped sediment before it reaches one-third of the above ground fence height and before fence removal.

I. Other Sediment Barriers (such as biobags): Remove sediment before it reaches 2 inches depth above ground height and before BMP removal.

J. Catch Basins: Clean before retention capacity has been reduced by 50 percent.

K. Sediment Basins and Sediment Traps: Remove trapped sediments before design capacity has been reduced by 50 percent and at completion of Project.

L. Initiate repair or replacement of damaged erosion and sediment control BMPs immediately, and work completed by end of next work day. Significant replacement or repair must be completed within 7 days, unless infeasible.

M. Within 24 hours, remediate any significant sediment that has left construction site. Investigate cause of the sediment release and implement steps to prevent a recurrence of discharge within same 24 hours. Perform in-stream cleanup of sediment according to applicable regulations.

N. At end of each work day, stabilize or cover soil stockpiles or implement other BMPs to prevent discharges to surface waters or conveyance systems leading to surface waters.

O. Temporarily stabilize soils at end of shift before holidays and weekends, if needed. Ensure soils are stable during rain events at all times of year.

P. Initiate stabilization by no later than end of next work day after construction work in an area has stopped permanently or temporarily.

Q. Within 14 days of initiating stabilization or as specified in permit, either seed or plant stabilized area (see Section 32 92 00, Turf and Grasses); or apply non-vegetative measures and cover all areas of exposed soil. Seed dry areas as soon as Site conditions allow. Ensure that vegetation covers at least 70 percent of stabilized area. In areas where Contractor’s activities have compromised erosion control functions of existing grasses, overseed existing grass. Non-vegetative measures may include blown straw and a tackifier, loose straw, or an adequate covering of compost mulch. Complete initial stabilization within 7 days if storm water discharges to surface waters impaired for sediment or nutrients, or high quality waters.

R. Provide permanent erosion control measures on all exposed areas. Do not remove temporary sediment control practices until permanent vegetation or other cover of exposed areas is established. However, do remove all temporary erosion control measures as exposed areas become stabilized, unless doing so conflicts with local requirements. Properly dispose of construction materials and waste, including sediment retained by temporary BMPs.

3.04 EMERGENCY MATERIALS

A. Provide, stockpile, and protect the following emergency erosion and sediment control materials on the Project Site for unknown weather or erosion conditions. Emergency materials are in addition to other erosion control materials required to implement and maintain the TESC Plan. Replenish emergency materials as they are used. Remove all unused emergency materials from the Project Site at completion of the Project.

Item	Quantity
Silt (sediment) fence	100 ft
Rope	1,000 ft
Straw bales	10
Inflatable pipe plugs	One for each size of pipe

3.05 REMOVAL

A. When Engineer determines that an erosion control BMP is no longer required, remove BMP and all associated hardware from the Project limits. When materials are biodegradable, Engineer may approve leaving temporary BMP in place.

B. Permanently stabilize all bare and disturbed soil after removal of erosion and sediment control BMPs. Dress sediment deposits remaining after BMPs have been removed to conform to existing grade. Prepare and seed graded area. If installation and use of erosion control BMPs have compacted or otherwise rendered soil inhospitable to plant growth, such as construction entrances, take measures to rehabilitate soil to facilitate plant growth. This may include, but is not limited to, ripping the soil, incorporating soil amendments, or seeding with specified seed.

END OF SECTION

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Products:

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

1.02 DESIGN REQUIREMENTS

A. Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of latest edition of International Building Code (IBC) by International Code Council and amended by the State of Alabama.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 720 feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 0 degrees F to 110 degrees F.

1.04 PREPARATION FOR SHIPMENT

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

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

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

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

D. Request a minimum 7-day advance notice of shipment from manufacturer.

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

1.05 DELIVERY AND INSPECTION

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

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

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

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

1.06 HANDLING, STORAGE, AND PROTECTION

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

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

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

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

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

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

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

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

PART 2 PRODUCTS

2.01 GENERAL

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

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

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

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

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

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

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

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

I. Authority Having Jurisdiction (AHJ):

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

J. Equipment Finish:

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

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

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

M. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 FABRICATION AND MANUFACTURE

A. General:

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

B. Lubrication System:

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

2.03 SOURCE QUALITY CONTROL

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

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

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

PART 3 EXECUTION

3.01 INSPECTION

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

3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

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

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

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

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

3.03 INSTALLATION

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

B. No shimming between machined surfaces is allowed.

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

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

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

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

G. For material and equipment specifically indicated or specified to be reused in the Work:

1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.04 FIELD FINISHING

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

3.05 ADJUSTMENT AND CLEANING

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

3.06 LUBRICANTS

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

3.07 SUPPLEMENTS

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

1. Manufacturer's Certificate of Compliance Form.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

_____

_____

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

Date of Execution: _____, 20___

Manufacturer: _____

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

_____

(Authorized Signature)

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
   a. Record Documents: As required in General Conditions.
   b. Special bonds, Special Guarantees, and Service Agreements.
   c. Consent of Surety to Final Payment: As required in General Conditions.
   d. Releases or Waivers of Liens and Claims: As required in General Conditions.
   e. Releases from Agreements.
   f. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
   g. Extra Materials: As required by individual Specification sections.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
   a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
   b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
4. Prior to submitting each request for progress payment, request Engineer’s review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor’s Application for Payment, either partial or final.

1.03 RELEASES FROM AGREEMENTS

A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within the Owner's construction right-of-way.

B. In the event Contractor is unable to secure written releases:

1. Inform Owner of the reasons.
2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
4. When Owner is satisfied that the Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if: (i) Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that Contractor has failed to fulfill terms of side agreement or special easement, or (ii) Contractor is unable to contact or has had undue hardship in contacting grantor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents.
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large, printed letters.
3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Engineer.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
   a. Color Coding:
      1) Green when showing information deleted from Drawings.
      2) Red when showing information added to Drawings.
      3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by “cloud” drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
   a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
   b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.
   c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
   d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
   e. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer’s written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
   a. Clearly identify the item by accurate note such as “cast iron drain,” “galv. water,” and the like.
   b. Show, by symbol or note, vertical location of item (“under slab,” “in ceiling plenum,” “exposed,” and the like).
   c. Make identification so descriptive that it may be related reliably to Specifications.

3.02 FINAL CLEANING

A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.

1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner and Engineer.
2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
4. Clean all windows.
5. Clean and wax wood, vinyl, or painted floors.
6. Broom clean exterior paved driveways and parking areas.
7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
8. Rake clean all other surfaces.
9. Remove snow and ice from access to buildings.
10. Replace air handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
11. Leave water courses, gutters, and ditches open and clean.
12. Perform site restoration to repair areas disturbed by construction activities to include grading, filling of ruts, seeding, and mulching to the satisfaction of the property owner and Engineer and in accordance with all Federal, State, and Local regulations.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.

1.02 DEFINITIONS

A. Preliminary Data: Initial and subsequent submissions for Engineer's review.

B. Final Data: Engineer-accepted data, submitted as specified herein.

C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.03 SEQUENCING AND SCHEDULING

A. Equipment and System Data:

1. Preliminary Data:
   a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
   b. Submit prior to shipment date.
2. Final Data: Submit Instructional Manual Formatted data not less than 30 days prior to installation of equipment or system equipment or system field functional testing.

B. Materials and Finishes Data:

1. Preliminary Data: Submit at least 15 days prior to request for final inspection.
2. Final Data: Submit within 10 days after final inspection.

1.04 DATA FORMAT

A. Prepare preliminary and final data in the form of an instructional manual.

B. Instructional Manual Format:

1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
2. Size: 8-1/2 inches by 11 inches, minimum.
3. Cover: Identify manual with typed or printed title “OPERATION AND MAINTENANCE DATA” and list:
    a. Project title.
    b. Designate applicable system, equipment, material, or finish.
    c. Identity of separate structure as applicable.
    d. Identify volume number if more than one volume.
    e. Identity of general subject matter covered in manual. Identity of equipment number and Specification section.
4. Spine:
    a. Project title.
    b. Identify volume number if more than one volume.
5. Title Page:
    a. Contractor name, address, and telephone number.
    b. Subcontractor, Supplier, installer, or maintenance contractor’s name, address, and telephone number, as appropriate.
        1) Identify area of responsibility of each.
        2) Provide name and telephone number of local source of supply for parts and replacement.
6. Table of Contents:
    a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
    b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
7. Paper: 20-pound minimum, white for typed pages.
8. Text: Manufacturer’s printed data, or neatly typewritten.
9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. Electronic Media Format:

1. Portable Document Format (PDF):
    a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on USB device.
    b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.

c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.
d. PDF to be bookmarked for ease of navigation.

2. Manufacturers' standard electronic format.

1.05 SUBMITTALS

A. Informational:

1. Data Outline: Submit two copies of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Preliminary Data:
   a. Submit one electronic copy for Engineer's review.
   b. If data does not meet conditions of the Contract:
      1) Copies will be returned to Contractor with Engineer's comments (on separate document) for revision.
      2) Engineer's comments will be retained in Engineer's file.
      3) Resubmit copy revised in accordance with Engineer's comments.
3. Final Data: Submit two copies in format specified herein.

1.06 DATA FOR EQUIPMENT AND SYSTEMS

A. Content For Each Unit (or Common Units) and System:

1. Product Data:
   a. Include only those sheets that are pertinent to specific product.
   b. Clearly annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.
   c. Function, normal operating characteristics, and limiting conditions.
   d. Performance curves, engineering data, nameplate data, and tests.
   e. Complete nomenclature and commercial number of replaceable parts.
   f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
   g. Spare parts ordering instructions.
   h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).

2. As-installed, color-coded piping diagrams.
3. Charts of valve tag numbers, with the location and function of each valve.
4. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
    a. Format:
        1) Provide reinforced, punched, binder tab; bind in with text.
        2) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
        3) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
        4) Identify Specification section and product on Drawings and envelopes.
    b. Relations of component parts of equipment and systems.
    c. Control and flow diagrams.
    d. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
    e. Testing data including final testing data completed after installation.
5. Instructions and Procedures: Within text, as required to supplement product data.
    a. Format:
        1) Organize in consistent format under separate heading for each different procedure.
        2) Provide logical sequence of instructions for each procedure.
        3) Provide information sheet for Owner’s personnel, including:
            a) Proper procedures in event of failure.
            b) Instances that might affect validity of guarantee or Bond.
    b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
    c. Operating Procedures:
        1) Startup, break-in, routine, and normal operating instructions.
        2) Test procedures and results of factory tests where required.
        3) Regulation, control, stopping, and emergency instructions.
        4) Description of operation sequence by control manufacturer.
        5) Shutdown instructions for both short and extended duration.
        6) Summer and winter operating instructions, as applicable.
        7) Safety precautions.
        8) Special operating instructions.

d. Maintenance and Overhaul Procedures:
   1) Routine maintenance.
   2) Guide to troubleshooting.
   3) Disassembly, removal, repair, reinstallation, and re-assembly.

6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit Directories of Panelboards:
3. Electrical service.
4. Control requirements and interfaces.
5. Communication requirements and interfaces.
6. List of electrical relay settings, and control and alarm contact settings.
7. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
8. As-installed control diagrams by control manufacturer.
9. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Startup and shutdown sequences, normal and emergency.
   c. Safety precautions.
   d. Special operating instructions.
10. Maintenance Procedures:
   a. Routine maintenance.
   b. Guide to troubleshooting.
   c. Adjustment and checking.
   d. List of relay settings, control and alarm contact settings.
11. Manufacturer’s printed operating and maintenance instructions.
12. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.
13. All testing data.

C. Maintenance Summary:

1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
2. Format:
   a. Use Maintenance Summary Form bound with this section or electronic facsimile of such.
   b. Each Maintenance Summary may take as many pages as required.
   c. Use only 8-1/2-inch by 11-inch size paper.
   d. Complete using typewriter or electronic printing.
3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
   a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
   b. "Unit" is the unit of measure for ordering the part.
   c. "Quantity" is the number of units recommended.
   d. "Unit Cost" is the current purchase price.

1.07 DATA FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
   a. Catalog number, size, and composition.
   b. Color and texture designations.
   c. Information required for reordering special-manufactured products.
2. Instructions for Care and Maintenance:
   a. Manufacturer's recommendation for types of cleaning agents and methods.
   b. Cautions against cleaning agents and methods that are detrimental to product.
   c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer's data, giving full information on products:
   a. Applicable standards.
   b. Chemical composition.
   c. Details of installation.
2. Instructions for inspection, maintenance, and repair.

1.08 SUPPLEMENTS

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

1. Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

   a. Name_____ Telephone No. _____

   b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01 88 15
ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the ICC 2021 International Building Code (IBC), for seismic, wind, gravity, soil, and operational loads.

1.02 REFERENCES

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

1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
3. International Code Council (ICC): International Building Code (IBC).

1.03 DEFINITIONS

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

B. Designated Seismic System: Architectural, electrical, and mechanical system or their components for which component importance factor is greater than 1.0.

C. Component Important Factor:

1. Ip > 1.0, unless noted otherwise.
2. Ip shall be taken as 1.5 if any of the following conditions apply:
   a. Component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.

b. Component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public is released.
c. Component is in or attached to Risk Category IV structure and is needed for continued operation of facility or its failure could impair continued operation of facility.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Alabama.
2. Design anchorage into concrete including embedment in accordance with ACI 318-19; Chapter 17 (or other industry standard approved by Engineer), and Project Specifications.
   a. Unless otherwise noted, design for cracked concrete condition.
3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
6. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
7. Distribution Systems: Includes, but are not limited to, piping, conduit, cable trays, and ductwork.
8. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
9. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.

10. Design anchorage and bracing for all equipment and components for seismic loads except those exempted below. Include other loads as applicable in the design load combinations.
    a. Excepted equipment and components include:
    b. All Seismic Design Categories:
        1) Furniture, excluding storage cabinets.
        2) Temporary components that remain in place for 180 days or less.
        3) Mobile units and equipment including components that are moved from one point in the structure to another during ordinary use.
    c. SDC A:
        1) All components.
    d. SDC B:
        1) Architectural Components, other than parapets, provided that the component Importance Factor, Ip, is equal to 1.0.
        2) Mechanical and electrical Components.
    e. SDC C:
        1) Mechanical and Electrical Components, provided that either:
            a) The component Importance Factor, Ip, is equal to 1.0 and the component is positively attached to the structure.
            b) The component weighs 20 pounds or less.
    f. SDC D, E, and F:
        1) Mechanical and electrical components positively attached to the structure, provided that either:
            a) For discrete mechanical and electrical components, the component weighs 400 pounds or less, the center of mass is located 4 feet or less above the adjacent floor level, flexible connections are provided between the component and associated ductwork, piping, and conduit, and the component Importance Factor, Ip, is equal to 1.0.
            b) For discrete mechanical and electrical components, the component weighs 20 pounds or less.
            c) For distribution systems, the component Importance Factor, Ip, is equal to 1.0 and the operating weight of the system is 5 lb/ft or less.

11. Design seismic anchorage and bracing for Designated Seismic Systems regardless of weight or mounting height.
    a. Refer to Section 01 45 36, Equipment Seismic Certification, for list of designated components which Ip equals 1.5.
12. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
3. Operational:
    a. For loading supplied by equipment manufacturer for IBC required load cases.
    b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, pipe thrust, and other load-inducing conditions.
    c. Locate braces to minimize vibration to or movement of structure.
    d. For vibrating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications or Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer’s ICC-ES report.
4. Seismic:
    a. In accordance with 2021 IBC, Section 1613, and Chapter 13 of ASCE 7.
    b. Design anchorage and bracing for design criteria listed on General Structural Notes on Drawings.
    c. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2, or IBC Section 1905.1.8 as applicable for Project Seismic Design Category.

C. Seismic Design Requirements:

1. Nonstructural Components: Design as nonbuilding structures for components with weights greater than or equal to 25 percent of effective seismic weight of overall structure.
2. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component Ip = 1.5.
3. Provide support drawings and calculations for mechanical and electrical systems in accordance with Section 13.6 of ASCE 7.Existing components, systems, and equipment in their final condition that are modified by Project requirements and are not exempted by above paragraph require the same anchorage and bracing drawing and calculation submittals as new equipment. Field verify existing conditions.
4. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new and modified or noted architectural, mechanical and electrical components, systems, or equipment.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
   b. Manufacturers' engineered seismic and non-seismic hardware product data.
   c. Attachment assemblies' drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
   d. List of existing architectural, mechanical, and electrical equipment or components to be modified in Project requiring Contractor-designed anchorage and bracing in final retrofitted condition.
   e. Drawings for attachment assemblies include connection hardware, braces, and anchors (or anchor bolts) for modified, nonexempt existing components, equipment, and systems where a combination of new and existing systems or components' final condition would require anchorage or bracing under this specification for new equipment.
   f. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer's specific criteria used for design; sealed by a civil or structural engineer registered in the State of Alabama.
2. Manufacturer's hardware installation requirements.

C. Deferred Submittals:

1. Submitted anchorage drawings and calculations when Designated Seismic Systems are identified as IBC deferred submittals and will be submitted to and must be accepted by AHJ prior to installation of component, equipment, or distribution system.
2. Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment or distribution system to be anchored to structure.

1.06 SOURCE QUALITY CONTROL

A. Contractor and supplier responsibilities to accommodate Owner-furnished shop fabrication related special inspections and testing are provided in Project's Statement of Special Inspections in Supplement located at the end of Section 01 45 33, Special Inspection, Observation, and Testing.

B. Provide all other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.

C. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and construct attachments and supports transferring seismic and non-seismic loads to structure of materials and products suitable for application and in accordance with design criteria shown on Drawings and nationally recognized standards.

B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

D. Do not use powder-actuated fasteners or sleeve anchors for seismic attachments and anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 horsepower.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.

B. Design, provide, and install overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.

C. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

D. Calculations shall limit anchor bolt concrete edge distance to a maximum of 4 inches or as required to provide sufficient anchor bolt capacity to resist the applied loads.

E. Provide distribution system anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

F. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Engineer.

G. Do not attach architectural, mechanical, or electrical components to more than one element of a building structure at a single restraint location where such elements may respond differently during a seismic event. Do not make such attachments across building expansion and contraction joints.

3.02 INSTALLATION

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

B. Notify Engineer upon completion of installation of seismic restraints in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. In accordance with Section 05 50 00, Metal Fabrications and Section 05 05 19, Post-Installed Anchors.

B. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

C. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 GENERAL

1.01 DEFINITIONS

A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

B. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.

C. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.

D. Facility Performance Demonstration:

1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.02 SUBMITTALS

A. Informational Submittals:

1. Facility Startup and Performance Demonstration Plan.
2. Functional and performance test results.
3. Completed Facility Performance Demonstration/Certification Form.

1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:

1. Step-by-step instructions for startup of each unit process and the complete facility.
2. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
   a. Description of unit processes included in the facility startup.
   b. Sequence of unit process startup to achieve facility startup.
   c. Description of computerized operations, if any, included in the facility.
   d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
   e. Signature spaces for Contractor and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Facility Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.

B. Contractor's Testing and Startup Representative:

1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.

C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.

D. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.

E. Owner will:

1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
2. Operate process units and facility with support of Contractor.
3. Provide labor and materials as required for laboratory analyses.

3.02 EQUIPMENT TESTING

A. Preparation:

1. Complete installation before testing.
2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.
4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
    a. Owner/Project Name.
    b. Equipment or item tested.
    c. Date and time of test.
    d. Type of test performed (Functional or Performance).
    e. Test method.
    f. Test conditions.
    g. Test results.
    h. Signature spaces for Contractor and Engineer as witness.
5. Cleaning and Checking Prior to Beginning Functional Testing:
    a. Calibrate testing equipment in accordance with manufacturer's instructions.
    b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
    c. Lubricate equipment in accordance with manufacturer's instructions.
    d. Turn rotating equipment by hand, when possible, to confirm that equipment is not bound.
    e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
    f. Check power supply to electric-powered equipment for correct voltage.
    g. Adjust clearances and torque.
    h. Test piping for leaks.

6. Ready-to-test determination will be by Engineer based at least on the following:
    a. Acceptable Operation and Maintenance Data.
    b. Notification by Contractor of equipment readiness for testing.
    c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
    d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
    e. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
    f. Satisfactory fulfillment of other specified manufacturer's responsibilities.
    g. Equipment and electrical tagging complete.
    h. Delivery of all spare parts and special tools.

B. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
3. Prepare Equipment Test Report summarizing test method and results.
4. When, in Engineer's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

3.03 STARTUP OF UNIT PROCESSES

A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.

3.04 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.

B. Demonstrate proper operation of required interfaces within and between individual unit processes.

C. After facility is operating, complete performance testing of equipment and systems not previously tested.

D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility.

E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic operation.

3.05 SUPPLEMENTS

A. Supplement listed below, following “End of Section,” is a part of this Specification:

1. Facility Performance Demonstration/Certification Form.

END OF SECTION

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER:_____ **PROJECT:**_____

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

_____

_____

_____

_____

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

_____

_____

_____

_____

_____

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

Contractor: _____ **Date:** _____**, 20____**

Engineer: _____ **Date:** _____**, 20____**
(Authorized Signature)

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
3. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
4. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
   a. Part 61—National Emission Standards for Hazardous Air Pollutants.
   b. Part 82—Protection of Stratospheric Ozone.
   c. Part 273—Standards for Universal Waste Management.

1.02 DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof. Demolition also includes removal of pipes, manholes tanks, conduit, and other underground facilities, whether as a separate activity or in conjunction with construction of new facilities.

C. Abandonment: Performing specific work necessary to disconnect and leave existing facilities and piping in place but not in use; properly capped, plugged, and otherwise left in place in such a manner to not cause any conflict with existing or future operations of this facility.

D. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

E. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.

F. Renovation: Altering a facility or one or more facility components in any way.

G. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition/Renovation Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to requirements of the General Conditions, Contractor's safety requirements shall conform to ANSI A10.6.

1.05 DEMOLITION/RENOVATION PLAN

A. Demolition/Renovation Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for each operation.
2. The Contractor's planned sequence of operations, including coordination with other work in progress.
3. Procedures for removal and disposition of materials specified to be salvaged.

B. Abandonment Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for the abandonment of the existing force main and air release vaults and assemblies.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this Specification shall not commence until Contractor's Demolition/Renovation Plan has been approved by Engineer.

B. Include the Work of this Specification in the progress schedule, as specified in Section 01 32 00, Construction Progress Documentation.

C. Coordinate the relocation of the repurposed chlorine feed line in transfer pump room with plant staff.

D. Existing 24-inch WM piping to be replaced in-kind. This line cannot be replaced until the successful startup of the new finished water pump station and new yard piping and proposed tie-ins to existing complete. Contractor to coordinate with the plant for items required to abandon in place for yard piping.

E. Demolition of existing Maintenance Building. Contractor to coordinate with plant to relocate equipment currently being stored in building prior to demolition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

A. Structures: CMU partition walls, footer and concrete slab at existing generator and scrubber shall be removed as shown.

B. Utilities and Related Equipment:

1. Notify Engineer or appropriate utilities to turn off affected services at least 48 hours before starting demolition or renovation activities.
2. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Engineer.
3. When utility lines are encountered that are not indicated on the Drawings, notify Engineer prior to further work in that area.
4. Remove meters and related equipment and deliver to a location as determined by the Engineer.
5. Provide a permanent leak-proof closure for water and gas lines.

C. Paving and Slabs:

1. Sawcut concrete and asphaltic concrete paving and slabs full depth.
2. Provide neat sawcuts at limits of pavement removal as indicated.

D. Masonry: Sawcut and remove masonry so as to prevent damage to surfaces to remain and to facilitate the installation of new Work. Where new masonry adjoins existing, the new Work shall abut or tie into the existing construction as indicated.

E. Concrete:

1. Core drill corners of new opening to avoid overcutting adjacent reinforcing in existing concrete to remain. Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished Work, and the remaining concrete is sound.
2. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Repair exposed rebar ends and embeds as shown on Drawings.
3. Where new concrete adjoins existing concrete, thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 3/16 inch. Rebar and small embeds at existing concrete may be required to be left to engage new concrete. Saturate surface with water for 24 hours prior to placing new concrete. The new Work shall tie into the existing construction as shown on Drawings.

F. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.

G. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. When removing designated equipment, conduit, and wiring may require rework to maintain service to other equipment.

3. Rework existing circuits, or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or concealed above Accessible Ceilings: Remove.
8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where the concealed raceway is uncovered remove raceway (or extend to new location if appropriate).
12. Provide new typewritten panelboard circuit directory cards.

3.02 PROTECTION

A. Dust and Debris Control:

1. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.
2. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.

B. Existing Work:

1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.
2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.

3. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
4. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
5. Do not overload pavements to remain.

C. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.

D. Trees: Protect trees within the Site that might be damaged during demolition and are indicated to be left in place, by a 6-foot-high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the Work shall be replaced in kind, as approved by the Engineer.

E. Facilities:

1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
2. Floors, roofs, walls, columns, pilasters, and other structural elements that are designed and constructed to stand without lateral support or shoring, and are determined by Contractor to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Engineer.
3. Protect all facility elements not scheduled for demolition.
4. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities.

F. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner's personnel and the general public from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Owner's personnel and the general public to occupied portions of the structure.

3.03 BURNING

A. The use of burning at the Site for the disposal of refuse and debris will not be permitted.

3.04 RELOCATIONS

A. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.05 BACKFILL

A. Do not use demolition debris as backfill material.

B. Fill excavations, open basements and other hazardous openings to existing ground level or foundation level of new construction in accordance with Section 31 23 23, Fill and Backfill.

3.06 TITLE TO MATERIALS

A. All salvaged equipment and materials will remain the property of Owner.

B. All items designated to be removed shall become the property of Contractor.

C. Title to equipment and materials resulting from demolition is vested in the Contractor upon approval by Engineer of Contractor's Demolition/Renovation Plan, and the resulting authorization by Engineer to begin demolition.

3.07 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor's Demolition/Renovation Plan by Engineer.

B. Salvage equipment and material to the maximum extent possible.

C. Remove salvaged items in a manner to prevent damage, and pack or crate to protect the items from damage while in storage or during shipment. Properly identify containers as to contents.

D. Repair or replace, at the discretion of Engineer, items damaged during removal or storage.

E. Repair or replace, at the discretion of Engineer, items damaged during removal or storage.

F. Deliver salvaged items that are designated as the property of Owner to a storage site as directed by Owner.

G. Owner will not be responsible for the condition or loss of, or damage to, property scheduled to become Contractor's property after Engineer's authorization to begin demolition. Materials and equipment shall not be viewed by prospective purchasers or sold on the site

3.08 REUSE OF MATERIALS AND EQUIPMENT

A. Remove and store materials and equipment listed in Article Title To Materials to be reused or relocated to prevent damage, and reinstall as the Work progresses.

B. Properly store and maintain equipment and materials in same condition as when removed.

C. Store equipment and material designated to be reused in a location designated by Owner.

D. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.

E. Engineer will determine condition of equipment and materials prior to removal.

3.09 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

SECTION 03 01 32
REPAIR OF VERTICAL AND OVERHEAD CONCRETE SURFACES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 301, Specifications for Concrete Construction.
   b. 506.2, Specification for Shotcrete.
2. ASTM International (ASTM):
   a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   b. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   c. A1064/A1064 M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   d. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   e. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   f. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   g. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   h. C293/C293M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading.
   i. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   j. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   k. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   l. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
   m. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

o. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
p. C1583/C1583M, 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).
q. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
r. D4259, Standard Practice for Abrading Concrete.
s. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

1.02 DEFINITIONS

A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete**.**

C. High-Pressure Water Blasting: Sometimes referred to as hydro-demolition. Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.

D. Low-Pressure Spray Mortar: Mortar suitable to be applied by low-pressure spraying, and in small areas may be applied by hand troweling.

E. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets for each material supplied.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer's preparation and installation instructions.
2. Written description of equipment proposed for concrete removal and surface preparation.

3. Certificates:
    a. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on vertical and overhead surfaces that are exposed to weather and moisture.
    b. Mortar Manufacturer's Certificate of Proper Installation.
4. Statements of Qualification:
    a. Repair mortar system applicator.
    b. Repair mortar system manufacturer's representative.
    c. Independent Testing Laboratory.
5. Repair mortar system manufacturer's proposed modified test procedures for ASTM C109/C109M, ASTM C882/C882M, and ASTM C157/C157M test methods.
6. Field and laboratory test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: For Repair System B – Low-Pressure Spray Mortar, in lieu of recognition or certification, demonstrate application of repair mortar manufacturer's system and obtain Certification of Proper Installation, in accordance with Article Manufacturer's Services.
2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Independent Testing Laboratory: Meet criteria stated in ASTM E699.

C. Demonstration Mockup for Repair System B – Low-Pressure Spray Mortar Repair System:

1. For each noted type of repair mortar system to be used, prepare one demonstration mockup in each vertical and overhead orientation of at least 10 feet by 10 feet with average thickness, and containing reinforcement, representative of area being repaired on Project. Alternatively, a repair area in each vertical and overhead orientation that is representative of areas to be repaired in terms of size, thickness, and reinforcement, may be used for demonstration in lieu of mockups; subject to acceptance by Engineer.

2. Repair Mortar System Manufacturer's Demonstration:
    a. Schedule time for manufacturer's demonstration of repair system proposed for Project.
    b. Prepare mortar to specified consistency for testing and placement.
    c. Cure portions of each type of surface to be repaired using proposed curing procedure and materials, including overhead and vertical applications.
    d. Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
    e. Demonstrate the following:
        1) Mixing and application equipment capabilities and procedures, including flow of material from nozzle or sprayer.
        2) 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.
    f. Tensile Bond Test: Test in situ or take a core of demonstration placement and test as specified herein below for tensile bond at 7 days as specified in Paragraph Direct Tension Bond Test.

D. If required: Demonstration Mockup for Repair System C – Polymer Modified Repair Mortar System:

1. Prepare one demonstration mockup in each vertical and overhead orientation of average size and thickness, and containing reinforcement, representative of area being repaired on Project. Alternatively, a repair area in each vertical and overhead orientation that is representative of areas to be repaired in terms of size, thickness, and reinforcement, may be used for demonstration in lieu of mockups; subject to acceptance by Engineer.
2. Repair Mortar System Manufacturer's Demonstration:
    a. Schedule time for manufacturer's demonstration of repair system proposed for Project.
    b. Prepare mortar to specified consistency, for testing and placement.
    c. Cure portions of each type of surface to be repaired using proposed curing procedure and materials, including overhead and vertical applications.
    d. Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
    e. Demonstrate mixing and application procedures.
    f. Tensile Bond Test: Test in situ or take a core of demonstration placement and test for tensile bond at 7 days as specified in Paragraph Direct Tension Bond Test.

E. Pre-repair Conference:

1. Required Meeting Attendees:
   a. Contractor.
   b. Repair Subcontractor.
   c. Technical representative for repair material manufacturer.
   d. Owner or Owner's representative.
2. Schedule and conduct prior to conducting mockups and incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include, but not limited to:
   a. Review of field conditions. Conduct field observations of Work to be performed.
   b. Based on above observations, repair material manufacturer's technical representative shall confirm material selection and make Project-specific repair method recommendations.
   c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
   d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.

B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR

A. One-component, cement based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.

B. Cured materials mixed in accordance with manufacturer's instructions shall conform to the following criteria:

1. Compressive Strength, ASTM C109/C109M at 28 Days: 6,000 psi minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,100 psi minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent, at 28 Days: 3,000 psi minimum.

4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.
5. Drying Shrinkage, ASTM C157/C157M Modified at 28 Days or ASTM C531: 0.1 percent maximum.
6. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 1,000 coulombs maximum.
7. System shall not produce a vapor barrier.
8. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only addition of water.
9. Free of chlorides and other chemicals causing corrosion.

C. Manufacturers and Products:

1. Master Builders Solutions US, Shakopee, MN; MasterEmaco S 488CI.
2. Sika Corp., Lyndhurst, NJ; SikaRepair-224.
3. Euclid Chemical Co., Cleveland, OH; Tamms Structural Mortar.

2.02 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR

A. Polymer-modified, one- or two-component, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar.

B. Cured Mortar Properties:

1. Compressive Strength, ASTM C109/C109M at 28 Days: 7,000 psi minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,200 psi minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent at 28 Days: 2,000 psi minimum.
4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 psi minimum.
5. Drying Shrinkage, ASTM C596 at 28 Days: 0.12 percent maximum. Not required for small repair areas approximately 1 square foot in area or less.
6. Freeze Thaw Resistance, ASTM C666/C666M, at 300 Cycles: 90 percent RDM.
7. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 800 coulombs maximum for liquid holding and belowgrade repairs.

C. Manufacturers and Products:

1. Master Builders Solutions US, Shakopee, MN; MasterEmaco N 300CI.
2. Do not use this product on hydraulic structures or where material will be in contact with moisture.
3. Sika Corp., Lyndhurst, NJ; SikaTop-123 PLUS.
4. Euclid Chemical Co., Cleveland, OH; Duraltop Gel.

2.03 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.04 REINFORCEMENT

A. Deformed Steel Reinforcement:

1. Per Section 03 21 00, Steel Reinforcement.

B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

2.05 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

A. Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.

1. Mixed Bonding Agent Properties:
   a. Pot Life: 75 minutes to 105 minutes.
   b. Contact Time: 24 hours.
   c. Color: Concrete gray.
2. Cured Cementitious Adhesive Properties:
   a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 psi minimum.
   b. Flexural Strength, ASTM C348: 1,000 psi minimum.
   c. Slant Shear Bond Strength, ASTM C882/C882M at 14 Days:
      1) 2-Hour Open Time: 2,500 psi minimum.
      2) 24-Hour Open Time: 2,000 psi minimum.
3. Bonding agent shall not produce a vapor barrier.
4. Compatible with and from same manufacturer as the repair system used.

B. Manufacturers and Products:

1. Master Builders Solutions US, LLC - Building Systems, Shakopee, MN; MasterEmaco P 124.
2. Sika Corp., Lyndhurst, NJ; Sika Armatec-110 EpoCem.
3. Euclid Chemical Co., Cleveland, OH: Duralprep A.C.**]**

2.06 EVAPORATION RETARDANT

A. As specified in Section 03 39 00, Concrete Curing.

2.07 CURING COMPOUND

A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL

A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system. Refer to Section 03 30 00, Cast-in-Place Concrete.

B. Existing Concrete Work: Repair concrete as identified in Contract Documents.

3.02 APPLICATION

A. General:

1. Repair System B: Medium to large areas and number of repair areas.
2. Repair System C: Small and limited areas and number of repair areas.] [Not used.]

3.03 PREPARATION

A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer, and review proposed extent of repair with Engineer.

B. Remove unsound, honeycombed, deteriorated, or otherwise defective areas of concrete from work areas.

1. Use 8,000 psi minimum high-pressure water or abrasive blasting machine as required for Site conditions.
2. Remove concrete to abrade substrate concrete surfaces to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
3. For existing structures, extent of concrete removal as shown on Drawings, in Specifications, or based on investigation by contractor.
4. Where final surface is required to be flush with existing adjacent surface remove existing concrete depth as required for application of minimum thickness of repair mortar.

C. Do not use power-driven jackhammers, chipping hammers, or scabblers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 15 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.

D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.

E. Remove unsound concrete to satisfaction of Engineer.

F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.

G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to circumference of exposed steel reinforcement if one or more of the following surface conditions exist:

1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.

H. Remove loose, flaky, or laminar sections of rust from surface of reinforcing bars. Surface of reinforcing bar with light well-adhered rust is acceptable.

I. Remove deleterious material and concrete splatter from surface of reinforcing bars.

J. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminates from prepared areas.

K. Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar as required by and in accordance with repair mortar manufacturer's printed instructions.

L. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.

3.04 REINFORCEMENT INSTALLATION

A. Replace deteriorated steel reinforcement with new steel reinforcement equivalent in cross-sectional area to original steel reinforcement.

B. Fasten steel reinforcement to maintain and prevent from moving during placement of repair mortar.

C. Coat exposed new and existing steel reinforcement with cementitious reinforcement coating at same time as substrate concrete is coated, as specified below, per repair mortar and cementitious reinforcement coating manufacturers' printed instructions.

3.05 PROTECTION

A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.

B. Protect adjacent surfaces, and equipment, from being damaged by overshooting, rebound, and dust, as applicable for repair mortar system used, from low-pressure spray mortar.

3.06 REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR PLACEMENT

A. Mix mortar in accordance with manufacturer's printed instructions.

B. After priming prepared substrate concrete surface per manufacturer's recommendations, apply mortar by low-pressure spraying equipment, unless noted otherwise.

C. Bonding Agent:

1. Use bonding agent when manufacture required for hand applied areas, in accordance with repair mortar manufacturer's instructions.
2. Application of repair mortar over bonding agent shall be completed within time frame recommended by bonding agent manufacturer.
3. Consult with manufacturer for optimum and minimum acceptable degrees of surface tackiness of coat.

D. Work mortar firmly and quickly into repair area.

E. Finish repair mortar to match adjacent concrete surface.

F. Provide evaporation retardant at full strength.

G. Cure as specified in Article Curing.

3.07 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR PLACEMENT

A. Mix mortar in accordance with manufacturer's printed instructions.

B. Bond Coat: Apply to prepared substrate concrete surface before application of mortar in accordance with repair mortar manufacturer's printed instructions. Do not apply more bond coat than can be covered with mortar before bond coat dries. Do not retemper bond coat.

C. Place mortar by hand or low-pressure spray and trowel to specified surface finish, in accordance with requirements of repair material's printed instructions.

D. Finish repair mortar to match adjacent concrete surface.

E. Cure as specified in Article Curing, and in accordance with manufacturer's printed instructions.

3.08 CURING

A. Prior to curing, apply water fog to repair mortar system in accordance with repair mortar system manufacturer's printed instructions.

B. Cure in accordance with repair mortar manufacturer's printed instructions.

C. Where permitted by repair mortar manufacturer's printed instructions, continue water fog curing after repair mortar system application and when curing will not cause erosion of mortar.

D. Continuously water fog cure repair mortar system for a period of 7 days.

E. Do not cure using curing compound or membrane, unless method is part of repair mortar system manufacturer's printed instructions and approval is obtained from Engineer.

F. Cure intermediate layers of repair mortar in accordance with repair mortar manufacturer's printed instructions.

G. Where curing compound is permitted by repair mortar system manufacturer, apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.09 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:

1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
2. Obtain production samples of mixed wet mortar materials from nozzle, or mixer, during construction for compliance with Specifications for testing at 7 days, and 28 days.
3. Provide a minimum of three samples for each 1,000 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing.
4. Record location where repair mortar is being applied at time production samples are obtained.

C. Direct Tension Bond Test:

1. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
2. Record locations on in situ bond tests on each type of applied repair mortar.
3. Laboratory Bond Testing:
   a. Core two 2-1/2-inch or 3-inch-diameter core drilled samples per ASTM C42/C42M for each 2,000 square feet of repair work for direct tension bond testing. Where total area repaired is less than 2,000 square feet, core two 2-1/2-inch or 3-inch diameter samples for direct tension bond testing. Record locations of core drilled samples extracted from each type of applied repair mortar.

b. Cut core samples through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness. Avoid core drilling through structural element.
c. Saw cut core samples after removal to trim base concrete thickness to same thickness as mortar so bond line is at center of prepared core sample.
d. Bond core samples to steel plates at each end using epoxy bonding agent.
e. Perform tension bond testing using calibrated independent test laboratory equipment and eyebolts or threaded connectors tapped and threaded into baseplate in order that tension load is concentric with center of core sample.
f. Bond Strength of Repair Mortar to Substrate Concrete: 300 psi minimum in direct tension without failure or movement.

D. Retest mortar repairs that do not meet test requirements.

E. Repair and fill holes using same repair mortar where core samples have been removed.

3.10 MORTAR REPAIR FAILED TEST

A. Remove and replace unacceptable Work.

B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge. Remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.

C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.

D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.

E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.11 MANUFACTURER'S SERVICES

A. Provide repair mortar system manufacturer's representative at Site to review acceptability of surface preparation, mixing and installation assistance, training of repair mortar system applicators,] inspection, and Certification of Proper Installation.

3.12 CLEANING

A. Remove overshot low-pressure spray, Repair System B repair mortar and rebound materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of or repair areas and for finishing, and curing. Dispose offsite at an approved disposal site.

END OF SECTION

SECTION 03 01 33
REPAIR OF HORIZONTAL CONCRETE SURFACES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): T277, Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
2. ASTM International (ASTM):
   a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   b. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   c. A1064/A1064 M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   d. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   e. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   f. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   g. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   h. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   i. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
   j. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   k. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   l. C779/C779M, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
   m. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   n. C928/C928M, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs.

o. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
p. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
q. C1583/C1583M, 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).
r. D638, Standard Test Method for Tensile Properties of Plastics.
s. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
t. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
u. D4259, Standard Practice for Abrading Concrete.
v. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

1.02 DEFINITIONS

A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. High-Pressure Water Blasting (sometimes referred to as hydro-demolition): Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.

D. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete**.**

1.03 SUBMITTALS

A. Action Submittals: Product data sheets for each material supplied.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer's preparation and installation instructions.
2. Written description of equipment proposed for concrete removal and surface preparation.

3. Certificates:
    a. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems meet requirements of ASTM C928/C928M.
    b. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on horizontal surfaces that are exposed to weather, moisture, or receive traffic.
    c. Mortar Manufacturer's Certificate of Proper Installation.
4. Statements of Qualification:
    a. Repair mortar system applicator.
    b. Independent Testing Laboratory.
5. Field and laboratory test results.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: Trained and experienced applicator endorsed by repair mortar system manufacturer.
2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Demonstration Mockup for Repair Mortar:

C. Pre-repair Conference:

1. Required Meeting Attendees:
    a. Contractor.
    b. Repair Subcontractor.
    c. Technical representative for repair material manufacturer.
    d. Owner or Owner's representative.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include, but not limited to:
    a. Review of field conditions. Conduct field observations of the Work to be performed.
    b. Based on above observations, repair material manufacturer's technical representative shall confirm material selection and make Project specific repair method recommendations.

c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.

B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR MORTAR SYSTEM NO. 2—HIGH EARLY STRENGTH REPAIR MORTAR

A. One-component, fast-setting, high early strength repair mortar.

B. Compressive Strength, ASTM C109/C109M:

1. 2 Hours: 1,500 psi minimum.
2. 1 Day: 4,500 psi minimum.
3. 7 Days: 8,000 psi minimum.
4. 28 Days: 9,000 psi minimum.

C. Flexural Strength, ASTM C348:

1. 1 Day: 850 psi minimum.
2. 7 Days: 1,000 psi minimum.
3. 28 Days: 1,100 psi minimum.

D. Modulus of Elasticity, ASTM C469:

1. 1 Day: 3.8 by 106 psi minimum.
2. 28 Days: 4.5 by 10^6 psi minimum.

E. Slant Shear Bond Strength, ASTM C882/C882M (Modified):

1. 1 Day: 2,500 psi minimum.
2. 7 Days: 2,900 psi minimum.
3. 28 Days: 3,100 psi minimum.

F. Splitting Tensile Strength, ASTM C496/C496M:

1. 1 Day: 850 psi minimum.
2. 7 Days: 1,200 psi minimum.
3. 28 Days: 1,300 psi minimum.

G. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 98 percent RDM.

H. Chloride Ion Permeability Based on Charge Passed, ASTM C1202 or AASHTO T277, 28 Days: 960 coulombs maximum.

I. Manufacturers and Products:

1. Master Builders Solutions US; MasterEmaco T 415.
2. Euclid Chemical Co., Cleveland, OH; VersaSpeed.

2.02 REPAIR MORTAR SYSTEM NO. 3—SHRINKAGE COMPENSATED REPAIR MORTAR

A. One-component cement-based, flowable, shrinkage compensated repair mortar system.

B. Compressive Strength, ASTM C109/C109M:

1. 1 Day: 2,500 psi minimum.
2. 7 Days: 6,000 psi minimum.
3. 28 Days: 8,000 psi minimum.

C. Flexural Strength, ASTM C348 at 28 Days: 770 psi minimum.

D. Modulus of Elasticity, ASTM C469 at 28 Days: 5.9 by 106 psi minimum.

E. Slant Shear Bond Strength, ASTM C882/C882M Modified:

1. 7 Days: 2,150 psi minimum.
2. 28 Days: 3, 000 psi minimum.

F. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 97.0 percent RDM.

G. Chloride Ion Permeability Based on Charge Passed, ASTM C1202 at 28 Days: 650 coulombs maximum.

H. Sulfate Resistance, ASTM C1012/C1012M after 6 Months: 0.01 percent length change maximum.

I. Manufacturers and Products:

1. Master Builders Solutions US; MasterEmaco S 466 CI.
2. Euclid Chemical Co., Cleveland, OH; Eucocrete Supreme.

2.03 REPAIR MORTAR SYSTEM NO. 5—POLYMER MODIFIED REPAIR MORTAR

A. One-component, fast-setting, polymer modified cementitious based repair mortar system.

B. Compressive Strength, ASTM C109/C109M:

1. 1 Day: 2,500 psi minimum.
2. 7 Days: 5,000 psi minimum.
3. 28 Days: 7,000 psi minimum.

C. Flexural Strength, ASTM C348 at 28 Days: 1,500 psi minimum.

D. Slant Shear Bond Strength, ASTM C882/C882M Modified at 28 Days: 2,000 psi minimum.

E. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.

F. Abrasion Resistance Depth of Wear, ASTM C779/C779M, Procedure A, at 60 Minutes: 0.033 inch maximum.

G. Drying Shrinkage, ASTM C157/C157M Modified, at 28 Days: 0.09 percent maximum.

H. Rapid Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 28 Days: Under 850 coulombs maximum.

I. Manufacturers and Products:

1. Euclid Chemical Co., Cleveland, OH; Duraltop Flowable Mortar.
2. Sika Corp., Lyndhurst, NJ; SikaTop 111 PLUS.

2.04 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.05 REINFORCEMENT

A. Deformed Steel reinforcement: Per Section 03 21 00, Steel Reinforcement.

B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameterge.

2.06 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

A. Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.

1. Mixed Bonding Agent Properties:
   a. Pot Life: 75 minutes to 105 minutes.
   b. Contact Time: 24 hours.
   c. Color: Concrete gray.
2. Cured Cementitious Adhesive Properties:
   a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.
   b. Flexural Strength, ASTM C348: 1,000 psi minimum.
   c. Slant Shear Bond Strength, ASTM C882/C882M:
      1) 2-Hour Open Time: 2,500 psi minimum.
      2) 24-Hour Open Time: 2,000 psi minimum.
3. Bonding agent shall not produce a vapor barrier.
4. Compatible with, and from same manufacturer as the, repair mortar system used.

B. Manufacturers and Products:

1. Master Builders Solutions US; MasterEmaco P 124.
2. Sika Corp., Lyndhurst, NJ; Sika Armatec-110 EpoCem.
3. Euclid Chemical Co., Cleveland, OH; Duralprep A.C.

2.07 EPOXY BONDING AGENT

A. Two-component, moisture insensitive, 100 percent solids epoxy resin.

B. Tensile Strength, ASTM D638, at 14 Days: 3,800 psi minimum.

C. Elongation at Break, ASTM D638: 1.49 percent minimum.

D. Compressive Strength, ASTM D695, at 28 Days for Application Temperature of 73 Degrees F to 77 Degrees F: 8,000 psi minimum.

E. Bond Strength, ASTM C882/C882M, at 14 Days: 1,800 psi minimum.

F. Pot Life, at 73 Degrees F to 77 Degrees F: 75 minutes minimum.

G. Manufacturers and Products:

1. Master Builders Solutions US; MasterEmaco ADH 326 when ambient temperature is 73 degrees F or higher.
2. Sika Corp., Lyndhurst, NJ; Sikadur-32 Hi-Mod LPL.

2.08 EVAPORATION RETARDANT

A. As specified in Section 03 39 00, Concrete Curing.

2.09 CURING COMPOUND

A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL

A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system.

B. Existing Concrete Work: Repair concrete as identified in Contract Documents.

3.02 APPLICATION

A. General:

1. Repair Mortar System No. 2: Patches, joints, or overlays 1/2 inch to 3 inches thick. Return to service in 3 hours to 7 days.
2. Repair Mortar System No. 3: Patches, joints, or overlays 1 inch thick or greater. Return to service in 7 days or more.
3. Repair Mortar System No. 5:
   a. Patches and Overlays: 1/4 inch to 3 inches thick.
   b. Return to service for foot traffic in 4 hours; wheel traffic in 7 days.
   c. Working Time: 30 minutes at 70 degrees F.
   d. Application Temperature Range: 45 degrees F to 90 degrees F.

3.03 PREPARATION

A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer. Review proposed extent of repair with Engineer.

B. Remove unsound, deteriorated, or otherwise defective areas of concrete from Work areas.

1. Use 8,000 psi minimum high-pressure water or abrasive blasting machine, as appropriate to suit Site conditions.
2. Remove concrete to abrade substrate concrete surface to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
3. For existing structures, extent of concrete removal as shown on Drawings, in Specifications, or based on investigation by contractor.
4. Where final surface is required to be flush with existing adjacent surface, remove existing concrete depth as required for application of minimum thickness of repair mortar.

C. Do not use power-driven jackhammers, chipping hammers, scabblers, or scarifiers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 15 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.

D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.

E. Remove unsound concrete to satisfaction of Engineer.

F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.

G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to entire circumference of exposed steel reinforcement if one or more of the following surface conditions exist:

1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.

2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.

H. Remove loose, flaky, or laminar sections of rust from surface of reinforcing bars. Surface of reinforcing bar with light well-adhered rust is acceptable.

I. Remove deleterious material and concrete splatter from surface of reinforcing bars.

J. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminates from prepared areas.

K. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System Nos. 2, 3 and 5: Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar, as required by and in accordance with repair mortar manufacturer’s printed instructions.

L. Spalled Joints:

1. Saw cut edge 1 inch deep and 6 inches back from old joint.
2. Remove unsound concrete and concrete between saw cut and joint.
3. Place wood or fiber spacer to thickness of joint at joint line.

M. Overlays:

1. Square cut edges to a minimum of 1/4 inch deep.
2. Do not feather edge area.
3. Perform special preparation recommended by mortar manufacturer.

N. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.

3.04 REINFORCEMENT INSTALLATION

A. Replace deteriorated steel reinforcement with new steel reinforcement equivalent in cross-sectional area to original steel reinforcement.

B. Fasten steel reinforcement to chairs with tie wire to prevent from moving during placement of repair mortar.

C. Coat exposed new and existing steel reinforcement with cementitious reinforcement coating at the same time as substrate concrete is coated, as specified below, per repair mortar and cementitious reinforcement coating manufacturers' printed instructions.

3.05 PROTECTION

A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.

B. Protect adjacent surfaces, and equipment from spillage of repair mortar and dust, as applicable for repair mortar system used.

3.06 PLACEMENT

A. Repair Mortar System Nos. 2, 3 and 5:

1. Remove standing and free water from prepared area.
2. Apply bond scrub coat of mortar to prepared surface in accordance with manufacturer's instructions. Do not apply more scrub coat of mortar than can be covered with repair mortar before scrub coat begins drying.
3. Immediately place mixed repair mortar into prepared area from one side to the other side.
4. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
5. Level repair mortar and screed to elevation of existing concrete.
6. Finish to same texture as existing concrete around patch.
7. Repair Mortar System No. 5 screed or use self-leveling mixture to obtain a uniform and plane surface.

B. Joint Repair:

1. Remove joint spacer when repair mortar is hard enough that a pointed trowel will penetrate surface less than 1/2 inch.
2. When repair mortar is cured and ready for use, fill joint in accordance with repair mortar system manufacturer's instructions.

3.07 FINISHING

A. Where final surface is not in contact with potable water,] Spray full strength evaporation retardant on fresh concrete to prevent rapid drying during hot and windy weather.

3.08 CURING

A. Repair Mortar System Nos. 2, 3, or 5: Cure in accordance with manufacturer's instructions and Section 03 39 00, Concrete Curing.

3.09 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Chain drag or light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:

1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
2. Obtain production samples of mixed materials from mixer during construction for compliance with Specifications.
3. Provide minimum of three samples for each 1,000 square feet of mortar repair, and a minimum of three samples in total, whichever is greater for testing.
4. Record location where repair mortar is being applied at time production samples are obtained.

C. Direct Tension Bond Test:

1. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
2. Record locations on in situ bond tests on each type of applied repair mortar.
3. Laboratory Bond Testing:
   a. Core two 2-1/2-inch or 3-inch diameter core drilled samples per ASTM C42/C42M for each 2,000 square feet of repair work for direct tension bond testing. Where total area repaired is less than 2,000 square feet, core two 2-1/2-inch or 3-inch diameter samples for direct tension bond testing. Record locations of core drilled samples extracted from each type of applied repair mortar.

b. Cut core samples through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness.
c. Saw cut core samples after removal to trim base concrete thickness to same thickness as mortar so bond line is at center of prepared core sample.
d. Bond core samples to steel plates at each end using epoxy bonding agent.
e. Perform tension bond testing using calibrated independent test laboratory equipment and eyebolts or threaded connectors tapped and threaded into baseplate in order that tension load is concentric with the center of the core sample.
f. Bond Strength of Repair Mortar to Substrate Concrete: 200 psi minimum in direct tension without failure or movement.

D. Retest mortar repairs that do not meet test requirements.

E. Repair and fill holes using same repair mortar where core samples have been removed.

3.10 MORTAR REPAIR FAILED TEST

A. Remove and replace unacceptable Work.

B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge, remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.

C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.

D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.

E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.11 MANUFACTURERS' SERVICES

A. Provide mortar manufacturer's representative at Site to advice on product selection, review acceptability of surface preparation, mixing and installation assistance, inspection, and Certification of Proper Installation.

3.12 CLEANING

A. Remove excess repair mortar materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of repair areas and for finishing and curing. Dispose offsite at approved disposal site.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 GENERAL

A. Unless otherwise specified, Work shall conform to requirements of Section 1 through Section 5 of ACI 301, Specifications for Structural Concrete.

1. Environmental concrete structures are included in the scope of the Work.

1.02 REFERENCES

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

1. American Concrete Institute (ACI): 301, Specifications for Structural Concrete.

1.03 DEFINITIONS

A. Unless otherwise specified, definitions are in accordance with 1.3 of ACI 301 and Section 03 30 00, Cast-in-Place Concrete.

1.04 SUBMITTALS

A. Unless otherwise specified, submittals shall be in accordance with 2.1.2 of ACI 301.

B. Action Submittals:

1. Form-Facing Materials: Submittal is not required.
2. Construction and Movement Joints.
3. Testing for Formwork Removal: Submittal is not required.
4. Manufacturer’s Product Data on Formwork Release Agent for Use on Each Form-Facing Material.
5. Manufacturer’s Product Data on Form Liner Proposed for Use with Each Formed Surface: Submittal is not required.
6. Manufacturer’s Data Sheet for Form Ties.
7. Manufacturer’s Data Sheet for Formwork Materials Not Listed Elsewhere in Contract Documents, Which Are to Be Left in Place Within Work.
8. Double-Wall Construction (New Wall Cast Adjacent to Existing Wall): Drawings and details of double-wall forming and premolded

C. Informational Submittals: Reshoring and Backshoring Procedures.

1.05 DESIGN REQUIREMENTS

A. In accordance with ACI 301 to provide concrete finishes specified in Section 03 30 00, Cast-in-Place Concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified, in accordance with 2.2.1 of ACI 301.

B. Materials:

1. Form-facing Materials:
   a. Where steel forms are used, treat steel surfaces to prevent rusting using products approved for use on steel forms.
      1) Form Snap-Ties:
      2) Material:
         a) Unless otherwise specified: Steel.
      3) Spreader Inserts:
         a) Conical or spherical type.
         b) Design to maintain positive contact with forming material.
         c) Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
      4) Wire ties not permitted.
      5) Flat bar ties for panel forms; furnish plastic or rubber inserts with minimum 1.5-inch depth and sufficient dimensions to permit patching of tie hole.
      6) Form Snap-Ties with Water Stop:
         a) For hydraulic structures, basements, pipe galleries, and accessible spaces below finish grade:
            (1) Neoprene water stop 1/8-inch thick and 5/8-inch diameter that fits tightly around tie so as to prevent displacement of the waterstop during concrete placement, or molded plastic water stop of comparable size.
         b) Orient waterstop perpendicular to tie and symmetrical about center of tie.
         c) Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.

b. Through-Bolts:
1) At Contractor's option, may be used as alternate to form snap-tie or form snap-tie with water stop.
2) Tapered minimum 1-inch diameter at smallest end.
3) Plug for Through-Bolt Tie Holes:
a) Design and size of plug to allow insertion and compression of plug to form impermeable seal at center of member.
b) Manufacturers and Products:
(1) Sika Greenstreak, St. Louis, MO; X-Plug.

2. Formwork Release Agents:
a. Use commercially manufactured formwork release agents that reduce formwork moisture absorption, inhibit bond with concrete, and do not stain concrete surfaces exposed to view in the finished construction.
b. Formwork release agents shall comply with federal, state, and local regulations.
c. Manufacturers and Products: Not for surfaces exposed to potable water. Master Builders Solutions US, Shakopee, MN; MasterFinish RL-211.Euclid Chemical, Cleveland, OH; FORMSHIELD WB.
3. Expansion Joint Filler: See Section 03 15 00, Concrete Joints and Accessories.
4. Other Embedded Items: Unless otherwise specified, in accordance with 2.2.1.5 of ACI 301.
5. Chamfer Materials.

C. Performance and Design Requirements:

1. Unless otherwise noted, in accordance with 2.2.2 of ACI 301.
2. Provide concrete finishes specified in Section 03 30 00, Cast-in-Place Concrete, and within specified tolerances.
a. Earth cuts may be used as forms for vertical or sloping surfaces provided the following is satisfied:Concrete element shall not be visible in finished construction.
2) Contractor solicits and receives Building Official's concurrence that soil conditions do not require formwork.
3) Contractor coordinates interface between concrete element and adjacent construction, and adjudicates conflicts between concrete element and adjacent construction, at no additional cost to Owner.
4) Concrete cover at sides of concrete element shall comply with minimum requirements for concrete cast against earth. Achieve minimum cover by increasing width of concrete element by 1 inch, for each vertical face cast against earth.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise specified, execution shall be in accordance with in accordance with 2.3 of ACI 301.

1. Unless otherwise noted, provide bevels on re-entrant corners of concrete.
   a. Do not provide bevels in re-entrant corner of penetration where appurtenance passing through penetration shall fit tight within penetration.
2. Unless otherwise noted, provide bevels on edges of formed concrete joints.
   a. Do not provide bevels along expansion joints or interior construction joints of slabs.

B. Form Tolerances:

1. Unless otherwise specified, provide forms in accordance with ACI 117 for cast in place concrete buildings and ACI 301, and the following tolerances for finishes specified:
   a. See the Schedule of Concrete Finishes in Section 03 30 00, Cast-in-Place Concrete, for beam, column, and wall types related to required form tolerances.
   b. Wall Tolerances:
      1) Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
      2) Wall Type W-A:
         a) Plumb within 1/4 inch in 10 feet or within 1 inch from top to bottom for walls over 40 feet high.
         b) Depressions in Wall Surface: Maximum 5/16 inch when 10-foot straightedge is placed on high points in all directions.
      3) Wall Type W-B:
         a) Plumb within 1/8 inch in 10 feet or within 1/2 inch from top to bottom for walls over 40 feet high.
         b) Depressions in Wall Surface: Maximum 1/8 inch when 10-foot straightedge is placed on high points in all directions.
      4) Thickness: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
      5) Form Offset: Between adjacent pieces of formwork, facing material shall not exceed 1/4 inch.

c. Beams and Columns Tolerances:
   1) Exposed Straight Horizontal and Vertical Surfaces: Flat planes within tolerances specified.
   2) Lateral Alignment:
      a) Centerlines shall be within plus or minus 1/2 inch from dimensions shown.
      b) At intersections, centerlines shall intersect within plus or minus 1/2 inch of dimensions shown.
   3) Beam Type B-A:
      a) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
      b) Elevations: Within plus or minus 1/2 inch, except where tops of beams become part of finished slab. In this case refer to slab tolerances.
   4) Column Type C-A:
      a) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
      b) Plumb within 1/4 inch in 10 feet in all directions with maximum 1/2 inch out-of-plumb at top with respect to bottom.

3.02 CONSTRUCTION OF FORMWORK

A. Unless otherwise specified, construction of formwork shall be in accordance with 2.3.1 of ACI 301.

B. Provide chamfer strips in corners of formwork where concrete will be exposed to view in finished construction.

C. Do not provide chamfer along top of formed edge of along an expansion joint in slab.

D. Double-Wall Construction (new wall cast against existing wall):

   1. Joint Filler Attachment:
      a. Use attachments to secure premolded joint filler to one wall only.
      b. Secure premolded joint filler without gaps and separations keeping concrete from second wall pour from penetrating thickness and space occupied by premolded joint filler.
   2. Do not use form ties or other devices permanently penetrating premolded joint filler between walls or produce a rigid connection between walls.

3. First cast wall shall obtain the greater of the wall design concrete strength or the construction strength required, as determine by form design engineer, prior to casting second wall. Strength determination shall be based on field cast and cured test cylinders.
4. Do not use formwork that leaks mortar.
5. Provide premolded joint filler or sealant to minimize transfer of movement from one structure to the other.

E. Curb, Sidewalk, and Driveway Forms:

1. Provide standard steel or wood forms.
2. Set forms to true lines and grades, and securely stake in position.

3.03 REMOVAL OF FORMWORK

A. Unless otherwise specified, removal of formwork shall be in accordance with 2.3.2 of ACI 301.

B. Form Ties: Remove conical inserts or through bolts and plug holes as specified in Section 03 30 00, Cast-in-Place Concrete.

C. Shoring shall not be removed unless replaced with reshoring and backshoring, earlier than 72 hours from when final curing began on the last placement of concrete in the pour.

D. Reshoring and backshoring shall not be removed earlier than 72 hours from when final curing began on the last placement of concrete in the pour.

3.04 RESHORING AND BACKSHORING

A. Unless otherwise specified, reshoring and backshoring shall be in accordance with 2.3.3 of ACI 301.

3.05 STRENGTH OF CONCRETE REQUIRED FOR REMOVAL OF FORMWORK, SHORING, RESHORING, AND BACKSHORING

A. Unless otherwise specified, determination of strength of in-place concrete shall be in accordance with 2.3.4 of ACI 301 and 3.03 Removal of Formwork.

B. Unless otherwise specified, in-place strength of concrete shall be determined using field cured cylinders prepared in accordance with ASTM C31/C31M and tested in accordance with ASTM C39/C39M.

3.06 FIELD SURVEY CONTROLS

A. In accordance with 2.3.5 of ACI 301.

3.07 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

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

END OF SECTION

SECTION 03 15 00
CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A36/A36M, Specification for Carbon Structural Steel.
   b. A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   d. A767/A767M, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   e. C920, Specification for Elastomeric Joint Sealants.
   f. D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   g. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
   h. D994, Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
   i. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
   j. D1171, Standard Guide for Evaluating Nonwoven Fabrics.
   k. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   l. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   m. D2240, Standard Test Method for Rubber Property – Durometer Hardness.
2. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
   b. Construction Joints, Expansion Joints, and Control Joints: Layout and location for each type. Include joint locations shown on Drawings, additional required joint locations, and any proposed alternate locations.
2. Product Data:
   a. Waterstops.
   b. Bond breaker.
   c. Premolded joint fillers.
   d. Pourable joint fillers.
   e. Preformed control joints.
   f. Roofing felt.
   g. Accessories not specified in other sections.
3. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.

B. Informational Submittals:

1. Certification:
   a. Letter stating compatibility between liquids being contained and materials used for:
      1) Waterstops.
      2) Joint fillers.
   b. Manufacturer’s application instructions for:
      1) Bonding agent.
      2) Bond breaker.
2. Manufacturer’s written instructions for product shipment, storage, handling, installation/application, and repair for:
   a. Waterstops.
   b. Bond breaker.
   c. Bonding agent.
   d. Premolded joint fillers.
   e. Pourable joint fillers (sealant proportions not required as products used only as a filler).
   f. Preformed control joints.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site: Verify delivered materials are in accordance with Specifications, regulatory agencies, and Manufacturer's product data sheets prior to unloading and storing onsite.

B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight or as required by Manufacturer.

PART 2 PRODUCTS

2.01 THERMOPLASTIC VULCANIZATE (TPV) OR THERMOPLASTIC ELASTOMERIC RUBBER (TPER) WATERSTOP

A. Extruded from thermoplastic vulcanizate rubber compound. Compound shall not contain scrapped material, reclaimed material, or pigment.

B. Shore Durometer Type A Hardness: Approximately 85.

C. Ozone Resistance: Per ASTM D1171, must pass at 600 pphm.

D. Type Required in Expansion, Contraction, and Control Joints: 4 inches wide, 6 inches wide or 9 inches wide with center bulb and parallel longitudinal ribs or protrusions on each side of strip center, as indicated on the Drawings.

E. Type Required in Construction Joints: Flat ribbed with same dimensional properties as described above.

F. Thickness: Constant from bulb edge (or center of waterstop) to outside stop edge.

G. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

H. Manufacturers and Products:

1. Sika Corporation, Lyndhurst, NJ; (TPE-R), Envirostop 600 Series.
2. Vinylex, St. Louis, MO; Model VRB6316 (6 inches by 3/8 inch) and VRB9316 (9 inches by 3/8 inch).
3. J.P Specialties, Inc. Flexible TPV Waterstop; Model JP436 (4 inches by 3/16 inch) and JP636 (6 inches by 3/16 inch).

2.02 POLYVINYL CHLORIDE (PVC) WATERSTOP

A. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.

B. Specific Gravity: Approximately 1.37.

C. Shore Durometer Type A Hardness: Approximately 80.

D. Performance Requirements: COE Specification CRD-C-572.

E. Type Required in Expansion Joints: Where waterstop is indicated on Drawings, provide 6 inches wide with center bulb and parallel longitudinal ribs or protrusions on each side of strip center.

F. Type Required in Contraction and Control Joints: Where waterstop is indicated on the Drawings, provide 6 inches wide or 9 inches wide with center bulb and parallel longitudinal ribs or protrusions on each side of strip center.

G. Type Required in Construction Joints: Where waterstop is indicated on Drawings, provide flat ribbed, 6 inches wide or 9 inches wide with parallel longitudinal ribs or protrusions on each side of strip center. Center bulb is optional.

H. Corrugated or tapered type waterstops are not acceptable.

I. Thickness: Constant from bulb edge (or center of waterstop) to outside stop edge.

J. Minimum Weight per Foot of Waterstop:

1. 1.60 pounds for 3/8 inch by 6 inches.
2. 2.30 pounds for 3/8 inch by 9 inches.

K. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

L. Manufacturers and Products for Center Bulb Type:

1. Use same manufacturers for flat ribbed profile:
   a. Vinylex Corp., St. Louis, MO; No. RB638H (6 inches by 3/8 inch) and No. RB938H (9 inches by 3/8 inch).
   b. Sika Corporation, Lyndhurst, NJ; Style 732 (6 inches by 3/8 inch) and Style 735 (9 inches by 3/8 inch).

c. Durajoint, Garrettsville, OH; Type 9 (6 inches by 3/8 inch), and Type 10 (9 inches by 3/8 inch).
d. JP Specialties, Inc., Murrieta, CA; PVC638 (6 inches by 3/8 inch ribbed center bulb), and PVC938 (9 inches by 3/8 inch).
e. BoMetals, Carrollton, GA; No. RCB-638LB (6 inches by 3/8 inch) and No. RCB-938NT (9 inches by 3/8 inch).
f. Dacon Plastics LLC, Jacksonville, TX; No. RCB17 (6 inches by 3/8 inch) and No. RCB18 (9 inches by 3/8 inch).

2.03 HYDROPHILIC WATERSTOP

A. For use at construction joints only, where new concrete is placed against existing concrete and as shown on the Drawings.

B. Material shall be a nonbentonite hydrophilic rubber compound.

C. Manufacturers and Products:

1. Sika Corporation, Lyndhurst, NJ; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
2. Adeka Ultra Seal, OCM Inc., Grayslake, IL; MC-2010M with 3M-2141 adhesive and P-201 sealant.
3. JP Specialties, Inc., Murrieta, CA; Type NB190 Profile A with Type NB190 Waterstop Paste and NB 190 Waterstop Adhesive sealant.

2.04 BOND BREAKER

A. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape. Same width as joint that will adhere to premolded joint material or concrete surface.

B. Use bond prevention material as specified in Section 03 30 00, Cast-in-Place Concrete, except where bond breaker tape is specifically called for on Drawings.

2.05 PREMOLDED JOINT FILLER

A. Bituminous Type: ASTM D994 or ASTM D1751.

B. Sponge Rubber:

1. Neoprene, closed cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum. Use in joints for potable and nonpotable water containment structures.
2. Manufacturer and Product: Monmouth Rubber and Plastics, Corp, Long Branch, NJ; Durafoam DK5151.

C. Self-Expanding Cork:

1. ASTM D1752, Type III.
2. Manufacturer and Product: WR Meadows, Inc., York, PA; self-expanding cork.

2.06 BUILDING PREFORMED CONTROL JOINT

A. One-Piece, Flexible, Polyvinyl Chloride Joint Former:

1. Manufacturer and Product: WR Meadows, Inc., Hampshire, IL; Keyway.

B. One-Piece Galvanized Steel Strip with Preformed Groove:

1. Manufacturer and Product: BoMetals, Inc. Carrollton, GA; QuickKey or ProKey Joint.

C. Furnish in full-length, unspliced pieces.

2.07 POURABLE JOINT FILLERS

A. General:

1. Although product is a sealant, it is being specified as a filler to prevent debris accumulation and allow expansion and contraction under shrinkage and thermal loads. It does not need to meet proportional sealant geometry requirements.

B. Filler for Potable or Non-Potable Water Containment Structures:

1. Multicomponent sealant, self-leveling, or nonsag as required for level, sloping, or vertical joints.
2. Color: White.
3. Manufacturer and Product: Sika Corp., Lyndhurst, NJ; Sikaflex-2c.

2.08 ACCESSORIES

A. Joint Sealant: Polyurethane as specified in Section 07 92 00, Joint Sealants.

B. One-Part Polyurethane, Immersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or Grade P, Class 25.
2. Capable of being continuously immersed in water.

3. Manufacturers and Products for Nonsag:
   a. Sika Chemical Corp.; Sikaflex-1a.
   b. Tremco; Vulkem 116.
4. Manufacturers and Products for Self-leveling:
   a. BASF; Sonneborn, SL-1.
   b. Tremco; Vulkem 45.
   c. Sika Chemical Corp.; Sikaflex 1c SL.

C. Roofing Felt: ASTM D226, Type II, 30-pound asphalt-saturated or equal weight of ASTM D227 coal-tar saturated felt.

D. Steel Reinforcement: As specified in Section 03 21 00, Steel Reinforcement.

E. Nails: Galvanized, as required for securing premolded joint filler.

F. Galvanized Rebar at Control Joints: ASTM A767/A767M and ASTM A615/A615M Grade 60 prior to galvanizing.

G. Ties for PVC Waterstop: “Hog Rings” or grommets for each edge at 12-inch maximum spacing.

PART 3 EXECUTION

3.01 GENERAL

A. Commence concrete placement after joint preparation is complete.

B. Time Between Concrete Pours: As specified in Section 03 30 00, Cast-in-Place Concrete.

3.02 SURFACE PREPARATION

A. Construction Joints: Clean concrete surface prior to placement of abutting concrete.

1. Remove laitance and spillage from steel reinforcement and dowels.
2. Roughen surface to minimum of 1/4-inch amplitude:
   a. Sandblast after concrete has fully cured.
   b. Water blast after concrete has partially cured.
   c. Green cut fresh concrete with high-pressure water and hand tools.
3. If present in joint, do not damage waterstop.

B. Contraction Joint:

1. Coat concrete surfaces above and below plastic waterstop with bond breaker.
2. If present in joint, do not damage or coat waterstop.

C. Construction Joint with Hydrophilic Waterstop:

1. Follow hydrophilic waterstop manufacturer's written instructions.
2. Concrete surface along which waterstop will be installed must be smooth, clean, and dry. Grind concrete as required.
3. Clean debris, dirt, dust, and foreign material from concrete and waterstop surfaces.

3.03 INSTALLATION OF WATERSTOPS

A. General:

1. Continuous waterstop shall be installed in all construction joints in walls and slabs of liquid-containing basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
2. Join waterstop at intersections to provide continuous seal.
3. Center waterstop on joint.
4. Secure waterstop in correct position. Tie waterstop to steel reinforcement using grommets, "Hog Rings," or tiewire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.
5. Repair or replace damaged waterstop.
6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
7. Joints in Footings and Slabs:
    a. Ensure that space beneath horizontal waterstop is completely filled with concrete.
    b. During concrete placement, make visual inspection of waterstop area.
    c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift ribbed waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. Plastic (PVC) Waterstops:

1. Install in accordance with manufacturer's written instructions.
2. Splice in accordance with waterstop manufacturer's written instructions using Teflon-coated thermostatically controlled heating iron at approximately 380 degrees F.
   a. Allow at least 10 minutes before new splice is pulled or strained in any way.
   b. Finished splices shall provide cross section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.
   c. Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
   d. Field splice permitted only for straight butt welds.
   e. Edge welding not permitted.
   f. Additional splicing defects which are unacceptable and are cause for rejection:
      1) Misalignment of center bulbs and ribs greater than 1/16 inch or where waterstop cross-section is reduced by more than 15 percent.
      2) Charred or burnt material.
3. Wire looped plastic waterstop may be substituted for plastic waterstop.

C. Thermoplastic Vulcanizate (TPV) and Thermoplastic Elastomer Rubber Waterstop (TPER):

1. Install similar to Plastic Waterstops in accordance with manufacturer's written instructions.
2. Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
3. Field splice permitted only for straight butt welds. Use heat butt weld splices.

D. Hydrophilic Waterstop:

1. Install in accordance with manufacturer's written instructions.
2. Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of steel reinforcement, locate centered between layers of steel or as shown.
3. Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
4. Lap ends of waterstop strip together at splices and corners and join with sealant.

5. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.
6. Lap hydrophilic waterstop 2 feet minimum with intersecting plastic waterstops.

3.04 EXPANSION JOINT INSTALLATION

A. Premolded Joint Filler:

1. Sufficient in width to completely fill joint space where shown.
2. Install per manufacturer's written instructions.
3. If waterstop is in joint, cut premolded joint filler to butt tightly against waterstop and concrete face.
4. Precut premolded joint filler to required depth at locations where joint filler or sealant is to be applied.
5. Form cavities for joint filler with either precut, premolded joint filler, or smooth removable accurately shaped material. Entire joint above waterstop, in slabs, shall be formed and removed so that entire space down to waterstop can be filled with the pourable joint filler.
6. Vibrate concrete thoroughly along joint form to produce dense, smooth surface.

B. Bituminous Type Premolded Joint Filler:

1. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.
2. Secure premolded joint filler in forms before concrete is placed.

C. Sponge Rubber Joint Filler: Install per manufacturer's written instructions.

D. Self-Expanding Cork Premolded Joint Filler: Install per manufacturer's written instructions.

E. Pourable Joint Filler:

1. General:
   a. Install in accordance with the manufacturer's written instructions, except as specified below:
      1) Apply primer prior to pouring joint filler.
      2) Fill entire joint above the waterstop with joint filler as shown.
      3) Use masking tape on top of slabs at sides of joints. Clean spillage. Remove masking tape afterwards.
      4) Sealant products used as fillers need not meet sealant geometry parameters. Do not use backing rods.

3.05 CONTRACTION JOINT INSTALLATION

A. Place bond breaker above and below waterstop.

B. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

3.06 CONTROL JOINT INSTALLATION

A. Locate galvanized steel reinforcement as shown.

B. Install waterstop.

C. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

D. Install bond breaker to concrete surfaces above and below waterstop.

3.07 PREFORMED CONTROL JOINTS

A. Use only where specifically shown; do not use in water-holding basins.

B. Locate slightly below top of slab.

C. Install in accordance with manufacturer’s written instructions in straight, full-length pieces.

D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement using only approved stakes and other secondary installation materials.

3.08 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

3.09 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

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

END OF SECTION

SECTION 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 GENERAL

A. Unless otherwise specified, Work shall conform to requirements of ACI 301-20, Specifications for Concrete Construction.

B. Unless otherwise specified, requirements of this section shall comply with requirements for corresponding term in ACI 301.

C. Scope: In accordance with 3.1.1 *Scope* of ACI 301.

1.02 REFERENCES

A. Unless otherwise noted, see 1.4 *Referenced standards* of ACI 301 for referenced standards.

B. Additional references are as follows:

1. American Concrete Institute (ACI): 301-20, Specifications for Structural Concrete.

C. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

A. Unless specified otherwise, in accordance with 3.1.2 *Submittals* of ACI 301.

B. Action Submittals: Unless otherwise specified, comply with the following before fabrication and execution of Work:

1. Placing drawings: In accordance with 3.1.2.1(b) of ACI 301.
2. Splices: In accordance with 3.1.2.1(c) of ACI 301.
3. Column dowels: In accordance with 3.1.2.1(e) of ACI 301.
4. Field bending or straightening: In accordance with 3.1.2.1(f) of ACI 301.
5. Field cutting of reinforcing bars: In accordance with 3.1.2.1(h) of ACI 301.

C. Informational Submittals:

1. Reinforcement: In accordance with 3.1.2.1(a) of ACI 301.
2. Bar mats: In accordance with 3.1.2.1(j) of ACI 301.

1.04 MATERIAL STORAGE, AND HANDLING

A. In accordance with 3.1.3 *Material storage and handling* of ACI 301.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified, in accordance with 3.2.1 *Materials* of ACI 301 and the following:

1. Steel reinforcing bars: Unless otherwise specified, in accordance with 3.2.1.1 of ACI 301 and shall conform to ASTM A615/A615M, Grade 60, and the following:
   a. Unless otherwise specified in Contract Documents, steel reinforcing bars shall be deformed.
2. Bar mats: In accordance with 3.2.1.3. of ACI 301.
3. Wire: In accordance with 3.2.1.5. of ACI 301 and the following:
   a. Minimum Yield Strength:
   b. Plain and deformed steel wire: In accordance with 3.2.1.5(a). of ACI 301, except that for wire with a specified yield strength (fy) exceeding 60,000 psi, fy shall correspond to a strain of 0.35 percent.
4. Welded wire reinforcement: In accordance with 3.2.1.6. of ACI 301 and the following:
   a. Unless otherwise specified, welded wire reinforcement shall be provided in flat sheets.
      1) If welded wire reinforcement is specified to be bent, provide in bent sheets.
   b. Minimum Yield Strength:
   c. Plain welded wire reinforcement: In accordance with 3.2.1.6(a) of ACI 301, except that for wire with a specified yield strength fy exceeding 60,000 psi, fy shall correspond to a strain of 0.35 percent.
   d. Deformed welded wire reinforcement: In accordance with 3.2.1.6(b) of ACI 301.

5. Headed shear stud reinforcement: In accordance with 3.2.1.7.
6. Reinforcement supports and spacers: In accordance with 3.2.1.8 of ACI 301 and the following:
    a. Plastic protected wire bar supports: In compliance with ANSI/CRSI – RB 4.1 Class 1 Reinforcement Supports, except provide Class 1A with epoxy-coated or dual-coated reinforcing steel.
    b. Stainless steel protected wire bar supports: In compliance with ANSI/CRSI – RB 4.1 Class 2B Reinforcement Supports, except the non-stainless steel portion of the supports shall not extend closer than ¾ inch from the surface of the concrete.
    c. Precast cementitious bar supports and spacers: In compliance with ANSI/CRSI – RB 4.1 Cementitious (Precast) Reinforcement Supports and the following:
        1) Precast cementitious bar supports shall have equal or greater strength than the surrounding concrete.
        2) Precast cementitious bar supports shall have water absorption and porosity equal to or less than water absorption and porosity of concrete being placed.
        3) Precast cementitious bar supports shall be four square inches minimum, in plan.
        4) Precast concrete shall contain a minimum of two tie embedded tie wires.
7. Tie Wire:
    a. Unless otherwise specified: Black, soft-annealed 16-gauge wire.
    b. For epoxy-coated or dual coated reinforcement: Tie wires with coated with epoxy or other polymer.
    c. For stainless steel reinforcement: Stainless steel or plastic coated tie wires.

2.02 FABRICATION

A. Unless otherwise specified, fabrication shall be in accordance with 3.2.2 *Fabrication* of ACI 301.

B. Bending - In accordance with 3.2.2.1 of ACI 301 and the following: The minimum inside bend diameters are specified in other Contract Documents.

C. Welding: Steel reinforcement shall not be welded.

PART 3 EXECUTION

3.01 PREPARATION

A. In accordance with 3.3.1 *Preparation* of ACI 301.

3.02 PLACING

A. Tolerances:

1. Reinforcing bars: In accordance with 3.3.2.1 of ACI 301.
2. Welded wire reinforcement: Shall be equal to that of reinforcing bars.

B. Reinforcement relocation: In accordance with 3.3.2.2 of ACI 301.

C. Concrete cover: In accordance with requirements specified elsewhere in Contract Documents.

D. Where reinforcement does not extend through a joint, terminate reinforcement 2 inches from face of joint, unless otherwise indicated.

E. Tying Reinforcing Bars:

1. Unless otherwise specified, reinforcing bars shall be tied as required to maintain position of reinforcing bars within specified tolerances, after concrete has been placed.
2. Tie every other intersection on mats of reinforcing steel made up of Nos. 3, 4, 5, and 6 bars.
3. Bend tie wire away from concrete surfaces.

F. Reinforcement Around Openings: Unless otherwise specified, provide one half the equivalent area of reinforcing bars interrupted by opening and penetration, on each side, above, and below openings and penetrations. Extend reinforcing bars lap length beyond opening at each end, which shall be calculated based on the minimum net spacing between typical and additional reinforcement.

1. Headed shear stud reinforcement: In accordance with 3.3.2.3(e) of ACI 301.
2. Minimum concrete cover around and above headed shear stud shall equal specified minimum concrete cover of reinforcement.

G. Reinforcement supports and spacers: Install reinforcement in accordance with 3.3.2.4 and the following:

1. Bar supports and spacers shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports, and location of reinforcement remains within tolerance throughout work.
2. Bar supports and spacers in contact with waterproofing barrier or vapor barrier, shall not damage barrier system.
3. Place reinforcement supported from ground or mud mat on precast cementitious reinforcement supports.
4. Bar supports and spacers in contact with forms: Unless otherwise specified, bar supports shall be plastic protected wire bar supports, stainless steel protected wire bar supports, or precast concrete bar supports.
    a. Unless otherwise specified, use Class 1 bar supports.
        1) Use Class 1A to support epoxy-coated and dual-coated reinforcing steel.
    b. Use stainless steel protected wire bar supports or precast concrete bar supports at formed surfaces that will be exposed to view in finished construction regardless of whether surface is specified to receive paint or coating.
    c. Use stainless steel protected wire bar supports or precast concrete bar supports at formed surfaces that will receive abrasive blasting, hydro-blasting, or grinding.

H. Welded wire reinforcement shall be supported in accordance with 3.3.2.5 of ACI 301 and as required for the welded wire reinforcement to be within specified tolerance after concrete has been placed.

I. Dowels: In accordance with 3.3.2.6 of ACI 301.

J. Lap splices, mechanical splices, and development of reinforcement: In accordance with 3.3.2.7 of ACI 301 and the following:

1. Lap splice lengths and development lengths of reinforcing bars: Refer to other Contract Documents for additional information and requirements.
2. Stagger splices in adjacent bars where indicated.

3. Mechanical Splices:
   a. Provide mechanical splices where shown on Drawings.
   b. Install assembly in accordance with manufacturer's written instructions and in accordance with ICC Evaluation Services Report or equivalent code agency report.
4. Lap splice lengths and development lengths of welded wire fabric reinforcing: Refer to other Contract Documents for additional information and requirements.

K. Field bending or straightening:

1. Unless otherwise specified, steel reinforcement shall not be field bent or straightened.
2. Where field bending and straightening is specified in Contract Documents, field bending and straightening may be performed only once per reinforcing bar, and shall be in accordance with 3.3.2.8 of ACI 301.

L. Field cutting reinforcement: In accordance with 3.3.2.9 of ACI 301.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

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

END OF SECTION

SECTION 03 24 00
FIBROUS REINFORCEMENT

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C78, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   b. C1116, Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
   c. C1550, Standard Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel).
   d. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).
   e. D2256, Tensile Properties of Yarns by the Single-Strand Method
   f. D7508, Standard Specification for Polyolefin Chopped Strands for Use in Concrete.
   g. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.

1.02 DEFINITIONS

A. Aspect Ratio: The ratio of length to diameter of the fiber.

B. Micro-Fibers: Shorter length, low dose, typically 0.1 percent by volume fibers designed to control plastic shrinkage cracking.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:2-hour fire resistance rating when tested under ASTM E119 on Series 700, Series 800, and Series 900 composite metal deck assemblies.

1.04 SUBMITTALS

A. Action Submittals:

1. Product data for fibrillated fibers.
2. Fiber reinforced concrete mix design.

B. Informational Submittals:

1. Manufacturer's written instructions for mixing and batching of fibrillated fibers.
2. Fiber manufacturer's Certificate of Compliance.
3. Manufacturer's written test procedure for the residual strength index of fiber reinforced concrete.
4. Certificate of Compliance from concrete supplier as to type, brand name, and amount of fibers added to mix.
5. Fiber manufacturer's certification of registration as proof of ISO 9002 Fiber Manufacturing Facility Certification.

PART 2 PRODUCTS

2.01 MATERIALS

A. Micro-Synthetic Fiber Reinforcement:

1. 100 percent virgin polypropylene self-fibrillating fibers.
2. Reprocessed olefin materials are not allowed.
3. Fibrillated bundles to allow uniform distributed angular fibrils (fiber strands) when mixed into concrete.
4. Multidesign gradation.
5. Specific Gravity: 0.91 minimum.
6. Minimum residual strength index of 50 psi.
7. Type III fibers conforming to ASTM C1116, Part 4.1.3.
8. Fiber Length: 0.50 inch to 1.0 inch
9. Manufacturers and Products:
    a. Euclid Chemical Company, Cleveland OH; Fiberstrand F.
    b. Sika Corporation, Lyndhurst, NJ: Fibermesh-300.

B. Concrete: Components shall conform to Section 03 30 00, Cast-in-Place Concrete.

2.02 CONCRETE MIX DESIGN AND CONCRETE MIXING

A. In accordance with Section 03 30 00, Cast-in-Place Concrete.

B. Add 1.5 pounds minimum per cubic yard at the time concrete is batched.

PART 3 EXECUTION

3.01 PLACING, PROTECTING, CURING, AND FINISHING

A. In accordance with Section 03 30 00, Cast-in-Place Concrete.

1. Mix fibers into concrete in accordance with fiber manufacturer's instructions.

3.02 FIELD QUALITY CONTROL

A. Test as specified in Section 03 30 00, Cast-in-Place Concrete.

3.03 MANUFACTURER'S SERVICE

A. Provide the services of a technical representative to instruct the concrete supplier in proper batching and mixing of materials.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 GENERAL

A. Unless otherwise specified, Work must be in accordance with ACI 301, Specifications for Structural Concrete.

1.02 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction Materials.
   b. 301, Specifications for Concrete Construction.
   c. 305.1, Specification for Hot Weather Concreting.
   d. 306.1, Standard Specification for Cold Weather Concreting.
   e. CP-1, Technical Workbook for Concrete Field Testing Technician – Grade I.
2. ASTM International (ASTM):
   a. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   b. C33/C33M, Standard Specification for Concrete Aggregates.
   c. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   e. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   f. C138/C138M, Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   g. C150/C150M, Standard Specification for Portland Cement.
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   j. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
   k. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
   l. C595/C595M, Standard Specification for Blended Hydraulic Cements.

m. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
n. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
o. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
p. C989/C989M, Standard Specification for Slag Cement for Use in Concrete and Mortars.
q. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
r. C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
s. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
t. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
u. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
v. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
w. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
x. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
y. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
z. ASTM C1581/C1581M, Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage.
aa. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
bb. C1583/C1583M, 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).
cc. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
dd. C1610/C1610M, Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique.
ee. C1611/C1611M, Standard Test Method for Slump Flow of Self-Consolidating Concrete.

ff. C1621/C1621M, Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring.
gg. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding.
hh. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
ii. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
jj. E1155, Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.

3. International Concrete Repair Institute (ICRI): PC1-10, Concrete Surface Profile Chip Set.
4. National Ready Mixed Concrete Association (NRMCA).

1.03 DEFINITIONS

A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

B. Defective Area:

1. Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4-inch in diameter, cracks in liquid containment structures and belowgrade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures with visible leakage or that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections.
2. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.
3. Cold joints.

C. Exposed Concrete: Concrete surface that in the finished construction can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained. Surfaces must be considered exposed concrete, even if covered by paint, sealers, or similar applications.

D. Flat and Elongated Particles of Aggregates: Those particles having a ratio of length to thickness greater than a 5 to 1.

E. Hot Weather: As defined in ACI 305.1.

F. Mass Concrete: Concrete sections with a minimum specified dimension that is equal to or greater than 2 feet 6 inches.

G. New Concrete: Less than 60 days old.

H. Permeability-Reducing Admixture: Crystalline materials consisting of proprietary active chemicals, used as constituent ingredient in a concrete mixture to reduce ingress and transport of moisture through cementitious matrix of hardened concrete. Also referred to as water-reducing admixture.

1.04 SUBMITTALS

A. Action Submittals:

1. Mix Designs:
   a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
   b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
   c. Manufacturer’s Certificate of Compliance, for the following:
      1) Portland cement.
      2) Blended cement.
      3) Performance-based cement for mix design for non-hydraulic structures in accordance with ACI 318.
      4) Fly ash.
      5) Slag cement.
      6) Silica fume.
      7) Aggregates, including specified class designation for coarse aggregate.
      8) Admixtures.
      9) Concrete producer has verified compatibility of constituent materials in design mix.
   d. Test Reports:
      1) Cement: Chemical analysis report.
      2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.

3) Aggregates:
   a) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
   b) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
4) Water-Soluble Chloride-Ion Content in Hardened Concrete:
   a) One of the following:
      (1) Test report in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
      (2) Calculation of water-soluble chloride content based on certified chloride content of each constituent material and proportion of constituent material in concrete mixture.
      (3) All of the following:
         (a) Manufacturer's Certificate of Compliance that each admixture does not intentionally add chlorides and/or that chloride content of each admixture does not exceed trace amounts.
         (b) Verification that potable water is used in concrete mix or test data documenting chloride content of water.
         (c) Letter from concrete supplier stating that fine aggregates and coarse aggregates are from sources that are not known to be susceptible to chlorides in aggregates.
5) Resistance to Alkali Silica Reaction: Supporting information for one of the options for mitigating alkali silica reaction listed in Article Concrete Mix Design. Include documentation of test results per applicable standards.
6) Self-consolidating Concrete:
   a) Passing ability in accordance with ASTM C1621/C1621M.
   b) Static segregation in accordance with ASTM C1610/C1610M.

2. Product Data:
   a. Admixtures:
      1) Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
      2) Color Pigment: Product data including application rate and color chart.
   b. Specified ancillary materials.

3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details must include, but not be limited to, the following:
    a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
    b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
    c. Methods for temperature protection during placement.
    d. Types of covering, insulation, housing, or heating to be provided.
    e. Curing methods to be used during and following protection period.
    f. Use of strength accelerating admixtures.
    g. Methods for verification of in-place strength.
    h. Procedures for measuring and recording concrete temperatures.
    i. Procedures for preventing drying during dry, windy conditions.
4. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan must include, but not be limited to, the following:
    a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
    b. Use of retarding admixture.
    c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
    d. Types of shading and wind protection to be provided.
    e. Curing methods, including use of evaporation retardant.
    f. Procedures for measuring and recording concrete temperatures.
    g. Procedures for preventing drying during dry, windy conditions.

B. Informational Submittals:

1. Preinstallation conference minutes.
2. Manufacturer’s application instructions for bonding agent and bond breaker.
3. Manufacturer’s Certificate of Compliance to specified standards:
    a. Bonding agent.
    b. Bond breaker.
    c. Repair materials.

4. Statement of Qualification:
    a. Batch Plant: Certification as specified herein.
    b. Mix designer.
    c. Installer.
    d. Testing agency.
5. Field test reports.
6. Thermal Control Plan: For mass concrete sections in accordance with ACI 301 Section 8, Mass Concrete.
7. Recorded temperature data from concrete placement where specified.
8. Concrete Delivery Tickets:
    a. For each batch of concrete before unloading at Site.
    b. In accordance with ASTM C94/C94M, including requirements 14.2.1 through 14.2.10.
    c. Indicate amount of mixing water withheld and maximum amount that is permitted to be added at Site.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Batch Plant: National Ready Mixed Concrete Association (NRMCA) Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or Department of Transportation (DOT)-certified mix designer in jurisdiction of the Work. Requirement may be waived if Mix Designer is a Professional Engineer registered in the state where the Project is located.
3. Testing Agency: Unless otherwise permitted, an independent agency, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
    a. Where field testing is required of Contractor, personnel conducting field tests must be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
    b. Personnel performing laboratory tests must be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor must be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
4. Thermal Control Plan: Shall be signed and sealed by a Professional Engineer registered in the state of the Project.

B. Thermal Control Mockup:

1. Mockup Size: Width, thickness, and length shall be a minimum dimension equal to maximum thickness of concrete elements in Project, and not less than 4 feet 0 inch in any direction.
2. Reinforce mockup with #6 @ 8 inches each way, each face.
3. Mockup shall include elements of thermal control plan.
4. Mockup shall demonstrate compliance to specified concrete temperature limits.
5. Demolish mockup upon acceptance of final temperature results.

C. Preinstallation Conference:

1. Required Meeting Attendees:
   a. The Contractor, including pumping, placing, and finishing, and curing subcontractors.
   b. Ready-mix producer.
   c. Admixture representative.
   d. Steel reinforcement installer.
   e. Testing and sampling personnel.
   f. The Owner and/or the Owner's designee.
2. Schedule and conduct Preinstallation Conference prior to incorporation of respective products into Project. Notify the Owner of location and time.
3. Agenda must include:
   a. Admixture types, dosage, performance, and redosing at Site.
   b. Mix designs, test of mixes, and Submittals.
   c. Placement methods, techniques, equipment, consolidation, and form pressures.
   d. Slump and placement time to maintain slump.
   e. Finish, curing, and water retention.
   f. Steel reinforcement details.
   g. Thermal control plan.
   h. Protection procedures for weather conditions.
   i. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 19, Project Meetings.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, Work must be in accordance with ACI 301.

2.02 MATERIALS

A. Cementitious Materials:

1. Cement:
   a. Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
   b. Blended Hydraulic Cement:
      1) Unless otherwise specified, excluding Type IS (greater than 70), conforming to ASTM C595/C595M.
      2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
   c. Performance-Based Cement: Conform to requirements of ASTM C1157/C1157M.
      1) For sections of structure that are assigned Exposure Class F3, submit certification on cement composition verifying that concrete mixture conforms to Table 4.2.1.1(b) of ACI 301.
   d. Furnish from one source.
2. Supplementary Cementitious Materials (SCM):
   a. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
      1) When air-entrainment is specified, fly ash shall comply with uniformity requirements of Table 3 of ASTM C618.
   b. Slag Cement: In accordance with ASTM C989/C989M, Grade 100 or Grade 120.
   c. Silica Fume: In accordance with ASTM C1240.

B. Aggregates: Furnish from one quarry location for each aggregate type used in a mix design.

1. Aggregates:
   a. In accordance with ACI 301, except as modified herein.
   b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
   c. Aggregates that are susceptible to alkali-carbonate reactions shall not be used.
   d. Resistance to Alkali Silica Reaction: See Article Concrete Mix Design.

2. Fine Aggregates:
    a. In accordance with ACI 301, except as modified herein.
    b. In the event manufactured sand is included in mix design, material must be from same source as coarse aggregate.
    c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
        1) Limit material finer than 75-µm (No. 200) sieve to 5 percent mass of total sample.
        2) Limit coal and lignite to 1.0 percent.
3. Coarse Aggregate:
    a. Crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles as determined by ASTM D4791.
    b. Class designation in accordance with ASTM C33/C33M, Table 4: 4S unless otherwise specified.
    c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

C. Admixtures:

1. Characteristics:
    a. Compatible with other constituents in mix.
    b. Contain at most, only trace amount chlorides in solution.
    c. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
    d. Do not use calcium chloride admixtures.
2. Air-entraining Admixture: ASTM C260/C260M.
3. Water-reducing Admixture: ASTM C494/C494M, Type A or Type D.
    a. Manufacturers and Products:
        1) Master Builders Solutions US, Shakopee, MN; MasterPozzolith Series or MasterPolyheed Series.
        2) Euclid Chemical Co., Cleveland, OH; Eucon Series.
        3) GCP Applied Technologies., Cambridge, MA; Mira Series.
4. Retarding Admixture: ASTM C494/C494M, Type B.
5. Accelerating Admixture: ASTM C494/C494M, Type C.
6. Do not use calcium chloride as an admixture.
7. High Range Water-reducing Admixture: ASTM C494/C494M, Type F or Type G.
    a. Manufacturers and Products:
        1) Master Builders Solutions US, Shakopee, MN; MasterGlenium Series or MasterRheobuild 1000.
        2) Euclid Chemical Co., Cleveland, OH; Eucon Series or Plastol Series.
        3) GCP Applied Technologies, Cambridge, MA; ADVA Series.

8. Viscosity Modifying Admixture (VMA): ASTM C494/C494M, Type S.
   a. Manufacturers and Products:
      1) Master Builders Solutions US, Shakopee, MN; MasterMatrix VMA Series.
      2) Euclid Chemical Co., Cleveland, OH; Visctrol.
      3) GCP Applied Technologies, Cambridge, MA; V-MAR Series.
9. Shrinkage Reducing Admixture:
   a. ASTM C494/C494M, Type S.
   b. Manufacturers and Products:
      1) BASF Admixtures Inc., Shakopee, MN; MasterLife SRA 035 or MasterLife CRA 007.
      2) Euclid Chemical Co., Cleveland, OH; Eucon SRA-XT.
      3) GCP Applied Technologies Inc., Cambridge, MA; Eclipse 4500.
10. Shrinkage-reducing/Compensating Admixture:
   a. ASTM C494/C494M, Type S.
   b. Designed to provide both of the following characteristics:
      1) Expands at a rate that closely compensates for shrinkage of concrete mix.
      2) Reduces capillary surface tension of concrete pore water.
   c. Provides at least 80 percent shrinkage reduction as measured and documented by field performance.
   d. Formulated for use in freezing and thawing weather.
   e. Dosage rate and mixing sequence shall be per manufacturer's recommendations.
   f. Shall have documented performance of ASTM C1581/C1581M, run with concrete (maximum aggregate size not to exceed 0.5 inch): No cracking for minimum 120 days.
   g. Manufacturers and Products:
      1) Premier Construction Products Group, West Conshohocken, PA; PREVent-C Series.
      2) "Or-equal" prior to submittal of Bid.
         a) May be supplied by one product that provides both expansion and pore water surface tension or two separate products each added at dosage recommended by manufacturer's technical data sheets.
11. Crack Reducing Admixture:
   a. ASTM C494/C494M, Type S.
   b. Manufacturers and Products:
      1) Master Builders Solutions US, Shakopee, MN; MasterLife CRA007.

D. Water and Ice: Mixing water for concrete and water used to make ice must be potable water.

2.03 ANCILLARY MATERIALS

A. Bonding Agent:

1. Unless otherwise specified, in accordance with the following:
   a. ASTM C881/C881M, Type V.
   b. Two-component, moisture insensitive, 100 percent solids epoxy.
   c. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
2. Manufacturers and Products:
   a. Master Builders Solutions US, Shakopee, MN; MasterInject 1500.
   b. Euclid Chemical Co., Cleveland, OH; Euco #452 Epoxy System.
   c. Prime Resins, Conyers, GA; Prime Bond 3000 and 3900 Series.
   d. Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

B. Bonding Agent for Fiber-Reinforced Topping: Provide creamy cement-water slurry mixture, thick enough to be broomed into place and sustain approximate 1/4-inch thickness until topping is cast.

C. Bond Breaker:

1. Nonstaining type, providing positive bond prevention.
2. Manufacturers and Products:
   a. Dayton Superior Corporation, Miamisburg, OH; Sure Lift J6WB.
   b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.

D. Repair Material:

1. In accordance with requirements of Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
2. In accordance with requirements of Section 03 01 33, Repair of Horizontal Concrete Surfaces.

E. Structural Non-Moving Crack Repair: In accordance with requirements of Section 03 64 23, Epoxy Resin Injection Grouting.

F. Moving Crack Repair: In accordance with requirements of Section 03 64 24, Polyurethane Injection Grouting.

2.04 CONCRETE MIX DESIGN

A. General:

1. See supplement at end of this section for mix design requirements for each class of concrete used on Project.
2. Unless otherwise specified, prepare design mixtures for each type and strength of concrete, in accordance with requirements of ACI 301.
3. Unless specified otherwise, selection of constituent materials and products in mix design are optional.
4. Use water-reducing admixture or water-reducing admixture and high-range water-reducing admixture for the following:
   a. Concrete mixtures that will be pumped.
   b. Concrete mixtures with a water-cementitious materials ratio below 0.50.
   c. Concrete mixtures used in elements of a liquid-containment structure.
   d. Concrete mixtures used in columns, piers, pilasters, and walls.
   e. When needed to achieve fresh properties that facilitate handling, placing, and consolidating of concrete mixtures, and to achieve specified hardened properties.
   f. When anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
5. Unless otherwise specified, desired fresh properties of concrete must be determined by Contractor and coordinated with concrete producer. Fresh properties of concrete must remain stable to satisfaction of Contractor, for duration of placement and consolidation, and must remain in conformance with requirements of Contract Documents.
6. Concrete producer is encouraged to employ environmentally sustainable concrete mix design technologies such as supplementary cementitious materials and aggregate packing.
7. Color Pigment: Where required in Supplement, add color pigment to concrete mixture according to manufacturer’s written instructions and to result in hardened concrete color consistent with approved mockup.

B. Proportions:

1. Concrete mixtures must meet specified aesthetic, durability, and strength requirements.
2. Where fly ash is included in mix, minimum fly ash content shall be 15 percent of weight of total cementitious materials.
3. Where silica fume is included in mix, minimum silica fume content shall be 5 percent of weight of total cementitious materials.

C. Resistance to Alkali-Silica Reaction:

1. Unless otherwise specified, or unless members are designated as being dry in service and not in contact with ground, or assigned to Exposure Class W0, use one of the three following options for qualifying concrete mixtures to reduce potential of alkali-silica reaction.
   a. For each aggregate used in concrete, expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at 1 year.
   b. For each aggregate used in concrete, expansion result of aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at age of 16 days. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent at 16 days when tested in accordance with ASTM C1260.
   c. Alkali content in concrete (LBA), excluding that from supplementary cementitious materials and the pozzolans and slags in blended cements, must not exceed 4 lb/yd^3 for aggregates with expansions more than or equal to 0.04 percent and less than 0.12 percent or 3 lb/yd^3 for aggregates with expansions greater than or equal to 0.12 percent and less than 0.24 percent. Reactivity must be determined by testing in accordance with ASTM C1293. Alkali content must be calculated as follows:
      1) LBA = (cement content, lb/yd^3) × (equivalent alkali content of portland cement in percent/100 percent).
2. Option 1.c. shall not be used with natural pozzolan or fly ash that has a CaO content greater than 18 percent, or for aggregate with expansion at 1 year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293.
3. Fly ash with an alkali content greater than 4.0 percent shall not be used in Option 1.b. or Option 1.c.

D. Slump:

1. Unless otherwise specified, select a target slump at point of delivery for concrete mixtures used for Work. Selected target slump shall not exceed 9 inches.
2. Concrete shall not show visible signs of segregation.
3. Target slump indicated on submittal shall be used as basis for acceptance during the Project.
4. Determine slump by ASTM C143/C143M.
5. Slump tolerances shall be in accordance with ACI 117.

E. Self-Consolidating Concrete:

1. Unless otherwise specified, select a target slump flow at point of delivery for self-consolidating concrete mixtures.
2. Selected target slump flow shall not exceed 30 inches.
3. Concrete shall not show visible signs of segregation.
4. Target slump flow value indicated on submittal shall be used as basis for acceptance during the Project.
5. Determine slump flow in accordance with ASTM C1611/C1611M.
6. Slump flow tolerances shall be in accordance with ASTM C94/C94M.
7. If specified, evaluate during mixture qualification stage, proposed concrete mixtures for passing ability in accordance with ASTM C1621/C1621M and for static segregation in accordance with ASTM C1610/C1610M to meet criteria indicated in Contract Documents.

F. Size of Coarse Aggregate:

1. Unless otherwise specified, nominal maximum size of coarse aggregate shall not exceed:
   a. Three-fourths of minimum clear spacing between reinforcement.
   b. One-fifth of narrowest dimension between sides of forms.
   c. One-third of thickness of slabs or toppings.

G. Combined Aggregate Gradation:

1. Combined Gradation Limits: Fine aggregate must be in range of 36 percent to 40 percent of total aggregate weight.

2.05 CONCRETE MIXING

A. General: Unless otherwise specified, in accordance with ACI 301.

B. Temperature Limits:

1. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.

2. For mass concrete sections, provide documentation that maximum concrete temperature in structure will not exceed160 degrees F, and maximum temperature differential between center of section and external surfaces of concrete will not exceed 35 degrees F.
    a. Accelerating admixture may not be used in mass concrete sections unless the thermal control plan specifically addresses the concrete mixtures with the same accelerating admixture, at a dosage equal to or greater than being proposed for the mass concrete.

2.06 SOURCE QUALITY CONTROL

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

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise specified, in accordance with ACI 301.

3.02 PREPARATION

A. Preparation: In accordance with ACI 301 and the following:

1. Where vapor retarder or barrier is required, coordinate subgrade preparation with requirements in Division 07 of Specifications.
2. Provide at least one standby vibrator in operable condition at Site prior to placing concrete.

B. Inspection: Notify Engineer and Special Inspector at least 1 full working day in advance before starting to place concrete.

C. Mass Concrete:

1. Strength measurement must be representative of in-place concrete within 2 inches of concrete surface.
2. Concrete strength must be verified through correlation of concrete temperature and compressive strengths established by cylinder compressive tests and in accordance with ASTM C1074.

3. Unless otherwise specified, control concrete temperatures to within specified limits from time concrete is placed until time internal temperature has cooled from its maximum, such that difference between average daily ambient and maximum internal concrete temperature at time of protection removal, is less than specified temperature difference limit.
4. Unless otherwise specified, place one temperature sensor at center of mass of placement and one temperature sensor at a depth 2 inches from center of nearest exterior surface. Place additional sensor at each location to serve as a backup in event that other temperature sensor fails. In addition, provide temperature sensor in shaded location for monitoring ambient onsite temperature.
    a. Unless otherwise specified, monitor temperatures hourly using electronic sensors capable of measuring temperature from 32 degrees F to 212 degrees F to an accuracy of 2 degrees F.
    b. Ensure temperature sensors are operational before placing concrete.
    c. Unless otherwise specified, provide data from sensors to Engineer daily, until requirements are met.
    d. Compare temperatures and temperature differences with maximum limits specified in Article Temperature Limits every 12 hours, unless otherwise permitted. If either exceeds specified limits, take immediate action as described in accepted thermal control plan to remedy situation. Do not place additional mass concrete until cause of excessive temperature or temperature difference has been identified and corrections are accepted.

3.03 CONCRETE BONDING

A. Construction Joints in New Concrete Members: Prepare surface of construction joint as specified in Section 03 15 00, Concrete Joints and Accessories.

B. Construction Joints at Existing Concrete:

1. Thoroughly clean and mechanically roughen existing concrete surfaces to a roughness profile range between CSP 7 to CSP 9 when verified by comparison to PC1-10.
2. Saturate surface with water for 24 hours prior to placing new concrete.

3.04 PLACEMENT OF CONCRETE

A. Unless otherwise specified, in accordance with ACI 301.

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

C. Pumping of Concrete: Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.

D. Joints in Footings and Slabs with Waterstops (Excluding Hydrophilic and Injection-Type): Verify space beneath plastic waterstop completely fills with concrete and is consolidated along entire length of waterstop.

E. Maximum Size of Concrete Placements:

1. Locate expansion, control, and contraction joints where shown on the Drawings.
2. Construction Joints: Locate additional construction joints as follows:
    a. Where approved in joint location submittal required in Section 03 15 00, Concrete Joints and Accessories.
    b. Provide vertical construction joints in walls and slabs at maximum spacing of 40 feet, unless shown or approved otherwise.
    c. When vertical expansion, contraction, or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.
3. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

3.05 FIBER-REINFORCED TOPPING

A. Location: Where indicated on the Drawings.

B. Surface Preparation:

1. Prepare concrete slab by high pressure water blasting machines capable of removing concrete surface.
2. High pressure water blasting machines with 8,000 psi minimum pressure capable of rapidly removing surface of sound concrete.
3. Remove slab surface material to create a roughness profile range between CSP 6 to CSP 8 when verified by comparison to PC1-10.
4. Collect spent water and debris and dispose in location and manner acceptable to Owner.
5. Square edges of removed concrete to avoid tapered shoulders.

6. Do not use power-driven jackhammers, scabblers, or scarifiers.
7. High pressure water blast areas to receive topping no more than 24 hours before placement of bonding agent.
    a. Remove laitance and contamination from existing concrete.
    b. Saturate existing concrete slab for 24 hours prior to topping placement.
    c. Surface must be damp but free of standing water at time of application of topping.

C. Fiber-Reinforced Topping Application:

1. Work fiber reinforced topping into place using conventional placing tools. Do not use leveling guide on rake arm to move topping.
2. Check topping elevation by measuring to top surface of fiber-reinforced topping from leveling guide board on rake arm. Place topping within specified tolerances.
3. Cure concrete as specified in Section 03 39 00, Concrete Curing.

3.06 CURING

A. In accordance with Section 03 39 00, Concrete Curing, unless otherwise specified.

3.07 REPAIRING CONCRETE

A. General:

1. Repair defective areas of concrete.
2. Repair horizontal concrete surfaces in accordance with Section 03 01 33, Repair of Horizontal Concrete Surfaces.
3. Repair vertical and overhead concrete surfaces in accordance with Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
4. Unless otherwise specified, cracks which meet definition of defective area must be repaired by injecting epoxy resin as specified in Section 03 64 23, Epoxy Resin Injection Grouting.
5. Moving cracks deemed as nonstructural by Owner must be repaired by injecting polyurethane resin as specified in Section 03 64 24, Polyurethane Injection Grouting.
6. Develop repair techniques with material manufacturer on surface that will not be visible in final construction or on mockup panels prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Owner.

7. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply enough repair material adjacent to repair to blend finish appearance.
8. Repair of concrete must provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Owner.

B. Tie Holes:

1. Unless otherwise specified, fill with specified repair material.
   a. Prepare substrate and mix, place, and cure repair material per manufacturer's written recommendations.

C. Alternate Form Ties, Through-Bolts:

1. Mechanically roughen entire interior surface of through hole.
2. Apply bonding agent to roughened surface and drive elastic vinyl plug to half depth.
3. Dry pack entire hole from both sides of plug with nonshrink grout, as specified in Section 03 62 00, Grouting.
4. Use only enough water to dry pack grout.
5. Dry pack while bonding agent is still tacky.
6. If bonding agent has dried, remove bonding agent by mechanical means and reapply new coat of bonding agent.
7. Compact grout using steel hammer and steel tool to drive grout to high density.
8. Cure grout with water and in accordance with manufacturer's written instructions.

D. Exposed Metal Objects:

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

E. Blockouts at Pipes or Other Penetrations: Where shown install in accordance with requirements of Drawings.

3.08 FORMED SURFACE FINISHES

A. As-Cast Concrete Surfaces Finishes:

1. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
2. Type SF-1: Not Used.
3. Type SF-2 (Ordinary Surface Finish):
   a. Patch voids larger than 3/4 inch wide or greater than 1/2 inch deep.
   b. Remove projections larger than 1/4 inch.
   c. Patch tie holes.
   d. Inject cracks.
   e. Repair defective areas to provide smooth uniform appearance.
   f. Unless otherwise specified, Surface tolerance Class B as specified in 4.8.3 *Formed surface irregularities (gradual or abrupt)* of ACI 117.
4. Type SF-3 (Smooth Surface Finish):
   a. Patch voids larger than 1/2 inch wide or greater than 1/4 inch deep.
   b. Remove projections larger than 1/8 inch.
   c. Patch tie holes.
   d. Inject cracks.
   e. Repair defective areas to provide smooth uniform appearance.
   f. Surface tolerance Class A as specified in 4.8.3 *Formed surface irregularities (gradual or abrupt)* of ACI 117.

3.09 CONCRETE SLAB FINISHES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Finish slab in accordance with specified slab finish.
4. Do not dust surfaces with dry materials nor add water to surfaces.
5. Cure concrete as specified in Section 03 39 00, Concrete Curing.

B. Type S-1 (Steel Troweled Finish):

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
2. Wood float to true, even plane with no coarse aggregate visible.
3. Use enough pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand steel trowel concrete to produce smooth, smooth dense surface, free from trowel marks.
5. Provide light steel-troweled finish (two trowelings) at air-entrained slabs. Provide hard steel-troweled finish (ringing sound from the trowel) for non-air entrained slabs.
6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
7. Power Finishing:
    a. Approved power machine may be used in lieu of or in addition to hand finishing in accordance with directions of machine manufacturer.
    b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high spots and low spots in slab.
    c. Do first steel troweling for slab S-1 finish by hand.

C. Type S-2 (Wood Float Finish):

1. Finish slab to receive fill and mortar setting bed by screeding with straightedges to bring surface to required finish plane.
2. Wood float finish to compact and seal surface.
3. Remove laitance and leave surface clean.
4. Coordinate with other finish procedures.

D. Type S-5 (Broomed Finish):

1. Finish as specified for Type S-1 floor finish, except use only a light-steel troweled finish, and then finish surface by drawing fine-hair broom lightly across surface.
2. Broom in same direction and parallel to expansion joints, or, in case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.

E. Type S-6 (Sidewalk Finish):

1. Slope walks down 1/8 inch per foot away from structures, unless otherwise shown.
2. Strike off surface by means of strike board and float with wood or cork float to true plane, then flat steel trowel before brooming.

3. Broom surface at right angles to direction of traffic or as shown.
4. Lay out sidewalk surfaces in blocks, as shown or as directed by Engineer, with grooving tool.

F. Concrete Curbs:

1. Float top surface of curb smooth and finish all discontinuous edges with steel edger.
2. After concrete has taken its initial set, remove front form and give exposed vertical surface an ordinary surface finish, Type SF-2.

3.10 CONCRETE SLAB TOLERANCES

A. General:

1. Deviation from elevation for top surface of base slab, base mat, foundation slab, or foundations that is integral with any previously listed elements of a hydraulic structure, shall be in accordance with ACI 117 tolerances for a slab-on-ground, for cast-in-place concrete building.
2. Concrete slab tolerances are in accordance with ACI 117 tolerances for random traffic floor surface finishes, for cast-in-place concrete buildings.

B. Slab Tolerances:

1. Slab tolerances must be in accordance with the following floor surface classifications as shown in Table 4.8.6.1 of ACI 117:
   a. Slab Type S-A: Floor Surface Classification: Moderately flat.
   b. Slab Type S-B: Floor Surface Classification: Flat.
2. Slab Elevation and Thickness:
   a. Finish Slab Elevation: Slope slabs to floor drains and gutter. Slabs must adequately drain regardless of tolerances.
   b. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown.

3.11 BACKFILL AGAINST STRUCTURES

A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.

B. Refer to General Structural Notes on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.

C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.12 FIELD QUALITY CONTROL

A. General:

1. Unless otherwise specified, concrete field-testing services will be in accordance with ACI 301 and Section 01 45 33, Special Inspection, Observation, and Testing.
2. Unless otherwise specified, refer to ACI 301 and Section 01 45 33, Special Inspection, Observation, and Testing for additional information regarding requirements related to concrete field quality assurance.
3. Unless otherwise specified, concrete field-testing services will be provided by Owner.
4. The following is an overview of types and frequency of concrete field testing.
    a. Employ one or more agencies to provide tests for concrete work during construction, as specified herein and in Section 01 45 33, Special Inspection, Observation, and Testing.
    b. Agencies shall be objective, competent, and independent from the Contractor responsible for the Work being inspected.
    c. Identify agencies to building official, for building official's approval.
    d. Agencies shall disclose to building official and registered design professional in responsible charge possible conflicts of interest so that objectivity can be confirmed.
    e. For additional information regarding requirements of the Contractor related to concrete field quality assurance, refer to Section 01 45 33, Special Inspection, Observation, and Testing.
5. Provide electrical and water services to area of site for safe storage and curing of concrete test specimens prior to transport of test specimens to testing lab.
6. Concrete testing agency will provide storage facility for proper curing of concrete test specimens onsite prior to transport of test specimens to testing lab.
7. Unless otherwise specified, concrete will be sampled for making test specimens, from point of delivery.
8. For additional information regarding requirements of the Contractor related to concrete field quality assurance, refer to Section 01 45 33, Special Inspection, Observation, and Testing.

9. Unless otherwise specified, sampled concrete used to mold strength test specimens (ASTM C31/C31M) will be tested for slump (ASTM C143/C143M) or slump flow (ASTM C1611/C1611M), air content (ASTM C231/C231M), temperature (ASTM C1064/C1064M), and density (ASTM C138/C138M).
10. Measured Air Content at Point of Delivery:
    a. When measured air content at point of delivery is greater than specified limit, a check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents.
    b. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents.
    c. Concrete that has failed to meet requirements of Contract Documents must be rejected.
11. If concrete is pumped, concrete will be sampled for air content testing at point of delivery and at point of placement.
        1) For each concrete mixture that will be pumped, once two consecutive results of air content testing taken at the point of placement are within specified tolerances:
        2) Average of the corresponding measured air content at point of delivery for the two consecutive test results, shall become the target air content.
        3) Subsequent testing will be performed at point of placement based on the following criteria:
            a) Every 100 cubic yards of concrete placed by pumping.
            b) Every 4 hours minimum.
            c) When measured air content at point of delivery deviates from the target air content by an amount beyond the specified tolerance.
            d) When fresh characteristics of the concrete mixture is visibly different at the point of placement is visibly different than what was observed when the two consecutive test results were measured.
            e) When required by Special Inspector or Owner.
12. Test specimens must be stored and cured in accordance with ASTM C31/C31M and tested in accordance with ASTM C39/C39M.
13. Frequency of testing may be changed at discretion of Special Inspector or Owner.
14. Evaluation and acceptance will be in accordance with ACI 301 and the Contract Documents.

B. Concrete Strength Test:

1. Unless otherwise specified, specimens will be made and tested as follows:
   a. One standard test specimen at age of 7 days for information.
   b. Minimum of two standard test specimens at age of 28 days for acceptance.
   c. A minimum of one spare standard test specimen per sample.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, moist cure in situ concrete in accordance with Section 03 39 00, Concrete Curing, for an additional 7 days.
3. Spare cylinder will be tested as directed by Owner.

C. Tolerances:

1. Concrete tolerances must comply with the more stringent of equipment manufacturers' tolerances and specified tolerances.
2. Formed Surfaces:
   a. Formed surface finishes must comply with specified requirements.
   b. Tolerances of formed surfaces must comply with specified requirements and with ACI 117 for cast-in-place concrete buildings.
3. Unformed Surfaces:
   a. Surface finishes must comply with specified requirements.
   b. Unless otherwise specified, tolerances for unformed surface must conform to requirements of ACI 117 for cast in place concrete buildings.
   c. Concrete slab tolerances must comply with specified requirements and with ACI 117 random traffic floor surface finish tolerances.
   d. Slab Elevation:
      1) Slabs must slope to drains.
      2) Top of concrete elevations must comply with specified requirements and ACI 117 for cast-in-place concrete buildings.
   e. Slab thickness tolerance must comply with specified requirements and ACI 117 for cast in place concrete buildings.

D. Evaluation and Acceptance of Fiber-Reinforced Topping:

1. Sounding for Hollow Areas:
   a. Topping surface will be sounded after 7-day curing period. Sounding will be executed by chain drag, light steel hammer tap, or electro-mechanical sounding device in accordance with ASTM D4580, listening for hollow sound to determine areas that may have not properly bonded to substrate concrete.
   b. Hollow areas will be marked for further investigation via direct tension bond testing.
2. Direct Tension Bond Test:
   a. Minimum of four in situ bond tests are required per hydraulic structure.
   b. Hollow areas identified by sounding will be investigated through in situ bond testing.
   c. In Situ Bond Testing: Direct tension bond test will be in accordance with ASTM C1583/C1583M.
   d. Locations of in situ bond tests will be recorded.
   e. Evaluation and Acceptance of Fiber-Reinforced Topping: 200 psi minimum in direct tension without failure or movement.
3. Disbonded, cracked, broken fiber-reinforced topping is noncompliant.
4. Noncompliant work shall be repaired or replaced.

3.13 MANUFACTURER'S SERVICES

A. Provide representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

1. Concrete Producer Representative:
   a. Observe how concrete mixes are performing.
   b. Be present during first placement of each type of concrete mix.
   c. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
   d. Establish control limits on concrete mix designs.
   e. Provide equipment for control of concrete redosing for air entrainment or high range water reducing admixture, superplasticizers, at Site to maintain proper slump and air content if needed.

2. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.
3. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.14 PROTECTION OF INSTALLED WORK

A. After curing as specified in Section 03 39 00, Concrete Curing, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage because of other construction work.

B. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.15 SCHEDULE OF CONCRETE FINISHES

A. Form Tolerances: As specified in Section 03 10 00, Concrete Forming and Accessories.

B. Unless otherwise specified, provide concrete finishes as scheduled:

Area	Type of Finish	Required Tolerances
Exterior Wall Surfaces		
Abovegrade/exposed (above point 6" below finish grade)	SF-3	W-B
Abovegrade/covered with brick veneer or other finish material	SF-2	W-A
Backfilled/waterproofed (below point 6" below finish grade)	SF-2	W-A
Backfilled/not waterproofed (below point 6" below final grade)	SF-2	W-A

Area	Type of Finish	Required Tolerances
Interior Wall Surfaces		
Hydraulic structures painted or coated	SF-6	W-A
Buildings, pipe galleries, and other dry areas not painted or coated	SF-3	W-A
Buildings, pipe galleries, and other dry areas painted or coated	SF-6	W-A
Exterior Slabs		
Roof slab/covered with roofing material	S-1	S-A
Top of wall	S-5	S-B
Top of footing	S-2	S-A
Slabs in hydraulic structures unless otherwise specified	S-1	S-A
Sidewalks	S-6	S-B
Exterior slabs unless otherwise specified	S-5	S-A
Interior Slabs		
Buildings, pipe galleries, and other dry areas	S-1	S-B

Note: In accordance with Section 4, *Cast-In-Place Concrete for Buildings* of ACI 117.

3.16 SUPPLEMENTS

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

1. Concrete Mix Design—CMD-1.
2. Concrete Mix Design—CMD-3.
3. Concrete Mix Design—CMD-4.
4. Concrete Mix Design—CMD-5.
5. Concrete Mix Design—CMD-7.

END OF SECTION

CONCRETE MIX DESIGN—CMD-1

A. Mix Locations: Typical, unless otherwise specified.

B. Exposure Categories and Classifications: F3S1W2C2 as defined in ACI 318-19.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.40.
2. Minimum concrete compressive strength (f'c) must be 5,000 psi at 28 days.
3. Air-entraining admixtures are prohibited in concrete mixtures and total air content must not be greater than 3 percent, for the following:
   a. Slabs to receive a hard-troweled finish.
   b. Slabs to receive a dry shake floor hardener.
   c. Slabs to receive a topping placed monolithically as a two-course floor on top of plastic concrete.
4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.
* Tolerance of air content is ±1-1/2 percent.

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

5. Limit supplementary cementitious materials as follows:

Limits on Cementitious Materials for Concrete Assigned to Exposure Class F3‡*	
Supplementary Cementitious Materials	**Maximum Percent of Total Cementitious Materials by Mass**
Fly as or natural pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or natural pozzolans and silica fume	35
Total of fly ash or natural pozzolans, slag cement, and silica fume	50

‡Supplementary cementitious materials, including fly ash and natural pozzolans, slag cement, and silica fume, used in the manufacture of ASTM C595/C595M and ASTM C1157/C1157M blended cements shall be included in assessing compliance with these limits.

*Individual limits shall apply regardless of the number of cementitious materials in a concrete mixture.

6. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II or Type V; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II or Type V in accordance with the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   c. ASTM C595/C595M Types excluding Type IS (greater than 70), conforming to ASTM C595/C595M and having (MS) designation.
   d. ASTM C1157/C1157M having (MS) designation.
7. Limit water-soluble, chloride ion content in hardened concrete, percent by mass of cementitious materials to 0.15.
   a. Limits are stated in terms of water-soluble chloride ions (Cl^-) in percent by mass of cementitious materials.

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

CONCRETE MIX DESIGN—CMD-3

A. Mix Locations:

1. Provide this concrete mix for the following elements:
   a. Electrical duct banks.
   b. Pipe encasements that are not cast monolithically with concrete base mats or slabs.
   c. Where specified in Contract Documents.

B. Exposure Categories and Classifications: F1S1W0C1 as defined in ACI 318-19.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.50.
2. Minimum concrete compressive strength (f'c) must be 3,500 psi at 28 days.
3. Air-entraining admixtures are prohibited in concrete mixtures and total air content must not be greater than 3 percent, for the following:
   a. Slabs to receive hard-troweled finish.
   b. Slabs to receive dry shake floor hardener.
   c. Slabs to receive topping placed monolithically as two-course floor on top of plastic concrete.
4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	6.0
1/2	5.5
3/4	5.0
1	4.5
1-1/2	4.5
2§	4.0
3§	3.5

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

*Tolerance of air content is ±1-1/2 percent.

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

5. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II or Type V; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II or Type V in accordance with the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   c. ASTM C595/C595M Types excluding Type IS (greater than 70), conforming to ASTM C595/C595M and having (MS) designation.
   d. ASTM C1157/C1157M having (MS) designation.
6. Limit water-soluble, chloride ion content in hardened concrete, percent by mass of cementitious materials to 0.30.
   a. Limits are stated in terms of water-soluble chloride ions (Cl^-) in percent by mass of cementitious materials.

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

CONCRETE MIX DESIGN—CMD-4

A. Mix Locations:

1. Provide fiber-reinforced concrete fill (FRCF) where specified in Contract Documents.

B. Exposure Categories and Classifications: F2S1W0C1 as defined in ACI 318-19.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) must be 4,000 psi at 28 days.
3. Air-entraining admixtures are prohibited in concrete mixtures and total air content must not be greater than 3 percent, for the following:
   a. Slabs to receive hard-troweled finish.
   b. Slabs to receive dry shake floor hardener.
4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
‡ See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations. * Tolerance of air content is ±1-1/2 percent. § Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.	

5. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II or Type V; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II or Type V in accordance with the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   c. ASTM C595/C595M Types excluding Type IS (greater than 70), conforming to ASTM C595/C595M and having (MS) designation.
   d. ASTM C1157/C1157M having (MS) designation.
6. Limit water-soluble, chloride ion content in hardened concrete, percent by mass of cementitious materials to 0.30.
   a. Limits are stated in terms of water-soluble chloride ions (Cl^-) in percent by mass of cementitious materials.
7. Fiber Reinforcement:
   a. Where required, provide polypropylene microfibers in design mix in accordance with Section 03 24 00, Fibrous Reinforcing.
   b. Add fiber-reinforcement to mix in concrete plant.

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

CONCRETE MIX DESIGN—CMD-5

A. Mix Locations:

1. Concrete curbs and sidewalks.

B. Exposure Categories and Classifications: F3S1W1C2 as defined in ACI 318-19.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.40.
2. Minimum concrete compressive strength (f'c) must be 4,500 psi at 28 days.
3. Air-entraining admixtures are prohibited in concrete mixtures and total air content must not be greater than 3 percent, for the following:
   a. Slabs to receive hard-troweled finish.
   b. Slabs to receive dry shake floor hardener.
4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations. *Tolerance of air content is ±1-1/2 percent. §Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.	

5. Limit supplementary cementitious materials as follows:

Limits on Cementitious Materials for Concrete Assigned to Exposure Class F3 ‡*	
Supplementary Cementitious Materials	**Maximum Percent of Total Cementitious Materials by Mass**
Fly as or natural pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or natural pozzolans and silica fume	35
Total of fly ash or natural pozzolans, slag cement, and silica fume	50
‡ Supplementary cementitious materials, including fly ash and natural pozzolans, silica fume, and slag cement, used in the manufacture of ASTM C595/C595M and ASTM C1157/C1157M blended cements shall be included in assessing compliance with these limits. *Individual limits shall apply regardless of the number of cementitious materials in concrete mixtures.	

6. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II or Type V; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II or Type V in accordance with the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   c. ASTM C595/C595M Types excluding Type IS (greater than 70), conforming to ASTM C595/C595M and having (MS) designation.
   d. ASTM C1157/C1157M having (MS) designation.
7. Limit water-soluble, chloride ion content in hardened concrete, percent by mass of cementitious materials to 0.30.
   a. Limits are stated in terms of water-soluble chloride ions (Cl^-) in percent by mass of cementitious materials.

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

CONCRETE MIX DESIGN CMD-7

A. Mix Locations: Tremie concrete.

B. Exposure Categories and Classifications: F0S1W2C1 as defined in ACI 318-19.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.42.
2. Minimum concrete compressive strength (f'c) must be 4,500 psi at 28 days.
3. Use natural round gravel.
4. Fine Aggregate Range: 40 percent to 50 percent of total aggregates by weight.
5. There are no restrictions on air content.
6. Use high range water reducing admixture.
7. Use anti-washout admixture in accordance with manufacturer's recommendations.
8. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II or Type V; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II or Type V in accordance with the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
   c. ASTM C595/C595M Types excluding Type IS (greater than 70), conforming to ASTM C595/C595M and having (MS) designation.
9. Limit water-soluble, chloride ion content in hardened concrete, percent by mass of cementitious materials to 0.10.
   a. Limits are stated in terms of water-soluble chloride ions (Cl^-) in percent by mass of cementitious materials.

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

SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 301, Specifications for Concrete Construction.
   b. 306.1, Specification for Cold Weather Concreting.
   c. 308.1, Specification for Curing Concrete.
2. ASTM International (ASTM):
   a. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' data indicating compliance with the requirements specified herein for the following products:
   a. Curing compound
   b. Evaporation reducer.
   c. Penetrating water repellent sealer.
   d. Clear liquid densifier.
2. Curing methods proposed for each type of element such as slab, walls, beams, and columns in each facility.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
   a. Curing compound showing moisture retention requirements.
   b. Retardants for exposed aggregate finish.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water for curing: In accordance with ACI 301.

B. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.
2. Manufacturers and Products:
   a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
   b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
   c. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
   d. Dayton Superior; Safe Cure and Seal 1315 EF.
3. Silicate-based liquid surface densifiers shall not be used as curing compounds.

C. Sheet material for curing: In accordance with ACI 301.

D. Absorbent materials: In accordance with ACI 301.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise specified, initial curing of unformed surfaces and final curing concrete shall be in accordance with ACI 301.

B. Unless otherwise specified, cure concrete for at least 7 days after completion of placement.

3.02 CONCRETE CURING

A. General: Unless otherwise specified, in accordance with ACI 301.

B. Initial Curing of Unformed Surfaces:

1. Unless otherwise specified, initial curing shall be in accordance with ACI 301.
   a. Fogging.
   b. Evaporation Reducer.

C. Final Curing:

1. Moist curing methods: Unless otherwise specified, cure concrete using at least one of the following methods as specified in ACI 301:
    a. Continuous fogging.
    b. Ponding.
    c. Continuous sprinkling.
    d. Application of absorbent material.
    e. Application of water-retention sheeting material.
        1) Keep concrete wet continuously wet under sheeting.
2. Unless otherwise specified, application of membrane-forming curing compound may be used.
    a. When a moist curing method is required for final curing, membrane-forming curing compound shall not be used as a replacement method.
3. Unformed surfaces:
4. Cold Weather:
    a. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
    b. Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3500 psi or design compressive strength if less than 3500 psi.
    c. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.
    d. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.
5. Hot Weather: Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
6. Where surfaces are to receive coatings, painting, cementitious material, or other similar finishes, use only moist curing procedures. Refer to Interior Finish Schedule for surfaces to receive coatings.
7. If moist curing is specified, assume moist curing must be used.
8. As required in Section 03 30 00, Cast-in-Place Concrete, if result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified below, by 7 additional days.

D. Mass Concrete:

1. Cure and protect concrete in accordance with accepted thermal control plan and as follows:
   a. Minimum curing period: 14 days.
   b. Preserve moisture on formed surfaces by maintaining forms in place.

E. Unless otherwise specified, use one of the following methods as approved by Owner:

1. Vertical Surfaces
   a. Method 1: Leave concrete forms in place and keep surfaces of forms and concrete moist for 7 days.
   b. Method 2: Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.
   c. Method 3: Apply curing compound, where allowed, immediately after removal of forms.
2. Horizontal Surfaces:
   a. Method 1: Sheet material in accordance with ACI 308.1 for 7 days.
   b. Method 2: Ponding in accordance with ACI 308.1 for 7 days.
   c. Method 3: Sprinkling in accordance with ACI 308.1 for 7 days.
   d. Method 4: Fogging in accordance with ACI 308.1 for 7 days.
   e. Method 5: Absorbent material in accordance with ACI 308.1 for 7 days. Cover with burlap or cotton mats and keep continuously moist for 7 days.
   f. Method 4: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously moist for 7 days.
   g. Method 4: Continuously sprinkle exposed surface for 7 days.
   h. Method 5: Place sheet material on the concrete as soon as it is possible without marring surface.
   i. Method 5: Apply curing compound, where allowed, immediately after final finishing when surface will no longer be damaged by traffic.

3.03 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

B. Provide curing compound manufacturer's representative to demonstrate proper application of curing compound to show coverage in one coat.

END OF SECTION

SECTION 03 62 00
GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   b. C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   c. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   d. C579, Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   e. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
   f. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   g. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   h. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   i. C1181, Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
   j. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data of grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing nonshrink grout.
3. Forming method for fluid grout placements.
4. Curing method for grout.

B. Informational Submittals:

1. Manufacturer's Written Instructions: Mixing of grout.
2. Manufacturer's proposed training schedule for grout work.
3. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements.
    a. Grout free from chlorides and other corrosion-causing chemicals.
    b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
4. Manufacturer's Certificate of Proper Installation.
5. Statements of Qualification: Grout manufacturer's representative.
6. Test Reports:
    a. Test report for 24-hour evaluation of nonshrink grout.
    b. Test results and service report from demonstration and training session.
    c. Field test reports and laboratory test results for field-drawn Samples.
7. List of Contractor's installation staff trained by grout manufacturer's representative in:
    a. Nonshrink grout installation and curing.
    b. Epoxy grout installation and curing.

1.03 QUALIFICATIONS

A. Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form, attached at the end of this section. Provide independent testing laboratory test results for testing conducted within last 18 months.

PART 2 PRODUCTS

2.01 NONSHRINK GROUT AND EPOXY GROUT SCHEDULE

A. Furnish nonshrink grout (Category I, II, and III) and epoxy grout for applications as indicated in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Machine bases 25 hp or less	II	II	II
Baseplates for legs of tanks, pipe supports, nonvibratory equipment	II	II	II
Form Tie-Through bolt openings	II	II	II
Machine bases 26 hp and up	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout
Baseplates and/or soleplates with vibration, thermal movement, etc.	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout

2.02 NONSHRINK GROUT

A. Category II:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F, 80 degrees F, and 90 degrees F.
5. One hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.

7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturers and Products:
    a. Master Builders Solutions, Shakopee, MN; MasterFlow 928.
    b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
    c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
    d. Dayton Superior Corp., Miamisburg, OH; Sure-Grip High Performance Grout.
    e. US MIX Co., Denver, CO; US SPEC MP Grout.

B. Category III:

1. Metallic and nongas-liberating.
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 in accordance with ASTM C1107/C1107M:
    a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
    b. Temperatures of 40 degrees F and 100 degrees F.
5. One hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid 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-yard to 9-yard loads in ready-mix truck.
8. Manufacturer and Product:
    a. Master Builders Solutions, Shakopee, MN; MasterFlow 885.
    b. Euclid Chemical Co, Cleveland, OH; Hi-Flow Metallic Grout.

2.03 EPOXY GROUT

A. High-strength, nonshrink, high-temperature epoxy grouting material developed for the support of heavy equipment with vibratory loads.

B. Three-component mixture of a two-component epoxy resin system (100 percent solids) with a graded, precision aggregate blend.

C. Premeasured, prepackaged system.

D. Flowable.

E. Minimum compressive strength in accordance with ASTM C579 Method B, 9,500 psi at 75 degrees F at 7 days, 11,000 psi at post cure.

F. Maximum creep resistance in accordance with ASTM C1181 at 600 psi, 140 degrees F; 6.0 by 10^{-3} in/in.

G. Minimum bond strength in accordance with ASTM C882, 2,000 psi.

H. Minimum tensile strength in accordance with ASTM C307, 2,000 psi.

I. Maximum coefficient of thermal expansion in accordance with ASTM C531 at 73 degrees F to 210 degrees F, 23.0 by 10^{-6} in/in/degrees F.

J. Working Time: Minimum 2 hours at 50 degrees F; 1.5 hours at 70 degrees F; 50 minutes at 90 degrees F.

K. Good chemical resistance.

L. Good effective bearing area.

M. Noncorrosive.

N. Moisture insensitive.

O. Modify resin and aggregate content where recommended by epoxy grout manufacturer to provide desired epoxy grout flow properties.

P. Manufacturer and Product:

1. Master Builders Solutions, Shakopee MN; MasterFlow 648.
2. Euclid Chemical Co., Cleveland, OH; E^3-Series.
3. Dayton Superior Corp., Miamisburg, OH; Pro-Poxy 2000 Normal Set.
4. Five Star Products Inc., Fairfield, CT; DP Epoxy Grout.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise specified, prepare and condition concrete substrate in accordance with grout manufacturer’s training instructions.

B. Mix, place, and cure grout in accordance with grout manufacturer’s representative’s training instructions.

C. Epoxy Grout: Concrete slab shall be fully cured for 28 days to ensure excess water has evaporated. Test concrete surface for moisture in accordance with ASTM D4263 before epoxy grout is placed.

D. Form Tie-Through Bolt Holes: Provide nonshrink grout, Category 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 Accessories, and bonding agent in Section 03 30 00, Cast-in-Place Concrete.

E. Form Snap-Tie Hole: Fill tie hole in accordance with requirements of Section 03 30 00, Cast-in-Place Concrete.

3.02 GROUTING MACHINERY FOUNDATIONS

A. 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. Surface roughness in accordance with manufacturer's written instructions.

B. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.

C. Sandblast to bright metal all metal surfaces in contact with epoxy grout in accordance with manufacturer's written instructions.

D. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.

E. Form with watertight forms at least 2 inches higher than bottom of plate.

F. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.

G. If grout cannot be placed from one edge and flowed to the opposite edge, air vents shall be provided through the plate to prevent air entrapment.

H. Radius corners of grout pad.

I. Install expansion joints for epoxy grout placement in accordance with manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

A. General:

1. Performed by Project representative's inspection staff.
2. Perform the following quality control inspections. Grout manufacturer's representative shall accompany the Project representative's inspection staff on the first installation of each size and type of equipment.

B. Evaluation and Acceptance of Nonshrink Grout:

1. Inspect surface preparation of concrete substrates onto which nonshrink grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
2. Inspect preparation and application of nonshrink grout form work for conformance to the manufacturer's recommendations.
3. Conduct a final review of completed nonshrink grout installation for conformance to these Specifications.
4. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
5. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
6. For large grout applications, make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
7. Consistency: As specified in Article Nonshrink Grout. Flow cone test in accordance with ASTM C939. Grout with consistencies outside range requirements shall be rejected.
8. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
9. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
10. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
11. Perform bleeding test in accordance with ASTM C940 to demonstrate grout will not bleed.

12. Store cubes at 70 degrees F.
13. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.
14. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

C. Evaluation and Acceptance of Epoxy Grout:

1. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
2. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
3. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
4. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
5. Inspect preparation and application of epoxy grout form work for conformance to the manufacturer's recommendation.
6. Verify consistency obtained is sufficient for the proper field placement at the installed temperatures.
7. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during the installation.
8. Inspect epoxy grout for cure.
9. Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.
10. Conduct a final review of completed epoxy grout installation for conformance to these Specifications.
11. Compression tests and fabrication of specimens for epoxy grout shall be made in accordance to ASTM C579, Method B, at intervals during construction as selected by the Project representative. Set of three specimens shall be made for testing at 7 days, and each earlier time period as appropriate.
12. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C579.
13. Grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

3.04 MANUFACTURER'S SERVICES

A. General:

1. Coordinate demonstrations, training sessions, and applicable Site visits with grout manufacturer's representative. Allow 2-week notice to grout manufacturer's representative for scheduling purposes.
2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of grout.
3. Necessary equipment and materials shall be available for demonstration.
4. Conduct training prior to equipment mount installation work on equipment pads.
5. Training for each type of grout shall be not less than 4 hours' duration.

B. Nonshrink Grout Training:

1. Training is required for all Type II and Type III grout installations.
2. Provide nonshrink grout installation training by the qualified grout manufacturer's representative for Contractor's workers that will be installing nonshrink grout for baseplates and equipment mounts. Schedule training to allow Engineer's attendance.
3. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, such as, baseplates and form tie-through bolt holes to provide actual on-the-job training.
4. Use minimum of two bags for each grout Category II and Category III. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1 day, 3 days, and 28 days. Use remaining grout for final Work.
5. Include recommended grout curing methods in the training.
6. Transport test cubes to independent test laboratory and obtain test reports.
7. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the work.
8. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

C. Epoxy Grout Training:

1. Provide epoxy grout installation training by the qualified epoxy grout manufacturer's representative for Contractor's workers that will be installing epoxy grout for equipment mounts. Schedule training to allow Engineer's attendance.
2. Include training in:
   a. Performance testing such as compressive strength testing of epoxy grout.
   b. All aspects of using the products, from mixing to application.
3. Transport test cubes to independent test laboratory and obtain test reports.
4. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the work.
5. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

3.05 SUPPLEMENTS

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

1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

SUPPLEMENT 1

_____

(Test Lab Name)

_____

(Address)

_____

(Phone No.)

24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain three bags of each type of grout.

1. From intended grout supplier for Project.
2. Three bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

A.	Product data and warranty information contained in company literature and data?	Yes_____ No_____
B.	Literature and bag information meet specified requirements?	Yes_____ No_____
C.	Manufacturer guarantees grout?	Yes_____ No_____
D.	Guarantee extends beyond grout replacement value and allows participation with Contractor in replacing and repairing defective areas?	Yes_____ No_____
E.	Water demands and limits printed on bag?	Yes_____ No_____
F.	Mixing information printed on the bag?	Yes_____ No_____
G.	Temperature restrictions printed on bag?	Yes_____ No_____

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____
2. List expiration date. _____
3. Weigh bags and record weight. _____

Owner's Representative will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of three bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10-gallon pail.
2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).
3. Use maximum water allowed per water requirements listed in bag instructions.
4. Mix grout to maximum time listed on bag instructions.
5. In accordance with ASTM C939 (flow cone) determine time of mixed grout through the flow cone. _____ seconds
6. Add water to attain 20-second to 30-second flow in accordance with ASTM C939.
7. Record time of grout through cone at new water demand. _____ seconds
8. Record total water needed to attain 20- to 30-second flow. _____ pounds
9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, ASTM C1107/C1107M will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.
2. Place one can of grout in tub of ice water and leave one can at ambient temperature.
3. Cover top of both cans with glass or plastic plate preventing evaporation.
4. Maintain 38 degrees F to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.

5. Visually check for bleeding of water at 15-minute intervals for 2 hours.

6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and Category III):

1. Divide the remaining grout into two 3-gallon cans. Place the cans into the 40-degree F and 90-degree F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4 inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.

2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take an ASTM C939 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 degrees F and 90 degrees F.

   a. 20 min _____, sec. @ 40 degrees F.

   b. 40 min _____, sec. @ 40 degrees F.

   c. 60 min _____, sec. @ 40 degrees F.

   d. 20 min _____, sec. @ 90 degrees F.

   e. 40 min _____, sec. @ 90 degrees F.

   f. 60 min _____, sec. @ 90 degrees F.

All Category II and Category III grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

Qualified Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with ASTM C1107/C1107M for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.

2. Store cubes at 70 degrees F for 24 hours.

3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are less than 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

_____ _____

Signature of Independent Testing Laboratory Date Test Conducted

SECTION 03 63 00
CONCRETE DOWELING

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. International Code Council (ICC):
   a. 2021 International Building Code (IBC).
   b. Evaluation Services Reports.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

B. Special Inspection: As defined in the ICC IBC and indicated on the Statement of Special Inspection (Plan) in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s catalog information.

B. Informational Submittals:

1. Manufacturer’s instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
2. Manufacturer’s written letter of certification identifying installer’s qualifications to install products.
3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

1.04 QUALITY ASSURANCE

A. Qualifications: Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

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

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

C. Dispose of when:

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

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Approved by an ICC Evaluation Services Report for conformance to 2021 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/C881M.
4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
5. Disposable, Self-Contained Cartridge System:
   a. Capable of dispensing both components in proper mixing ratio.
   b. Fit into manually or pneumatically operated caulking gun.
6. Mixed Adhesive: Nonsag, light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout.
7. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
8. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT-RE 500 V3 (ESR-3814) or HIT HY 200 (ESR 3187) Adhesive Anchors.
   b. Powers Fasteners, Brewster, NY; Power PURE110+ Epoxy Adhesive Anchor System (ESR-3298).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors (ESR-4057).

B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

C. Reinforcing Dowels: As specified in Section 03 21 00, Steel Reinforcement.

PART 3 EXECUTION

3.01 INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes:
   a. Electric or pneumatic rotary type with medium or light impact.
   b. Hollow drills with flushing air systems are preferred.
2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.

C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.

D. Doweling:

1. Install per details shown on Drawings and in accordance with adhesive manufacturer’s instructions.
2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
3. Bent Bar Dowels: Where edge distances are critical and intersection with steel reinforcement or other obstruction is likely, slant drill to address edge distance or to clear obstruction. If drill must be slanted more than indicated in the manufacturer’s installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

E. Adhesive:

1. Install in accordance with written manufacturer’s instructions.
2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspection (Plan) in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information on special inspection and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

1. Special inspection will be performed by the Special Inspector in accordance with ICC ESR requirements and as specified in Section 01 45 33, Special Inspection, Observation, and Testing.
2. Continuous inspection required where noted in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing and where concrete dowels are installed in overhead applications.
3. Periodic inspection required where continuous inspection is not specified.
4. Special Inspector will observe installation in accordance with requirements of the ICC Evaluation Services Report and will submit report including the following:
    a. Product Description: Product name, rod diameter, and length.
    b. Drill bit compliance.
    c. Hole diameter, diameter, and depth and cleanliness.
    d. Adhesive expiration date.
5. Verification of dowel installation in accordance with manufacturer’s published instructions

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

END OF SECTION

SECTION 03 64 23
EPOXY RESIN INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C882, Standard Specification for Test Method for Bond Strength of Epoxy Resin System Used with Concrete by Slant Shear.
   b. D570, Standard Test Method for Water Absorption of Plastics.
   c. D638, Standard Test Method for Tensile Properties of Plastics.
   d. D648, Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
   e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   f. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. Hydraulic Structure: Liquid containment structure and/or structure designed to mitigate liquid infiltration.

D. Injection: Method of bonding together, addressing or eliminating leakage through cracks or joints by installing resin under pressure to fill the void in crack or joint.

E. Joint: A planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements and may contain embedded waterstops.

F. Leak or Leakage: Crack or joint exhibiting presence of moisture, sign of efflorescence, intermittently wet to touch, or continuous flow of liquid.

G. Narrow Cracks: Width equal to or less than 0.015 inch.

H. Wide Cracks: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for epoxy resin.
2. Technical data for metering, mixing, and injection equipment.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for epoxy resins.
2. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements. Certified test results for each batch of epoxy resin.
3. Statements of Qualification for Epoxy Resin:
   a. Manufacturer's Site representative.
   b. Injection applicator.
   c. Injection pump operating technician.
4. Sample of epoxy resin two component ratio and injection pressure test records for concrete crack repair work.
5. Installation instructions for repairing core holes with repair mortar.
6. Health and Safety Plans for confined space entry. Test results of epoxy resin bond tests.
7. Epoxy resin two component ratio and injection pressure test records for concrete crack repair work.

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staffs:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods of epoxy injection process for concrete structure.
   b. Understands and is capable of explaining technical aspects of correct material selection and use.
   c. Experienced in operation, maintenance, and troubleshooting of application equipment.
2. Injection Crew and Job Foreman:
   a. Provide written and verifiable evidence showing compliance with the following requirements:
      1) Licensed or certified by epoxy resin material manufacturer.
      2) Minimum 3 years' experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection, including 2,000 linear feet of wet crack injection to stop water leakage.

B. Injected Epoxy Resin: Fill cracks with minimum resin depth penetration no less than 90 percent of:

1. Full thickness of concrete section for cracks or joints.
2. Depth between waterstop and inside [outside] face of structure for joints with an embedded waterstop.

C. Injected cracks which leak shall be considered deficient work irrespective of depth of penetration. Reinjection of deficient work or, with approval of Engineer, provide other repairs to eliminate leakage.

D. Bond Strength Test for Epoxy Resin:

1. Concrete failure before resin failure.
2. 1,500 psi minimum bond strength per ASTM C882 test requirements with no failure of either concrete or epoxy resin.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. Package resin material in new sealed containers and label with following information:
   a. Manufacturer's name.
   b. Product name and lot number.
   c. ANSI Hazard Classification.
   d. ANSI recommended precautions for handling.

B. Storage and Protection: Store epoxy resin material containers in accordance with manufacturer's printed instructions and at ambient temperatures below 110 degrees F and above 45 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials and accessories specified in this section shall be products of:

1. Master Builders Solutions, Shakopee, MN; MasterInject series products that meet properties below.
2. Sika Corp., Lyndhurst, NJ; Sikadur Series products that meet properties below.
3. Euclid Chemical Co., Cleveland, OH; Euco Series (#452) products that meet properties below.

2.02 EPOXY INJECTION RESIN

A. Two-component A and B structural epoxy resin for injection into cracks or joints in concrete structures for bonding or grouting.

B. Uncured Resin Properties:

1. When mixed in ratio specified on resin container label:

	Test Method	**Wide Cracks or Joints**	**Narrow Cracks or Joints**
Pot Life (60-gram mass) @ 77, plus or minus 4 deg F	As specified in Article Source Quality Control	13 to 25 minutes	15 to 30 minutes
Pot Life (60-gram mass) @ 100, plus or minus 4 deg F	As specified in Article Source Quality Control	3 to 10 minutes	10 to 20 minutes
Viscosity @ 40, plus or minus 3 deg F	Brookfield RVT Spindle No. 4 @ 20 rpm	4,400 cps	600 cps
Viscosity @ 75 to 77 deg F	Brookfield RVT Spindle No. 2 @ 20 rpm	375 to 350 cps	175 to 140 cps

C. Epoxy Resin Properties: When cured for 7 days at 77 degree F, plus or minus 3 degrees F and conditioned at test temperature 12 hours prior to test, unless otherwise specified.

	Test Method	**Wide Cracks or Joints**	**Narrow Cracks or Joints**
Ultimate Tensile Strength, psi	ASTM D368	8,000 min.	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	4.2 max.	3.0 max.
Flexural Strength, psi	ASTM D790	10,000 min.	10,000 min.
Flexural Modulus, psi	ASTM D790	5.5×10^5 min.	4.5×10^5 min.
Compressive Yield Strength, psi	ASTM D695*	15,000 min.	12,000 min.

	Test Method	**Wide Cracks or Joints**	**Narrow Cracks or Joints**
Compressive Modulus, psi	ASTM D695*	$4.0x10^5$ min.	$4.0x10^5$ min.
Heat Deflection Temperature	ASTM D648*	130 deg F min.	140 deg F min.
Cured 3 days @ 40 deg F – Wet Concrete		3,500 psi min.	3,500 psi min.
Cured 1 day @ 77 deg F – Dry Concrete		5,000 psi min.	5,000 psi min.
Cured 3 days @ 77 deg plus or minus 3 deg F		5,000 psi min.	5,000 psi min.
*Cure test specimens so that peak exothermic temperature of resin does not exceed 100 degrees F. Note: See referenced specifications for preparation method of test specimens.			

2.03 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 resin has cured.

2.04 WATER

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

2.05 SAMPLE BOTTLE

A. Five-inch natural wide mouth HDPE bottle or 4-ounce clear PVC cylinder bottle; supplied with caps.

2.06 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of epoxy resin.

B. Pot Life Test:

1. Condition Component A and Component B to required temperature.
2. Measure components in ratio of Component B as stated on manufacturer’s label into an 8-fluid ounce paper cup.

3. Mix components for 60 seconds using non-metallic stirring instrument. Scrape sides and bottom of cup periodically.
4. Probe mixture once with non-metallic stirring instrument every 30 seconds, starting 2 minutes prior to minimum specified pot life.
5. Pot Life Definition: Time at which a soft stringy mass forms in center of cup.

C. Slant Shear Test: Prepare specimens and perform tests in accordance with ASTM C882.

PART 3 EXECUTION

3.01 GENERAL

A. Unless permitted otherwise, structurally repair cracks or joints listed below:

1. Cracks considered to be defective as defined in Section 03 30 00, Cast-in-Place Concrete.
2. All vertical cracks or joints near corners or intersections.
3. All horizontal cracks at wall bases.
4. All cracks caused by voids or honeycombs.
5. All horizontal joints with leaks and dampness.
6. All cracks caused by construction overloading.
7. All vertical or diagonal cracks or joints caused by drying shrinkage within a distance equal to the height of wall from the face of corners or intersecting walls. Inject 90 days after placement, unless approved otherwise by the project Structural Engineer.
8. All horizontal cracks within a distance equal to one-quarter on the wall height above or below elevated slabs. Inject 90 days after placement, unless approved otherwise by the project Structural Engineer.
9. All cracks as a result of thermal shrinkage where the concrete member being injected has been allowed to dry after placement for a minimum of 90 days.
10. All other cracks as a result of drying shrinkage to be repaired 90 days or more after placement.

B. Do not proceed with injection work until submittals have been reviewed and approved by Engineer.

C. Perform cracks or joints injection work after removing defective surface materials and after performing surface preparation, but prior to applying surface repair material unless otherwise noted. See Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces, Section 03 01 33, Repair of Horizontal Concrete Surfaces, for concrete surface repair system.

D. The width of cracks may vary along length and through thickness of concrete section.

E. Remove all excess, unused epoxy resin materials on concrete surfaces exposed to view prior to end of Work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter and mix two epoxy resin components and inject mixture into cracks or joints.

B. Pumps:

1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.
2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.
3. Capable of immediate compensation for changes in resins.
4. Do not use batch mix pumps.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed epoxy resin at pressures in accordance with epoxy resin manufacturer’s printed instruction and able to maintain pressure.

D. Automatic Shutoff Control: Provide sensors on both Component A and Component B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance: Maintain epoxy resin manufacturer’s prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:

1. Two independent valve 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.

3.03 PREPARATION

A. Free cracks or joints from loose matter, dirt, laitance, oil, grease, efflorescence, salt, and other contaminants.

B. Clean cracks or joints in accordance with epoxy resin manufacturer's instructions.

C. Clean surfaces adjacent to cracks or joints from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer's printed instruction.

D. Do not use acids and corrosives for cleaning, other than those specified herein unless neutralized prior to injecting epoxy resin.

E. During installation and curing of materials, if ambient temperature is expected to drop below manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

G. Dry out cracks or joints if required by manufacturer's instructions.

3.04 APPLICATION

A. All liquid is to be removed from hydraulic structure prior to commencing with epoxy injection, unless approved otherwise.

B. Entry Ports:

1. Establish openings for epoxy resin entry in surface seal along crack.
2. Determine space between entry ports equal to thickness of concrete member to allow epoxy resin to penetrate to the full thickness of the member.
3. Unless otherwise noted, drill injection holes at an angle between 45 degrees and 60 degrees from surface of concrete and perpendicular to alignment of cracks or joints, to intersect crack or joint at midpoint of concrete section, except if joint contains waterstop, then intersect joints at midpoint between waterstop and concrete surface.
4. Locate drill holes on alternate sides of crack or joint where possible, unless orientation of crack or joint is known or has been verified by non-destructive testing techniques or core drilling.

5. Drill Hole Spacing: Do not exceed concrete thicknesses or 12 inches maximum, except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack or joint and at commencement of drilling holes for injection and at beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow or too deep, or damaging existing waterstop in joints.
8. Remove dust and debris in drill holes and on surface of structure resulting from drilling operation, by flushing with water prior to installing the injection packers or ports.
9. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
    a. Cracks or joints extend entirely through concrete element.
    b. Backfill of walls on one side.
    c. Slab-on-grade.
    d. Difficult to excavate behind wall to seal both surfaces of crack.
10. Install injection packers or ports in drill holes in accordance with manufacturer's printed instructions with zerk coupling or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks and joints.

C. Application of Surface Seal along Cracks and Joints:

1. Apply surface seal in accordance with manufacturer's instructions to designated cracks and joints face prior to injection. Seal surface of cracks or joints to contain and prevent escape of injection epoxy.
2. Cure surface seal in accordance with manufacturer's printed instructions before commencing inject work.

D. Epoxy Injection:

1. Ensure zerk coupling is not installed in ports or packers next to the one being injected.
2. Start injection into each crack or joint at lowest elevation entry port or packer along vertical or diagonal crack or joint, and at one end of horizontal crack or joint.
3. Where injection entry ports or packers are used, continue injection at first port or packer until resin begins to flow out of port or packer at next highest elevation. Plug first port or packer and start injection at second port or packer until resin flows from next port or packer.
4. Inject entire crack or joint with same sequence.
5. At no time inject more than 6 feet length of first vertical crack or joint before verifying resin in sample bottle has start to set and cure.

6. Prior to commencing injection work along a horizontal crack [or joint] in structure when processed using ports or packers with zerk couplings are used, remove zerk couplings from injection ports or packers except for two ports or packers located where injection work will commence. Commence injection work in first two ports or packers. Once clean resin is vented from third injection port or packer, cease injection at first port or packer, and install zerk coupling and commence injection at third port or packer. Repeat process for fourth and subsequent ports or packers until full length of crack or joint has been injected.
7. The injected epoxy resin shall fill the cracks and joints, and in no case shall the depth of penetration of the injection material be less than ninety percent (90 percent) of:
   a. The full thickness of the concrete section for cracks or joints; and
   b. The depth between the waterstop and the face of the structure for joints with an embedded waterstop.
8. Injected cracks and joints found to exhibit leakage shall be deemed as deficient work irrespective of the depth of penetration. Carry out re-injection of deficient work as required , at no cost to the Owner.

E. Finishing:

1. Allow epoxy resin to cure in accordance with manufacturer’s instruction after cracks or joints have been completely injected to allow surface seal removal without draining or runback of uncured epoxy resin material from cracks or joints.
2. Remove surface seal and injection packers or ports from cured injection resin along crack.
3. Finish crack or joint faces flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports, packers, drill holes, or damage from removal of surface seal is not acceptable.
5. Grind off protrusions and patch indentations and holes from injection packers and entry ports with a suitable patch material to satisfaction of Engineer.
6. Remove surplus surface seal material splatters and injection resin material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Epoxy Resin Two Component Ratio Tests:

1. Disconnect mixing head and pump two resin components simultaneously through ratio check device.
2. Adjust discharge pressure to 160 psi for both resin components.

3. Simultaneously discharge both resin 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 work day, 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 resin 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 work day.
   b. When injection work stop for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Bottled Sample Tests:

1. During injection operation, provide at least one sample of mixed epoxy resin for each injection pump per shift per injection work day in a sample bottle.
2. Provide sufficient sample to demonstrate sample material epoxy resin will set and cure correctly.
3. Label each bottled sample with Contractor’s name, date, and time sample was taken, and location in structure where sample was taken. Record details of bottle sample tests.
4. Place filled sample bottle upright in a container and allow sample to cure.

5. After sample has been allowed to cure, cut bottled sample open and visually inspect contents to verify that epoxy resin material has completely reacted and cured.
6. Evaluation and Assessment of Test:
    a. Should bottled sample(s) indicate a problem; such as epoxy resin not cured or foreign liquid in sample bottle, take verifying core sample immediately from cracks [or joints], where material was used.
    b. Should above-referenced bottle sample(s) and core sample(s) indicate a problem with epoxy resin, arrange to have a Technical Representative of the epoxy resin manufacturer come to Site to review bottled sample(s) and core drilled sample(s) with Engineer and provide technical advice on corrective measures.
    c. Carry out further investigation work or corrective measures recommended by Technical Representative of epoxy resin manufacturer.

END OF SECTION

SECTION 03 64 24
POLYURETHANE INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D638, Standard Test Method for Tensile Properties of Plastics.
   b. D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
   c. D1623, Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   d. D3574, Standard Test Method for Flexible Cellular Material Slab, Bonded, and Molded Urethane Foams.

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Injection: Method of bonding together; method of addressing or eliminating leakage through cracks or joints by installing polymer under pressure to fill the void in crack or joint.

C. Joint: Planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements, and may contain embedded waterstops.

D. Leak or Leakage: Crack or joint exhibiting moisture, sign of efflorescence, intermittent wet to touch, or continuous flow of liquid.

E. Narrow Cracks: Width equal to or less than 0.015 inch.

F. Wide Crack: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for polyurethane injection resin.
2. Technical data for metering, mixing, and injection equipment.

3. Submit:
    a. Marked up drawings showing locations of proposed polyurethane injection work, including the following:
        1) Exact locations for injection.
        2) Depth of penetration or crack.
        3) Width of crack measured every 4 feet minimum.
        4) Length of penetration or crack.
    b. Proposed materials.
    c. Injection procedure, including the following:
        1) Preparation of penetration for polyurethane.
        2) Fittings for installation for injection.
        3) Temperature of installation.
        4) Measurement and monitoring of injection pressure.
        5) Surface cleaning and repair.
4. Sample bottle.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for polyurethane resin injection.
2. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements. Certified test results for each batch of polyurethane.
3. Statements of Qualification for Polyurethane Resin Injection:
    a. Manufacturer's Site representative.
    b. Injection applicator.
    c. Injection pump operating technician.
4. Health and Safety Plans for confined space entry.
5. Sample of polyurethane resin mix ratio and injection pressure test records for concrete crack and joint injection work.
6. Installation instructions for repairing core holes with repair mortar.
7. Polyurethane resins injection pressure test records for concrete crack and joint injection work.

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staff:

1. Manufacturer's Site Representative:
    a. Capable of instructing successful methods of polyurethane injection process for concrete structures.
    b. Understands and is capable of explaining 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 or certified by polyurethane resin manufacturer.
   b. Minimum 3 years' experience in successful polyurethane injection.

1.05 PERFORMANCE REQUIREMENTS

A. Injected polyurethane resin shall fill cracks, joints and mitigate leaks.

B. In cured state, injected polyurethane resin forms a dense rubber-like closed cell flexible foam compression gasket-type seal material.

C. Notwithstanding the foregoing, injected cracks or joints which exhibit leakage are considered deficient work irrespective of the depth of penetration observed in quality control core drilled samples. Reinject deficient work as required to meet the performance requirements.

1.06 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 for accelerator.

B. Storage and Protection: Store polyurethane resin material containers in accordance with manufacturer's printed instructions or in the absence of such information at ambient temperatures below 110 degrees F and above 68 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sika Corp., Lyndhurst, NJ; SikaFix HH Hydrophilic.

B. Euclid Chemical Co., Cleveland, OH; DURAL Aqua-Fil.

C. Prime Resins, Inc., Conyers, GA; Prime Flex 900 XLV.

2.02 POLYURETHANE RESIN

A. Single-component, water-activated, hydrophilic polyurethane injection resin.

B. Accelerator: Compatible with polyurethane resin from same manufacturer.

C. Elongation: Minimum 350 percent, in accordance with ASTM D3574 or ASTM D638 test method.

D. Tensile Strength: Minimum 150 psi, in accordance with ASTM D3574 or ASTM D638 test method.

E. Shrinkage: Less than 2 percent.

F. Meets NSF 61 requirements.

2.03 SURFACE SEAL

A. Provide seal with 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 resin has cured.

2.04 WATER

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

2.05 SAMPLE BOTTLE

A. 5 inches natural wide mouth HDPE bottle or 4 ounces clear PVC cylinder bottle, supplied with caps.

2.06 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of polyurethane resins.

PART 3 EXECUTION

3.01 GENERAL

A. Use of polyurethane injection shall be limited to locations as determined by Owner.

B. Unless permitted otherwise, polyurethane inject cracks and joints listed below:

1. Cracks and joints that leak.
2. Cracks and joints exhibit dampness, efflorescence, or other evidence of leakage.

C. Do not proceed with injection work until action submittals have been reviewed and approved by the Structural Engineer of Record.

D. Perform injection work after performing surface preparation.

E. Width of the cracks shown may vary along the length and through the thickness of the concrete section.

F. Remove all excess unused polyurethane resins materials inside the structure prior to the end of the work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter mixed components, and inject mixture into crack or joint.

B. Pumps:

1. Positive displacement type pump.
2. Equip the polyurethane injection equipment with pail heater(s) suitable for plastic pails capable of maintaining the polyurethane resin and accelerator mixture between 50 degrees F and 160 degrees F.
3. Thermometer with each pump for monitoring the temperature of the polyurethane resin.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed polyurethane resin at pressures in accordance with polyurethane resin manufacturer’s printed instructions, and able to maintain such pressure.

D. Proportioning Ratio Tolerance: Maintain polyurethane manufacturer’s prescribed mix ratio within a tolerance in accordance with polyurethane resin manufacturer’s printed instructions.

E. Pressure gauge capable of sensing pressure behind valve.

3.03 PREPARATION

A. Free cracks and joints from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks and joints in accordance with polyurethane resins manufacturer's printed instructions.

C. Clean surfaces adjacent to cracks and joints from dirt, dust, grease, oil, efflorescence, encrustation, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer's printed instructions.

D. Do not use acids and corrosives for cleaning, other than those specified herein, unless neutralized prior to injecting polyurethane resin.

E. During installation and curing of materials, if the ambient temperature is expected to drop below the manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

3.04 APPLICATION

A. Injection Ports:

1. Drill holes shall be installed along cracks and joints designated for injection as required to meet the performance requirements for injection.
2. The requirements for installing drill holes for injection provided below represent acceptable minimum standards of practice.
3. Drill holes for injection at an angle between 45 degrees and 60 degrees from the surface of the concrete and perpendicular to the cracks or joints alignment, to intersect the cracks at the midpoint of the concrete section, and intersect the joints at the midpoint between the waterstop and interior concrete surface, except as noted otherwise.
4. Locate drill holes on alternate sides of the crack or joint where possible, unless orientation of the crack or joint is known or has been verified by nondestructive testing techniques or core drilling.
5. The spacing of drill holes not to exceed the concrete thickness or 12 inches (maximum), except as noted otherwise.

6. Adjust location and angle of drill holes to suit orientation of crack or joint and at required angle, such as using a template, during the Work especially at the commencement of drilling holes for injection and at the beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow, or too deep, and/or damaging the existing waterstop in the joints. Shallow hole injections lead to concrete spalls. Repair spalls at Contractor's expense.
8. Remove dust and debris in drill holes and on interior surface of the structure resulting from drilling operation, by flushing with water prior to installing injection packers or ports.
9. Install injection packers or ports in drill holes in accordance with manufacturer's printed instructions with zerk coupling, or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks and joints.

B. Application of Surface Seal:

1. Apply surface seal along the length of the cracks and joints designated for injection on the top side and underside of slabs, or both sides of walls, where possible in order to contain, confine, and prevent escape of the injected polyurethane resin, in accordance with manufacturer's printed instructions.
2. Cure the surface seal in accordance with the material's manufacturer's printed instructions.

C. Mixing Polyurethane Injection Resin:

1. Add accelerator to polyurethane injection resin at the required dosage to produce cured polyurethane material meeting performance requirements, and mix thoroughly in accordance with manufacturer's printed instructions until a homogeneous mixture is obtained outside of the structure.
2. Heat polyurethane injection resin materials prior to and during mixing and injection as required and in accordance with manufacturer's printed instructions to a temperature between 85 degrees F and 130 degrees F. Injection of polyurethane resin when it is less than 85 degrees F or more than 130 degrees F is prohibited.

D. Polyurethane Injection of Cracks and Joints:

1. Inject polyurethane resins, mixed with accelerator or in a neat form, into cracks and joints in a sequential manner, and reinjection as required, to meet the performance requirements.
2. Start injection at lowest elevation entry port for vertical or diagonal cracks and joints and at one end for horizontal cracks and joints in vertical structure. Continue injection at first port until pure uncontaminated resin begins to flow out of next port. Plug first port and start injection at second port until polyurethane resin flows from next port. Inject crack or joint in a sequential manner until the full length of the crack or joint has been injected. At no time inject more than 6 feet length of vertical crack or joint before verifying that the first 12 inches of injected crack or joint is set and cured.
3. Prior to commencing the injection work along a crack or joint in horizontal structure when packers with zerk couplings are used, remove the zerk couplings from the injection packers or ports except for the two packers located where the injection work will commence. Commence injection work in the first two packers. Once clean resin is vented from the third injection packer, cease injection at the first packer, and install the zerk coupling and commence injection at the third packer. Repeat the process for the fourth and subsequent packers until the full length of the crack or joint has been injected.

E. Finishing:

1. Cure polyurethane resins after crack or joints has been completely filled without draining or runback of polyurethane resin material from crack or joints.
2. Remove surface seal and injection packers or ports from along the crack or joints.
3. Finish surface flush and to match surrounding concrete.
4. Indentations or protrusions caused by placement of entry ports drill holes, or damage from removal of surface seal, is not acceptable.
5. Grind off protrusions, and patch indentations and holes from packers and ports with a suitable patch material to the satisfaction of the Engineer.
6. Remove surplus surface seal material on splatters and injection material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect polyurethane component delivery line 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 work day.
   b. When injection work has stopped for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

B. Bottled Samples:

1. During the injection operation, provide at least one sample of the mixed polyurethane injection resins per shift per injection pump in a sample bottle.
2. Half fill each sample bottle, containing a small amount of water (5 percent by volume) with polyurethane injection resin material from the pump discharge hose. Swirl or lightly shake sample to thoroughly mix resin with the water. When foaming rises near the top of the bottle, install the cap to contain the expanding resin material.
3. Label each bottled sample with Contractor’s name, date and time sample was taken, and location in structure where sample was taken. Maintain a log of bottle samples.
4. Place filled sample bottle upright in a box or pail and allow sample to cure.
5. After sample cured, cut bottled sample open and visually inspect contents to verify that polyurethane injection resins material has completely reacted and cured.

6. Evaluation and Assessment of Test:
    a. If a bottled sample(s) indicates a problem with the polyurethane injection resins, such as polyurethane resin not cured; take verifying core sample immediately from the cracks or joints, where the material was used.
    b. If the above-referenced bottle sample(s) and core sample(s) indicate a problem with the polyurethane injection resins, have a Technical Representative of the polyurethane injection resins manufacturer come to site to review bottled sample(s) and core drilled sample(s) with Engineer and provide technical advice on corrective measures.
    c. Carry out further investigation work or corrective measures recommended by the Technical Representative of the polyurethane injection resins manufacturer.

C. Visual Inspection:

1. Confirm injection of polyurethane has stopped the leaking material.
2. Confirm installation of material is in accordance with manufacturers' requirements.
3. Confirm installation of material is not damaging concrete.

END OF SECTION

SECTION 04 21 13.13
MASONRY VENEER

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   c. B370, Standard Specification for Copper Sheet and Strip for Building Construction.
   d. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   e. C91, Standard Specification for Masonry Cement.
   f. C126, Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.
   g. C144, Standard Specification for Aggregate for Masonry Mortar.
   h. C150/C150M, Standard Specification for Portland Cement.
   i. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   j. C216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
   k. C270, Standard Specification for Mortar for Unit Masonry.
   l. C652, Standard Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale).
   m. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
   n. D1056, Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
   o. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
   p. E2178, Standard Test Method for Air Permeance of Building Materials.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer's product information for each different item specified.
   b. Mix designs for mortar.
   c. Details for cast stone units and special brick shapes and assemblies.
2. Samples:
   a. Full-size units for each different exposed masonry unit required showing full range of exposed color, texture, and dimensions to be expected in completed construction. Match existing buildings in type, size, color and texture.
      1) Include size variation data verifying that actual range of sizes for brick falls within ASTM C216 dimension tolerances for brick where modular dimensioning is indicated.
   b. Colored masonry mortar Samples for each color required showing full range of colors expected in finished construction. Label Samples to indicate type and amount of colorant used.
   c. Stone and cast stone Samples not less than 12 inches in length showing full range of colors and textures expected in finished construction.
   d. Cast stone copping cap Shop Drawings showing:
      1) Size and location of precast pieces.
      2) Locations and sizes of connection slots required for split tail and L anchors.
      3) Types of anchors and fastener, with locations used to anchor precast coping pieces in place.
   e. Masonry Mat: Submit 2 samples 6 inches by 6 inches in size with manufacturer's product datasheet with labeled thickness to be used.
   f. Weep: Submit 2 sample weep vents, actual size and color and manufacturer's data sheet.

B. Informational Submittals:

1. Experience record of mortar color pigment proposed for use.
2. Manufacturer's certificate of compliance for masonry units specified herein.
3. Method and materials for removal of efflorescence.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: For masonry construction meet requirements of the International Building Code including local and State amendments and as supplemented by these Specifications.

B. Mockups: Lay up a Sample panel for each type of masonry at the Site including reinforcing, air and water barrier, insulation, and veneer ties. Show bond pattern and method of finishing joints. Make Sample panels 8 feet high and 8 feet long, including base of wall flashing and one masonry control joint. Provide precast coping cap and flashing as specified. Provide representation of each color and shale pf brick and split face CMU veneer to be used. Remove mockup after acceptance of permanent masonry Work. Mockup may be a part of permanent construction. Acceptable Sample panel serves as a basis of color, texture, pattern, and workmanship for acceptance of the permanent construction.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:

1. Store all masonry materials off ground and protected from precipitation.
2. Protect veneer materials from mud splatters and staining.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not lay masonry when ambient temperature is below 32 degrees F on a rising temperature or below 40 degrees F on a falling temperature, or when there is a probability of such conditions occurring within 48 hours, unless express approval of Engineer is obtained. In such case, make special provisions for heating materials and protecting finished Work. Protect masonry against freezing for a minimum of 48 hours after being laid. Protect tops of walls from precipitation at all times. Cover with waterproof paper when rain or snow is imminent and the Work is discontinued.

B. Humidity: Protect masonry construction from direct exposure to wind and sun when erected in an ambient air temperature of 99 degrees F (37 degrees C) in the shade with relative humidity less than 50 percent.

PART 2 PRODUCTS

2.01 MASONRY UNITS

A. Color, Texture, and Pattern: Match submitted Samples matching existing building materials and approved by Engineer.

B. Concrete Masonry Veneer:

1. General:
   a. Furnish special shapes for corners, jambs, lintels, and other areas shown or required.
   b. Special units shall match texture of standard units.
   c. Where units are placed so end of unit is exposed, such as at a corner or at a wall opening, exposed end of that block shall have surface to match texture of sides of other units.
   d. Furnish sound, dry, clean units free of cracks and chips.
   e. All veneer block to have integral water repellency.
2. Textured Concrete Masonry Unit Veneer (TCMUV-2):
   a. Textured units to match existing buildings.
   b. Nominal Size: 16 inches long by 8 inches high by 4 inches thick. Furnish special shapes in sizes as required.
   c. Split-face texture at exposed faces and ends.
   d. Color of Units: To match existing buildings.
3. Existing building product: Graselli Concrete Products Co. Inc., Cliffside Crème.

2.02 FACING BRICK

A. The brick veneer is to match size, color, pattern and grout color of the existing building brick veneer. The proposed veneer brick to be the following:

1. Facing Brick: ASTM C2l6, Grade SW. Type FBX
   a. Minimum compressive strength for individual brick: 2,500 psi.
   b. Size: Match existing in size and color.
2. Existing Building Brick Products:
   a. Type “A” Belden Brick Company: Dutch Gray Velour.
   b. Type “B” Belden Brick Company: No. 503-505 Smooth.

2.03 CAST STONE AND CAST STONE COPING CAP

A. The cast stone and coping cap are to match size, color, pattern and grout color of the existing building stone cap and trim. The proposed cast stone to be the following:

1. Homogeneous, manufactured from portland cement concrete, precast, and of same composition throughout each piece. Use of selected aggregates for faces only is expressly prohibited.
2. Sound and perfect, with sharp and true corners.
3. Furnish with holes, regrets, rebates, and other features as required by the design and for installation.
4. Aggregate: Known durability; proportioned to produce maximum density.
5. Properties:
   a. Minimum Compressive Strength: 7,000 psi.
   b. Maximum Average Water Absorption: 5 percent.
6. Reinforcing: By manufacturer as required for strength of unit.
7. Properly cure prior to delivery.
8. Integral Color: Match existing building.
9. All cast stone to have integral water repellency.
   Coating: Coat each stone with coating per Specification Section 07 19 00, Water Repellants.

B. The cast stone coping cap pieces are to be made of the largest size possible to eliminate the number of joints while still facilitating installation. The proposed cast stone to be the following:

1. Cut or form slots to receive stainless steel split tail stone anchors. Size and placement to be coordinated with type of anchors used. 1-1/4 inches deep minimum. Slots in end pieces of coping cap to be located in the lower side of the cast stone. The slot should allow the vertical leg of the starter anchor to extend a minimum of 1 inch into the coping cap.
2. Center slot location over CMU fully grouted top course located below.

2.04 MORTAR MATERIALS

A. Masonry Cement: ASTM C91, low alkali content (0.03 percent maximum).

B. Portland Cement: ASTM C150, Type I, low alkali content (0.60 percent maximum).

C. Lime: ASTM C207, Type S.

D. Mortar: ASTM C270, Type S. Consisting of one part portland cement, from 1/4 part to 1/2 part lime putty or hydrated lime, and clean well-graded sand in the proportion of three times the sum of the cementitious material; or 1/2 part portland cement, one part masonry cement, and clean well-graded sand in the proportion of three times the sum of the cementitious material.

1. If color is added, add in a consistent manner to provide final uniformity.
2. No antifreeze liquid, salts, or other substances are allowed to lower freezing point. No calcium chloride is allowed in mortar.

E. Mortar Color:

1. Pure, concentrated mineral, pigment specially processed for mixing in to mortar; ASTM C979.
2. Manufacturer and Product:
   a. Davis Colors, True Tone Cement Colors.
   b. Solomon Colors, Mortar Colors.
3. Color: Match existing Building.

F. Sand: ASTM C144, in addition not less than 5 percent passes the No. 100 sieve.

G. Water: Fresh, clean, and free of deleterious acids, alkalies, chlorides, and organic materials.

2.05 MORTAR PREPARATION

A. Place one-half the water and aggregate in operating mixer; add cement; add remaining aggregate and water and mix for at least 2 minutes. Add lime and continue mixing as long as needed to secure a uniform mass, but no less than 3 minutes after the addition of lime. Time the addition of admixture in strict accordance with manufacturer’s instructions and the procedure used for adding it to the mix shall provide good dispersion.

B. Mix mortar in machine with mixing drums clean and free of debris and dried mortar. Use mortar before the initial setting of the cement has taken place. Do not retemper mortar in which the cement has started to set.

C. Retemper mortar boards by adding water within a basin formed with the mortar and the mortar reworked into the water. Dashing or pouring water over mortar and retempering of harsh, nonplastic mortar is not permitted.

D. Where color tinting of mortar is required, add sufficient lime-proof color-fast mineral pigment to mortar.

2.06 MASONRY CONTROL JOINTS

A. ASTM D1056, closed cell neoprene sponge, 3 inches wide by 3/8 inch thick.

2.07 AIR AND WATER BARRIER

A. Air and water barrier, fluid applied, one component, vapor permeable membrane, cures on masonry or concrete surfaces to form a resilient, monolithic, fully-bonded elastomeric sheet, 40 mils minimum dry thickness, meeting requirements of ASTM E2178 for air permeance.

B. Manufacturers and Products:

1. Grace, Perma-A-Barrier Liquid VP.
2. Hohmann and Barnard, Inc.; Textroflash Liquid VP.

2.08 THROUGH-WALL FLASHING

A. See Section 07 62 00, Sheet Metal Flashing and Trim; or

B. ASTM B370. Copper, 16 ounces, 0.0216-inch-thick, rib-bond cold-rolled with uniform, matching, pattern deformations, embossed to provide a mechanical bond in all directions within the mortar bed.

2.09 MASONRY ACCESSORIES AND ANCILLARY MATERIALS

A. Manufacturers, unless noted otherwise:

1. Hohmann and Barnard, Inc.
2. Heckmann Building Products.

B. Masonry accessories are, but are not limited to:

1. Horizontal Joint Reinforcement:
   a. Two parallel No. 9 wires, galvanized in accordance with ASTM A153/A153M, weld connected to No. 9 perpendicular cross wire at 15 inches on center.
   b. Reinforcement: Clean and free from loose rust, scale, and any coatings that reduce bond.
   c. Furnish special manufactured corner and wall intersection pieces at these locations.
   d. Seismic condition requires: 9 gauge or 3/16 inch continuous wire. (seismic dovetail anchor, if required).

e. Engage or enclose joint reinforcement with anchor tie.
f. Manufacturer and Product: Dur-O-Wal, Inc., Arlington Heights, IL.
g. Other Manufacturers: Hohmann and Bernard Inc., Hauppage, NY.

2. Adjustable Anchor Ties:
   a. 16-gauge stainless steel plate with slot.
   b. Anchor Tie: 12-gauge stainless steel pintle plate capable of being inserted into slotted plate.
   c. Engage or enclose No. 9 gauge wire joint reinforcing with anchor tie.
   d. Manufacturer and Product: Dur-O-Wal, Inc., Arlington Heights, IL; seismic Ladur-eye.
3. Masonry Mat and Weep System:
   a. Masonry drainage mat and weep system for air space maintenance, mortar dropping prevention and drainage system.
   b. Fluid conducting, non-absorbent, mold and mildew resistant polymer mesh consisting of 100 percent recycled plastic with binder.
   c. 1-3/4 inch thick allowing no more than 3/8-inch tolerance within air space to solid vertical surfaces.
   d. Manufacturer: CavClear.
4. Reglets for Masonry:
   a. Manufacturers and Products:
      1) Superior Concrete Accessories, Franklin Park, IL; Superior Cushion Lock reglets Type B-3.
      2) Fry Reglet Corp., Glendale, CA; Fry Springlok Type MA.
5. Split Tail and L Stone Anchors:
   a. Product to meet FY=45,000 p.s.i. (ASTM A666).
   b. Finish: Type 304 stainless steel.
   c. Thickness: 3/16 inch thick.
   d. Length: 3 inches or as required for proper attachment.
   e. Split bend length 1 inch minimum.
   f. Bend length: 2 inches.
   g. Size of attachment hole: 5/16 inch.
   h. Manufacturers and products:
      1) Masonry Accessories, Inc., Orlando FL, Split tail anchor/ L anchor.
      2) Heckmann Building Products, Norwalk CT. Split-Bend anchor 274/ L anchor with slot 342.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of masonry veneer.

B. Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.02 AIR AND WATER BARRIER

A. Cleaning of Substrate:

1. Thoroughly clean surfaces to receive membrane following membrane manufacturer’s recommendations.
2. Treat as necessary to remove laitance, loose material on surface, grease, oil, and other contaminants that will affect bond of the membrane.
3. Vacuum clean or clear water wash surfaces and allow to dry completely.

B. Fill voids and control joints with sealant and overcoat with nonflow membrane material. Fill or coat visible shrinkage cracks to minimum 2 inches either side of crack.

C. Follow manufacturer’s directions for application including limitations because of weather, temperature, and concrete cure time. Apply by brush or spray following manufacturer’s recommended coverage and coating rates.

3.03 GENERAL INSTALLATION

A. Matching Existing Masonry: Match coursing, bonding, color, and texture of new masonry with existing masonry. Proposed material to be used to be submitted as part of submittal for approval.

B. Provide or cut special shapes for corners, jambs, lintels, and other areas as shown or as required. Match color and texture of standard units.

C. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.

D. Matching Existing Masonry: Match coursing, bonding, color, and texture of new masonry with existing masonry.

E. Anchoring:

1. Anchor all veneer types to structural backing wall or to structural columns as shown on Drawings and in conformance to the International Building Code.
2. Maintain a space not less than 1 inch wide between masonry wall and concrete members.
3. Keep space free of mortar or other rigid material to permit differential movement between backing wall and masonry.
4. Attach veneer to backing with anchor ties.
   a. Use one anchor tie for each1.77 square feet of wall area.
   b. Maximum Space between Adjacent Ties:
      1) Vertically: 16 inches.
      2) Horizontally: 16 inches.
   c. Embed ties at least 2 inches in horizontal joint of veneer.
   d. Provide additional ties at openings:
      1) Maximum Spacing Around Perimeter: 24 inches.
      2) Install within 12 inches of opening.

3.04 MASONRY VENEER WALL CONSTRUCTION—GENERAL

A. Mortar Beds: Lay masonry with full mortar coverage on horizontal and vertical joints. Rock closures into place with head joints thrown against two adjacent units in-place. Do not pound corners or jambs to fit stretcher units after setting in-place. Where adjustment to corners or jambs must be made after mortar has started to set, remove mortar and replace with fresh mortar.

B. Horizontal and Vertical Face Joints:

1. Nominal Thickness: 3/8 inch.
2. Construct uniform joints.
3. Shove vertical joints tight.
4. Tool joints concave in exposed surfaces when thumbprint hard using jointing tool.
5. Concave tool exterior joints below grade.
6. Flush cut all joints not tooled.
7. Fill horizontal joints between top of masonry partition and underside of concrete beams with mortar.

C. Movement Joints: Keep clean of all mortar and debris.

D. Masonry Control Joints:

1. Provide continuous vertical control joints in masonry as shown on Drawings.
2. Omit mortar from vertical joints. Place control joint material as wall is built.

E. Through-Wall Flashing:

1. Place flashing on bed of mortar.
2. Lap cross joints of through-wall flashing at least 2 inches.
3. Extend flashing beyond exterior face of wall and provide drip edge.
4. Cover flashing with mortar.

F. Flashing: Clean surface of masonry smooth and free from projections that might puncture, gouge, or otherwise damage flashing material.

G. Weep Holes: Provide weep holes in head joints in first course immediately above all flashing leaving head joint free and clean of mortar. Install weep hole tube in head joint per manufacturer's instructions.

1. Maximum Spacing: 24 inches OC.
2. Keep weep holes and area above flashing free of mortar droppings.

H. Sealant Joints:

1. Retain sealant joints around outside perimeters of exterior doors, louver frames, and other wall openings:
   a. Uniform Depth: 3/4 inch.
   b. Uniform Width: 1/4 inch.

I. Pointing: Cut out defective joints and holes in exposed masonry and repoint with mortar. Dry brush masonry surface after mortar has set at end of each day's Work and after final pointing.

3.05 CONCRETE MASONRY UNIT VENEER INSTALLATION

A. General: Do not install cracked, broken, or chipped masonry units exceeding ASTM C216 allowances. Thoroughly wet masonry just before laying except in freezing weather where units are laid dry. Prewetting may also be omitted if the units at the time of laying has a rate of absorption not exceeding 0.025 ounce of water per square inch of surface after being placed in 1/8 inch of water for 1 minute.

1. Coordinate installation with backup walls, through wall flashing, and other construction. Use masonry saws to cut and fit exposed units. Lay units plumb, true to line, with level courses accurately spaced, and do not furrow bed joints.
2. Finish horizontal run by racking back in each course; toothing not permitted. Adjust all units to final position while mortar is soft and plastic. If units are displaced after mortar has stiffened, remove, clean joints and units of mortar, and relay with fresh mortar.
3. Bond unexposed units in wythe by lapping a minimum of 2 inches. Adjust ledger support members to keep Work level at proper elevation. Provide pressure relieving joints by placing a continuous compressible pad under ledger support members.
4. When joining fresh masonry to set or partially set masonry:
   a. Remove loose concrete masonry unit and mortar.
   b. Clean and lightly wet exposed surface of set masonry prior to laying fresh masonry.

B. Pattern: Lay masonry in running bond.

3.06 BRICK VENEER INSTALLATION

A. General: Do not install cracked, broken, or chipped masonry units exceeding ASTM C216 allowances. Thoroughly wet brick just before laying except in freezing weather where bricks are laid dry. Prewetting may also be omitted if the brick at the time of laying has a rate of absorption not exceeding 0.025 ounce of water per square inch of surface after being placed in 1/8 inch of water for 1 minute.

1. Coordinate installation with backup walls, through wall flashing, and other construction. Use masonry saws to cut and fit exposed units. Lay brick plumb, true to line, with level courses accurately spaced, and do not furrow bed joints.

2. Finish horizontal run by racking back in each course; toothing not permitted. Adjust all units to final position while mortar is soft and plastic. If units are displaced after mortar has stiffened, remove, clean joints and units of mortar, and relay with fresh mortar.
3. Bond unexposed units in wythe by lapping a minimum of 2 inches. Adjust shelf angles to keep Work level at proper elevation. Provide pressure relieving joints by placing a continuous compressible pad under the shelf angle.
4. When joining fresh masonry to set or partially set masonry:
   a. Remove loose brick and mortar.
   b. Clean and lightly wet exposed surface of set masonry prior to laying fresh masonry.

B. Pattern: Lay brick in running bond with soldier courses as shown on the Drawings.

3.07 SETTING CAST STONE

A. Clean stone immediately before setting.

B. Set each piece accurately, true to line, level, and plumb, in full bed of fresh mortar. Completely fill all joints and beds with fresh mortar.

C. Install anchor system as shown.

D. After stones are set in mortar, do not move or disturb in any manner that might destroy bond between cast stone and mortar. Cast stones that have been disturbed shall be removed and reset in fresh mortar.

E. Keep faces of cast stone free of mortar. Promptly remove mortar splashed on stone faces and other surfaces.

F. Upon completion, clean face of stone with stiff fiber brushes and detergent and water. Rinse thoroughly with fresh water.

3.08 SETTING CAST STONE COPPING CAP

A. Cast stone coping cap shall be installed over stainless steel flashing per Specification Section 07 62 00, Sheet Metal Flashing and Trim.

B. Prior to setting each precast cap, center a 3-inch square rubberized asphalt gasket at each of the stone anchor locations. Coordinate locations with receptor slots in precast coping.

C. Start with the stainless steel L anchor at the end piece of precast coping. Attach with 1/4 inch diameter by 2-1/4-inch stainless steel expansion anchor. Follow using the split tail anchors for each additional piece of precast.

D. Stone coping can be set in bed of mortar used as a leveling bed or dry laid on plastic shims. If mortar is used rake joints back 3/8 inch to receive backer rod and sealant at all exposed joints.

E. Once the coping is in place the head and bed joints receive backer rod and polyurethane sealant. Sealant to be custom color to match cast stone coping. Provide an additional continuous bead of sealant under the hemmed drip edge of the through wall flashing.

3.09 CLEANING

A. Cleaning Agents:

1. Proprietary Acidic Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned.

B. Follow masonry and mortar color manufacturer's recommendations for use of cleaning agents.

C. Application:

1. Thoroughly wet surface of masonry on which no efflorescence appears before using cleaning agent.
2. Scrub with acceptable cleaning agent.
3. Immediately rinse with clean water.
4. Work small sections at a time.
5. Work from top to bottom.
6. Protect sash, metal lintels, and other materials, which may corrode when masonry is cleaned with acid solution.
7. Remove efflorescence in accordance with masonry manufacturer's recommendations.

D. Leave Work area and surrounding surfaces clean and free of mortar spots, droppings, and broken masonry.

3.10 FIELD QUALITY CONTROL AND QUALITY CONTROL

A. At least once a week while installation of masonry veneer is in progress, take mortar Samples for testing. Continue on that basis for duration of installation of masonry veneer at discretion of Engineer.

B. Take Samples in accordance with ASTM C270.

C. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

D. Contractor-Furnished Quality Control: Inspect and test as required in Section 01 45 16.13, Contractor Quality Control.

3.11 WATER REPELLANT

A. As specified in Section 07 19 00, Water Repellant.

3.12 PROTECTION

A. Wall Covering: During erection, cover top of wall with strong waterproof membrane at end of each day or shutdown and as follows:

1. Cover partially completed walls when Work is not in progress.
2. Extend cover minimum of 24 inches down both sides.
3. Hold cover securely in-place.

B. Protect sills, ledges, and offsets from mortar drippings or other damage during construction. Remove misplaced mortar immediately. Protect face materials against staining. Protect the door jambs and corners from damage during construction.

END OF SECTION

SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   c. C140/C140M, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   d. C144, Standard Specification for Aggregate for Masonry Mortar.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   g. C270, Standard Specification for Mortar for Unit Masonry.
   h. C404, Standard Specification for Aggregates for Masonry Grout.
   i. C476, Standard Specification for Grout for Masonry.
   j. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   k. C744, Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
   l. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
   m. C989/C989M, Standard Specification for Slag Cement for Use in Concrete and Mortars.
   n. C1314, Standard Test Method for Compressive Strength of Masonry Prisms.
   o. C1403, Standard Test Method for Rate of Water Absorption of Masonry Mortars.
2. The Masonry Society (TMS):
   a. 402; Building Code Requirements for Masonry Structures and Companion Commentaries.
   b. 602; Specification for Masonry Structures.
3. International Code Council (ICC):
   a. International Building Code (IBC).
   b. ICC Evaluation Service (ICC-ES) Reports.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings.
2. Data Sheets:
   a. Horizontal joint reinforcement.
   b. Preformed control joint materials.
   c. Grout mix design.
   d. Mortar proportions or prebagged mortar properties and data sheets.
   e. Grout sand gradation in accordance with ASTM C404.
3. Samples:
   a. Sample: One of each type of masonry unit to be used on Project from the proposed manufacturer.
   b. Mortar colors for color selection.

B. Informational Submittals:

1. Method and Location of Placing Grout: High lift or low lift.
2. Mix design test results.
3. Certifications:
   a. Units comply with ASTM C55 and ASTM C90.
   b. Grout test results conform to ASTM C1019.
   c. Grout aggregates conform to requirements of ASTM C404.
   d. Mortar sand conform to requirements of ASTM C144.
4. Test results of Project samples from masonry unit manufacturer stating that units comply with ASTM C90. Documentation of material testing shall 1 year old or less.
5. Mix design and compressive strength test results of proposed grout complying with ASTM C1019. Documentation of material testing shall be 1 year old or less.
6. Test reports stating aggregates for mortar meet requirements of ASTM C144.
7. Test reports or letter of certification stating aggregates for grout meet requirements of ASTM C404.
8. Method and materials for removal of efflorescence.
9. Field test results to qualify materials.
   a. Grout tests in accordance with ASTM C1019.

1.03 QUALITY ASSURANCE

A. Mockups:

1. Lay up Sample panel for each type of masonry at Site.
2. Dimensions: Minimum 4 feet high by 4 feet long.
3. Use approved materials and procedures.
4. Leave intact after approval until acceptance of permanent masonry work and then remove at the end of the Project.
5. Approved panels shall serve as basis of color, texture, bond, quality of finished joints, surface applied finishes, and for acceptance of permanent construction.
6. Demonstrate ability to keep grout isolated and in certain cells during any sequence of placement, and to demonstrate materials will be restricted to cells and bond beams intended to receive grout.
7. Construction shall show areas required to receive mortar, including webs on each side of each grouted cell to prevent grout from entering adjacent cells or courses.
8. Where bond beams are to be used, demonstrate proper placement of grout to bond beam level, and proper placement of bond beam prior to placement of grout above bond beam level.
9. Demonstrate proper use of running bond.
10. Compliance Requirements: For masonry finish and appearance, dimension tolerances, tolerances of construction, joint tolerances, and wall plumb tolerances, comply with the requirements and criteria of NCMA, ASTM C90, and TMS 602.1.

B. Preinstallation Conference:

1. Required Meeting Attendees:
    a. Masonry subcontractor, including masonry foreman.
    b. Ready-mix producer.
    c. Admixture representative.
    d. Testing and sampling personnel.
    e. Owner of Owner’s Representative.
2. Schedule and conduct prior to start of masonry construction.
3. Notify Engineer of location and time.
4. Agenda shall include:
    a. High lift and low lift procedures.
    b. Mortar, grout, unit, and reinforcing submittals.
    c. Types and locations of rebar splices.
    d. Joint tooling.
    e. Admixture types, dosage, performance, and redosing at Site.
    f. Mix designs and test of mix.

g. Placement methods, techniques, equipment, consolidation, and reconsolidation.
h. Protection procedures for environmental conditions.
i. Other specified requirements requiring coordination.

5. Submit conference minutes as specified in Section 01 31 19, Project Meetings.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Keep units and mortar/grout cementitious ingredients, including lime, dry.

PART 2 PRODUCTS

2.01 COMPRESSIVE STRENGTH OF MASONRY ASSEMBLAGE

A. Minimum 28-Day Specified Compressive Strength (f'm) of Masonry: 2,000 psi.

2.02 CONCRETE MASONRY UNITS (CMU)

A. ASTM C90: Normal weight.

1. Net Area Compressive Strength: 2,000 psi minimum, in accordance with TMS 602, Table 2.
2. Nominal Size: 16 inches long by 8 inches high by thickness shown on Drawings.
3. Color of Units: Natural.
4. Surface Texture on Exposed Surfaces: Smooth.
5. Surface Texture: Smooth on interior, concealed exterior, and surface 1 foot below finished grade.

B. General Concrete Masonry Unit (CMU) Requirements:

1. Furnish or cut special shapes for corners, jambs, lintels, and other areas shown or required.
2. Special units shall match color and texture of standard units.
3. Where units are placed so end of unit is exposed, such as at a corner or intersection, exposed end of that block shall have surface to match color and texture of sides of other units.
4. Furnish sound, dry, clean units free of cracks, prior to placing in structure.

5. Vertical Cells to be Grouted: Capable of alignment sufficient to maintain clear, unobstructed continuous vertical cell dimensions in accordance with TMS 602, Table 7.
6. Masonry unit size and shape shall allow for all placement patterns. Use vertical grout dams to prevent materials, such as grout, from escaping from cell being filled to adjacent cells where material is not intended to be placed.

2.03 MORTAR MATERIALS

A. Portland Cement-Lime Mortar:

1. ASTM C270.
2. Lime: ASTM C207, Type S or SA.
3. Aggregates:
   a. Nonreactive in accordance with ASTM C33, Appendix X1.
4. Mortar: ASTM C144, sand.

B. Mortar Cement Mortar: ASTM C1329.

C. Water: Fresh, clean, and potable.

D. Mortar Color Admixture:

1. Meet the requirements of ASTM C979/C979M.
2. Manufacturer and Product: Davis Colors, Los Angeles, CA; True Tone Mortar Color.
3. Color shall be selected by Architect.

2.04 GROUT

A. Cement:

1. ASTM C150, Type II Portland cement or ASTM C595, Type IS (MS) Blended cement.
2. ASTM C476: Course

B. Fly Ash: Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618.

C. Slag Cement: In accordance with ASTM C989/C989M, Grade 100 or Grade 120.

2.05 REINFORCEMENT

A. Reinforcement: Clean and free from loose rust, scale, and coatings that reduce bond.

B. Deformed Bars: As specified in Section 03 21 00, Steel Reinforcement.

C. Horizontal Joint Reinforcement:

1. Two parallel, ASTM A1064/A1064M, No. 9 wires, galvanized in accordance with ASTM A153/A153M, weld connected to No. 9 perpendicular cross wire at 16 inches, maximum, center.
2. Furnish special manufactured corner and wall intersection pieces.
3. Manufacturer and Product: Hohmann and Barnard, Inc, Hauppauge, NY; 220 or 230 Ladder-Mesh-Joint Reinforcement.

2.06 PREFORMED CONTROL JOINTS

A. Solid rubber cross-shape extrusions as manufactured by:

1. Hohmann and Barnard, Inc, Hauppauge, NY; #RS-Standard.

2.07 MORTAR MIXES

A. In accordance with ASTM C270, Type S and TMS Specifications.

B. Mix Method:

1. Property Method: Minimum average mortar 28-day compressive strength 2000 psi.
2. Proportion Method: Proportion per Table 1 of ASTM C270.

C. Mixing:

1. Machine mix in approved mixers in accordance with ASTM C270. Time addition of approved admixtures in accordance with manufacturer’s instructions. Procedure used for adding it to mix shall provide good dispersion.
2. Follow manufacturer’s instructions for mortar color admixture.
3. Review compatibility with other mortar admixture.

2.08 GROUT MIXES

A. Compressive Strength Property:

1. Minimum 2,000 psi at 28 days. Grout shall not exceed 3,500 psi.
2. Proportions: Conform to ASTM C476, Table 1.

B. Mix Design:

1. Proportions:
   a. Design mix to meet property/strength requirements.
2. Slump: 8-inch minimum, 11-inch maximum.

C. Mixing:

1. Do not use water reducers, air entrainment, plasticizing, high-range water reducers, or other non-specified admixtures in grout mixes.
2. Transit-Mixed Grout: Meet requirements of ASTM C476.
3. For high lift grouting, add approved grout expansion admixture in accordance with manufacturer's recommendations.
4. Fluid consistency suitable for placing without segregation with a slump of 8 inches to 11 inches.

PART 3 EXECUTION

3.01 GENERAL

A. Meet requirements of 2021 IBC, Chapter 21 and 2016 The Masonry Society (TMS) 602, Specification for Masonry, Part 3, Execution, except as modified in this section.

B. Moisture Protection:

1. Keep units dry while stored on Site.
2. Do not wet units prior to laying.

C. Provide measures to prevent moisture from entering incomplete walls and open cells.

D. Cold Weather: Meet requirements of TMS Specification Section "Cold Weather Construction".

E. Hot Weather: Meet requirements of TMS Specification Section "Hot Weather Construction".

F. After construction during cold weather, maintain newly constructed masonry temperature above 32 degrees F for a minimum of 24 hours using TMS or other approved cold weather methods.

G. After construction and during hot weather, fog spray newly constructed masonry in accordance with TMS hot weather construction requirements.

3.02 PREPARATION

A. Concrete Foundations: Meet tolerance requirements of ACI 117 prior to starting any masonry work.

B. Prepare surface contact area of foundation concrete for initial mortar placement by removing laitance, loose aggregate, and other materials, and anything that would prevent mortar from bonding to foundation.

C. Patch or grind out-of-tolerance foundation surfaces to receive mortar prior to starting masonry work.

D. Clean reinforcement dowels and projecting embeds by removing laitance, spillage, or items that will adversely affect grout bond.

E. Prevent surface damage to foundation concrete that will be exposed to view outside of contact area.

3.03 LAYING MASONRY UNITS

A. General:

1. Finish Tolerances (Measured on Interior Surfaces): Meet requirements of “Site Tolerance” requirements of Part 3, Execution, of the TMS Specifications.
2. Place units with chipped edges or corners such that chipped area is not exposed to view.

B. Wall Units:

1. General:
   a. If necessary to move a unit after once set in-place, remove from wall, clean, and set in fresh mortar.
   b. Toothing of masonry units is not permitted.
2. Running Bond:
   a. Unless otherwise shown, lay up walls in straight, level, and uniform courses using a running bond pattern.

b. Place units for continuous vertical cells and mortar joints to prevent materials, such as grout, from escaping from cell being filled to adjacent cells where material is not intended to be placed.
c. Corners: Lay standard masonry bond for overlapping units and grout solid.
d. Intersecting Walls: Half unit appearance shall not extend and be visible on exterior side of intersecting wall. Provide hooked corner bars in bond beam units as shown on Drawings.

3. Stack Bond: Provide only where specifically indicated on Drawings. Lay up open end units in straight, uniform courses with vertical joints aligned and plumb.
4. Special Shapes:
   a. Provide and place such special units as corner block, doorjamb block, lintel block fillers, and similar blocks as may be required.
   b. Use required shapes and sizes to work to corners and openings, maintaining proper bond throughout wall.

3.04 BUILT-IN ITEMS

A. Position door frames, windows, vents, louvers, and other items to be built in wall, and construct wall around them.

B. Install masonry anchors to secure items to wall.

C. Fill spaces around items with grout except use mortar at mortar joints.

D. Do not place electrical, instrumentation, or water conduits in a cell containing parallel reinforcement, unless approved in writing by Engineer. Additionally, pipes, sleeves, and conduits shall meet requirements of TMS 402, Building Code Requirements for Masonry Structures and TMS specification construction requirements.

3.05 MORTAR JOINTS

A. General:

1. Meet masonry erection requirements of TMS, Part 3, Execution, 3.3B.
2. As units are laid, remove excess mortar from grout space of cells to be filled. Final grout space, including any remaining mortar projections, shall be as required by TMS Table “Grout Space Requirements”.
3. Place mortar before initial setting of cement takes place. Retemper only as required for it to remain plastic. Retempering of colored mortar is not allowed.

B. Exposed Joints:

1. Tool joints exposed to view after final construction, unless otherwise noted or shown.
2. Cut joints flush and as mortar takes its initial set; tool to provide a concave joint.
3. Perform tooling with tool that compacts mortar, pressing excess mortar out.
4. Perform tooling when mortar is partially set, but still sufficiently plastic to bond rather than dragging it out.
5. Rake out joints that are not tight at time of tooling, point, and then tool.
6. Rake and tool joints at split-face surfaces, interior and exterior.

C. Concealed Joints: Strike flush with no further treatment required.

3.06 CONTROL JOINTS

A. Preformed Control Joints:

1. Omit mortar from vertical joints.
2. Place in units fabricated to receive rubber control joint material as wall is built.
3. After wall is grouted, cured, and cleaned, install backing rod and sealant as specified in Section 07 92 00, Joint Sealants.
4. Place and tool sealant to match depth of typical joint.

3.07 REINFORCING

A. Foundation Dowels:

1. Locate first foundation dowel at end of wall in center of first cell; typically 4 inches from end of wall.
2. Locate at each side of control joints and openings and below beam and joist seats, and then locate at maximum required spacing between these bars.
3. Size, number, and location of foundation dowels shall match all typical and additional vertical wall reinforcing, unless otherwise noted.
4. When foundation dowel does not line up with vertical core, do not slope more than 1 horizontal to 6 vertical to bring it into alignment.

B. Vertical Reinforcing:

1. Use deformed bars.
2. Hold in position near ends of bars by wire ties to dowels or by reinforcing positioners.

3. For high lift grouting, hold in position at maximum intervals of 160 bar diameters by reinforcing positioners.
4. Lap reinforcing bars as shown or approved.
5. Wire tie splices together.
6. Minimum Bar Clearance: 1/2-inch from masonry for coarse grout 1/4-inch from masonry for fine grout, from formed surfaces, and from parallel bars in same grout space.

C. Horizontal Reinforcing:

1. Use deformed bars.
2. Lay on webs of bond beam units and place as wall is built. Increase web depth to ensure 1/2-inch cover over top of rebar.
3. Lap reinforcing bars where spliced and wire tie together.
4. Minimum Bar Clearance: 1/2 inch from masonry for coarse grout 1/4 inch from masonry for fine grout, from formed surfaces, and from parallel bars in same grout space.
5. Terminate reinforcing bars 2 inches clear from control joints except horizontal bars at roof and floor courses shall be continuous through joints.

D. Horizontal Joint Reinforcement:

1. Use where indicated on Drawings.
2. Space maximum **16** inches apart, vertically.
3. Lap ends 16 inches minimum.
4. Terminate reinforcing 2 inches clear from control joints except reinforcement at roof and floor courses shall be continuous through joints.
5. Use manufactured corner and other wall intersection pieces.

3.08 MORTAR PRODUCTION

A. Mix bulk materials in accordance with TMS Specification.

B. Mix prebagged materials with water to produce a workable consistency.

C. Remix or retemper to maintain workability. Discard mortar that has begun to stiffen or is not used within 2-1/2 hours after initial mixing.

3.09 GROUT PLACEMENT

A. Do not mix, convey, or place with equipment constructed of aluminum.

B. Secure vertical and horizontal reinforcement, ties, bolts, anchors, and other required embedments in place; inspect and verify before placing grout.

C. Grout beams over openings in one continuous operation.

D. Maintain vertical alignment in accordance with TMS 602, Section 3.4.

E. Place grout within 1-1/2 hours of addition of water to mix.

F. Grouting Requirements:

1. Partial grout all walls as shown.
2. For multi-wythe construction, space vertical grout barriers maximum 30 feet horizontally, extending full height of wall.
3. Slump: 8 inches to 11 inches.
4. Do not start grouting until wall mortar has cured for 4 hours, minimum.
5. Fully embed horizontal steel with grout in an uninterrupted pour.
6. Do not construct wall more than one course above top of grout pour prior to placing grout.
7. Partial Grouting Requirements:
    a. Fill cells containing reinforcing steel, anchor bolts, and other embedded items as shown with grout.
    b. Construct cells to be filled to confine grout within cell.
    c. Cover tops of unfilled vertical cells under a bond beam with metal lath to confine grout fill to bond beam section.
    d. Form horizontal construction joints between pours by stopping grout pour 1-1/2 inches below a mortar joint, except at a bond beam; stop pour 1/2 inch below top of masonry unit.

G. Vibration:

1. Use internal “pencil” type, low energy vibrator to thoroughly consolidate grout and reduce amount of air voids. Do not use concrete vibrators.
2. After initial water loss and settlement has occurred, but before it has taken any set, reconsolidate grout.
3. Waiting period for reconsolidation will vary depending upon weather conditions and block absorption rates, but under “normal” weather conditions with average masonry units the waiting period should be between 30 minutes and 60 minutes.

H. Cleanouts:

1. Construct in accordance with TMS specification.
2. Provide for grout pours heights over 5 feet 4 inches in accordance with TMS.
3. Provide of sufficient size to permit cleaning of cell, positioning of reinforcing, and inspection at bottom of every vertical cell containing reinforcing and maximum of 32 inches on center.
4. Location: Concealed from view after final construction, unless otherwise approved by Engineer.
5. After wall has been inspected and approved and prior to grouting, cap cleanouts in a manner that will seal them from grout leakage and provide a flush finish.

3.10 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

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

C. Masonry shall be tested by testing agency retained by Owner.

D. Provide adequate facilities for safe storage and proper curing of masonry prisms, mortar samples, and grout samples, as applicable, onsite for first 24 hours, and for additional time as may be required before transporting to test lab.

E. Masonry Testing:

1. Masonry strength shall be determined using unit strength method as shown.
2. Masonry test prisms, when required or desired, shall be constructed onsite with same materials and workmanship to be used for Project and in accordance with ASTM C1314. Method and frequency of prism testing shall be as shown on the Special Inspection and Testing Plan.

F. Unit Strength Method:

1. Method and frequency for mortar, grout, and masonry unit sampling and testing shall be as shown.
2. Provide masonry units for test samples required.

G. Corrective Action:

1. If compressive strength tests made prior to construction of permanent structure fail to meet Specifications, adjustments shall be made to mix designs for mortar, or grout, or both, as needed to produce specified strength.
2. If strength tests performed on materials representative of in-place construction fail to meet Specifications, prisms or cores shall be cut from constructed walls in sufficient locations to adequately determine strength in accordance with TMS.

3.11 CLEANING

A. Immediately after completion of grouting, clean masonry surfaces of excess mortar, grout spillage, scum, stains, dirt, and other foreign substances using clean water and fiber brushes.

B. Clean walls not requiring painting or sealing so there are no visible stains.

3.12 PROTECTION OF INSTALLED WORK

A. Do not allow grout and mortar stains to dry on face of exposed masonry.

B. Protect tops of walls at all times. Cover tops of walls with waterproof paper when rain or snow is imminent and when the Work is discontinued.

C. Adequately brace walls until walls and roof are completed.

D. Provide sufficient bracing to protect walls against damage from elements, including wind and snow.

E. Protect masonry against freezing for minimum 72 hours after being laid.

F. Protect masonry from damage until final acceptance of the Work. Damaged units will not be accepted.

END OF SECTION

SECTION 05 05 19
POST-INSTALLED ANCHORS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete.
   b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A143/A143M, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   e. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   f. A380/A380M, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   g. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
   h. A563, Standard Specification for Carbon and Alloy Steel Nuts.
   i. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   j. A967/A967M, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

k. E488/E488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
l. F436/F436M, Standard Specification for Hardened Steel Washers.
m. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Socket Head Cap Screws, and Studs for General Use.
n. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
o. F594, Standard Specification for Stainless Steel Nuts.
p. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete and Masonry Anchors.
6. International Code Council Evaluation Service (ICC-ES):
   a. Evaluation Reports for Concrete and Masonry Anchors.
   b. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
   c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
   d. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
   e. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   f. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.
7. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete and Masonry Anchors:
   a. Manufacturer’s product description and installation instructions.
   b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
   c. Adhesive Anchor Installer Certification.
2. Passivation method for stainless steel members.
3. Hot-Dip Galvanizing: Certificate of Compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
Carbon Steel:	
Threaded Rods	F1554, Grade 36
Flat and Beveled Washers (Hardened)	F436/F436M
Nuts*	A194/A194M, Grade 2H
Galvanized Steel:	
All	A153/A153M
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, and zinc-plated steel material types as indicated in Fastener Schedule at end of this section, unless otherwise noted on Drawings.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as shown in Fastener Schedule at end of this section, unless otherwise noted on Drawings.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; KWIK Bolt-TZ2 Expansion Anchor Safe Set System with hollow drill bit and vacuum and SI-AT-A22 tool with adaptive torque for applicable sizes (ESR-4266).
   b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1, +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Undercut Anchors:

1. Manufacturers and Products:
   a. USP Structural Connectors, Burnsville, MN; DUC Undercut Anchor (ESR-1970).
   b. Hilti, Inc., Tulsa, OK; HDA Undercut Anchor (ESR-1546).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; TORQ-CUT Self-Undercutting Anchor (ESR-2705).
   d. DeWalt/Powers Fasteners, Brewster, NY; CCU+ Undercut Anchor (ESR-4810).

D. Self-Tapping Concrete Screw Anchors:

1. Do not use for equipment anchorage unless specifically shown on Drawings.
2. Manufacturers and Products:
   a. DeWalt/Powers Fasteners, Brewster, NY; Screw-Bolt + (ESR-3889).
   b. DeWalt/Powers Fasteners, Brewster, NY; Hangermate+ Rod Hanger Screw Anchor (ESR-3889).
   c. DeWalt/Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
   d. Hilti, Inc., Tulsa, OK; Kwik HUS-EZ (KH-EZ), KH-EZ CRC, KH-EZ SS316, KH-EZ C, KH-EZ E,
      KH-EZ I, and KH-EZ P Screw Anchor Safe Set System with hollow drill bit and vacuum (ESR-3027).
   e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713 and IAPMO UES-493).

E. Adhesive Anchors:

1. Threaded Rod:
   a. Diameter as shown on Drawings.
   b. Length as required to provide minimum depth of embedment indicated and thread projection required.
   c. Clean and free of grease, oil, or other deleterious material.
2. Adhesive:
   a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
3. Packaging and Storage:
   a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
   b. Store adhesive on pallets or shelving in a covered storage area.
   c. Package Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
   d. Dispose of When:
      1) Shelf life has expired.
      2) Stored other than in accordance with manufacturer’s instructions.

4. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System:
      1) HIT-HY 200 V3 Safe Set System with HIT-Z ROD or HAS threaded rod (ESR-4868) unless anchor rod indicated on Drawings**,**
      2) HIT RE 500 V3 Safe Set System with HAS threaded rod (ESR-3814), unless anchor rod indicated on Drawings, or
      3) HIT-RE 500 V3 Safe Set System with Hilti Roughening Tool (HIT RT) with HAS threaded rod (ESR-3814) for diamond cored holes**,** unless anchor rod indicated on Drawings.
   b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).
   c. DeWalt/Powers Fasteners, Brewster NY; Pure 220+ Epoxy adhesive anchor system with Dust X+ System (ESR-5144).

F. Adhesive Threaded Inserts:

1. Type 316 stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-V3 or HIT-HY 200 adhesive.

2.03 POST-INSTALLED MASONRY ANCHORS

A. General: AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of section, unless otherwise indicated on Drawings.

B. Current ICC Evaluation Report indicating acceptance for anchors at structural applications in masonry.

1. AC 100+ Gold: https://www.icc-es.org/reports/pdf_files/ESR-2582.pdf.

C. Manufacturers and Products:

1. Hilti, Inc., Tulsa, OK:
   a. HIT-HY 270 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4143) for solid grouted masonry,
   b. HIT-HY 200 V3 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4878) for solid grouted masonry,
   c. HIT-HY 270 Safe Set System with Hilti hollow drill bit and vacuum (ESR-4144) for unreinforced three-wythe brick.

2. Simpson Strong-Tie Co., Inc., Pleasanton, CA:
   a. Strong-Bolt 2 (IAPMO ER 240) for grout filled CMU,
   b. Titen-HD (ESR-1056) for grout filled or hollow CMU,
   c. AT-XP (IAPMO ER-281) for grout filled CMU.
3. DeWalt/Powers Fasteners, Brewster NY:
   a. Power-Stud+ SD1 (ESR-2966) for grout-filled masonry,
   b. Screw-Bolt+ (ESR-4042) for grout-filled masonry,
4. AC100+ Gold with Dust X+ System for unreinforced three-wythe brick (ESR-2966 2582).

PART 3 EXECUTION

3.01 CONCRETE AND MASONRY ANCHORS

A. Begin installation only after concrete or masonry to receive anchors is a minimum of 21 days old or has attained design strength whichever requires a longer duration.

B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer’s instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated on Drawings.

E. Use only drill type and bit type and diameter recommended by anchor manufacturer. Use rotary hammer drill unless otherwise approved by Engineer. Core drilling may only be used if specifically allowed by the Engineer.

F. Clean hole of debris and dust per manufacturer’s requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer’s installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

H. Adhesive Anchors:

1. Unless otherwise approved by Engineer and adhesive manufacturer:
   a. Do not install adhesive anchors when temperature of concrete or masonry is below 40 degrees F or above 100 degrees F.
   b. Do not install prior to concrete attaining an age of 21 days.

c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
d. Do not disturb anchor during recommended curing time.
e. Do not exceed maximum torque as specified in manufacturer's instructions.

2. For hollow-unit masonry, install screen tube in accordance with manufacturer's instructions.
3. Prestressed Concrete: Do not use drilled-in anchors in prestressed or post-tensioned concrete members without Engineer's prior approval unless specifically shown on Drawings.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

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

C. Proof Loading:

1. To be performed where continuous inspection of anchors is required.
2. Testing will be performed by Owner's Independent Testing Agency.
3. Proof loading of adhesive anchors to be performed only after adhesive has achieved proper cure per manufacturer's requirements.
4. Testing will be conducted on minimum of 10 percent of installed anchors, with a minimum of two tension tests.
5. Testing will be conducted in accordance with ASTM E488/E488M and as follows:
   a. Performance of a static tension test of each test anchor.
   b. Test apparatus reaction base shall not interfere with bond failure of anchor, but shall preclude a pullout cone failure.
   c. Each test anchor to be tested at a proof load equal to the lesser of 80 percent of the yield strength of the anchor or 50 percent of calculated ultimate load based on adhesive bond strength or as directed by Engineer.
   d. Test load to be maintained for a minimum of 30 seconds without visible signs of movement of anchor or drop in gauge reading.

6. Failure of anchor or failure within base material will cause anchor to be rejected. For each rejected anchor, test two additional anchors. Rejected anchors shall be replaced as approved by Engineer.

3.03 MANUFACTURER'S SERVICES

A. Adhesive and Mechanical Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify Engineer of time and place for sessions.

3.04 FASTENER SCHEDULE

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

Service Use and Location	Product	Remarks
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)		
Interior Dry Areas, not including areas that randomly may be subjected to water or moisture	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment).	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
Typical Unless Otherwise Specified	Stainless steel adhesive anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
2. Anchors in Grout-Filled Concrete Masonry Units		
Interior Dry Areas, not including areas that randomly may be subjected to water or moisture	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment).	
Typical Unless Otherwise Specified	Stainless steel adhesive anchors	

Service Use and Location	Product	Remarks
3. Anchors in Hollow Concrete Masonry Units		
Interior Dry Areas, not including areas that randomly may be subjected to water or moisture	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment).	Adhesive anchors shall be installed with screen tubes.
Typical Unless Otherwise Specified	Stainless steel adhesive anchors	Adhesive anchors shall be installed with screen tubes.
4. All Others		
Typical Unless Otherwise Specified	Stainless steel fasteners	

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

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 05 05 23
WELDING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. BPVC SEC V, Nondestructive Examination.
   b. BPVC SEC IX, Welding and Brazing Qualifications.
2. American Society of Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.
3. ASTM International (ASTM): A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
4. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   b. A3.0, Standard Welding Terms and Definitions.
   c. D1.1/D1.1M, Structural Welding Code—Steel.
   d. D1.8/D1.8M, Structural Welding Code—Seismic Supplement.
   e. D1.2/D1.2M, Structural Welding Code—Aluminum.
   f. D1.3/1.3M, Structural Welding Code—Sheet Steel.
   g. D1.4/D1.4M, Structural Welding Code—Reinforcing Steel.
   h. D1.6/D1.6M, Structural Welding Code—Stainless Steel.
   i. QC1, Standard for AWS Certification of Welding Inspectors.

1.02 DEFINITIONS

A. CJP: Complete Joint Penetration.

B. CWI: Certified Welding Inspector.

1. Contractor’s Welding Inspector: Contractor’s CWI acts for, and on behalf of, the Contractor for all inspection and quality matters within the scope of the Contract Documents. Contractor is required to provide a welding inspector to oversee welding operations and be responsible for visual inspection and necessary correction of all deficiencies in materials and workmanship required to meet referenced welding codes. This type of Quality Control Inspection is not classified as Special Inspection.
2. Verification Inspector: This independent inspection is the prerogative of the Owner, who may employ their own, independent CWI, or waive this supplementary, independent CWI inspection.

C. MT: Magnetic Particle Testing.

D. NDE: Nondestructive Examination.

E. NDT: Nondestructive Testing.

F. PJP: Partial Joint Penetration.

G. PQR: Procedure Qualification Record.

H. PT: Liquid Penetrant Testing.

I. Special Inspection: Nondestructive weld examination including MT, PT, UT, and RT.

1. Special Inspection personnel report to, and are retained by the Owner**,** except as noted below: Contractor and fabricator are required to complete nondestructive weld examinations for welded steel tanks, welded steel pipe, and process piping.
2. See additional requirements in Section 01 45 33, Special Inspection, Observation, and Testing.

J. RT: Radiographic Testing.

K. UT: Ultrasonic Testing.

L. VT: Visual Inspection/Testing.

M. WPQ: Welder/Welding Operator Performance Qualification Record.

N. WPS: Welding Procedure Specification.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Shop and field WPSs and PQRs.
   b. NDT procedure specifications prepared in accordance with ASME BPVC SEC V.
   c. Welding Data (Shop and Field): Submit welding data together with Shop Drawings as a complete package.
      1) Show on Shop Drawings, or on a weld map, complete information regarding base metal ASTM specifications, and location, type, size, and length of welds.

2) Identify WPS to be used, and NDE requirements in tail of welding symbol.
3) Clearly distinguish between shop and field welds.
4) Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for welds.
5) Welding and NDE Symbols shall be in accordance with AWS A2.4. Welding terms and definitions shall comply with AWS A3.0.

B. Informational Submittals:

1. WPQs.
2. CWI credentials.
3. Testing agency NDE inspector credentials.
4. CWI visual inspection (VT) reports.
5. Welding Documentation: Submit on forms provided in referenced welding codes.

1.04 QUALIFICATIONS

A. WPSs: In accordance with AWS D1.1/D1.1M (Annex J Forms) for shop or field welding; or ASME BPVC SEC IX (Forms QW-482 and QW-483) for shop welding only.

B. WPQs: In accordance with AWS D1.1/D1.1M (Annex J Forms); or ASME BPVC SEC IX (Form QW-484).

C. CWI: Certified in accordance with AWS QC1 and having prior experience with specified welding codes. Alternate welding inspector qualifications require prior approval by Engineer.

D. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.

1.05 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, Submittals required in this section shall be submitted and approved prior to commencement of welding operations.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Contractor's CWI shall be present whenever shop welding is performed. CWI shall perform inspection at suitable intervals, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verify conformance of specified job materials and proper storage.
2. Monitor conformance with approved WPSs.
3. Monitor welder performance and conformance with approved WPQs.
4. Inspect weld joint fit-up and perform in-process inspections.
5. Provide 100 percent visual inspection of completed welds.
6. Coordinate with nondestructive testing personnel and review NDE results.
7. Maintain records and prepare reports documenting results of CWI VT and required NDE complies with the Work and referenced welding codes.

PART 3 EXECUTION

3.01 GENERAL

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Welding and Nondestructive Testing Table.

B. Qualify welding procedure specifications for pressure piping for notch toughness by limiting heat input. Conduct Charpy testing of weld metal and heat-affected zone as part of the welding procedure qualification in accordance with ASTM A370, at a test temperature of 30 degrees F. The minimum average energy of the test coupons shall not be less than 25 foot-pounds.

3.02 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. Quality Control Inspection:

1. All Welds: 100 percent VT by Contractor's CWI.
2. Acceptance Criteria:
   a. Structural Pipe and Tubing: AWS D1.1/D1.1M, Paragraph 10.24.
   b. All Other Structural Steel: AWS D1.1/D1.1M, Paragraph 8.9, Visual Inspection, Statically Loaded Nontubular Connections.
   c. Stud Connections: AWS D1.1/D1.1M, Paragraph 9.8.1.

B. Nondestructive Testing Requirements:

1. NDT frequency shall be as specified below, as required by referenced fabrication or welding codes, or as specified in the attached table. In case there is a conflict, the higher frequency level of NDT shall apply.
   a. Nontubular Connections:
      1) CJP Butt Joint Groove Welds: 10 percent random RT. Use UT for CJP butt joint groove welds that cannot be readily radiographed.
      2) All Other CJP Groove Welds: 10 percent random UT.
      3) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.
   b. Tubular Connections:
      1) CJP butt joint groove welds made from one side without backing: 100 percent RT or UT in accordance with AWS D1.1/D1.1M, Paragraph 10.25.2 requirements.
      2) CJP Butt Joint Groove Welds made with back-gouging: 10 percent random RT.
      3) CJP Butt Joint Groove Welds made with backing and other butt joint groove welds that cannot be readily radiographed: 10 percent random UT.
      4) All Other CJP Groove Welds: 10 percent random UT.
      5) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.
2. NDT Procedures and Acceptance Criteria:
   a. Nontubular Connections:
      1) RT: Perform in accordance with AWS D1.1/D1.1M, Clause 8, Part E. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.12.1.
      2) UT: Perform in accordance with AWS D1.1/D1.1M, Clause 8, Part F. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.13.1.
      3) PT and MT:
         a) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 8.14.4 and Paragraph 8.14.5.
         b) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 8.9, Visual Inspection, Statically Loaded Nontubular Connections.

b. Tubular Connections:
   1) RT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 10, Paragraph 10.27, and Paragraph 10.28.
   2) UT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 10, Paragraph 10.26, and Paragraph 10.29.
   3) PT and MT:
      a) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 8.14.4 and Paragraph 8.14.5.
      b) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 10.24.

3.03 FIELD QUALITY CONTROL

A. The Contractor's CWI shall be present whenever field welding is being done and shall perform inspection, at suitable intervals, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verify conformance of specified job materials and proper storage.
2. Monitor conformance with approved WPS.
3. Monitor welder performance and conformance with approved WPQs.
4. Inspect weld joint fit-up and perform in-process inspection.
5. Provide 100 percent visual inspection of all welds in accordance with Paragraph Quality Control Inspection.
6. Coordinate with nondestructive testing personnel and review test results.
7. Maintain records and prepare reports confirming results of inspection and testing comply with the Work.

3.04 WELD DEFECT REPAIR

A. Repair and retest rejectable weld defects until sound weld metal have been deposited in accordance with appropriate welding codes.

3.05 SUPPLEMENT

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

1. Welding and Nondestructive Testing Table.

END OF SECTION

Welding and Nondestructive Testing						
Specification Section	**Governing Welding Codes or Standards**	**Submit WPS**	**Submit WPQ**	**Onsite CWI Required?**	**Submit Written NDT Procedure Specifications**	**NDT Requirements**
05 21 19 Open Web Steel Joists Framing	AWS D1.1/D1.1M, Structural Welding Code—Steel	Yes	Yes	Yes	Yes	100% VT; also see Section 05 21 19
05 31 00 Steel Decking	AWS D1.1/D1.1M, Structural Welding Code—Steel or AWS D1.3/D1.3M, Structural Welding Code—Sheet Steel	Yes	Yes	Yes	No	100% VT; also see Section 05 31 00
05 50 00 Metal Fabrications	AWS D1.1/D1.1M, Structural Welding Code–Steel or AWS D1.2/D1.2M, Structural Welding Code—Aluminum or AWS D1.6/D1.6M, Structural Welding Code—Stainless Steel	Yes	Yes	Yes	Yes	100% VT; also see Section 05 50 00
05 53 00 Metal Gratings	AWS D1.1/D1.1M, Structural Welding Code—Steel or AWS D1.2/D1.2M, Structural Welding Code—Aluminum	No	No	No	No	100% VT; also see Section 05 53 00
33 05 01.01 Welded Steel Pipe and Fittings	ASME BPV Code, Section IX; and AWS D1.1/D1.1M, Structural Welding Code—Steel	Yes	Yes	Yes	Yes	100% VT; also see Section 33 05 01.01
40 27 00 Process Piping—General	ASME BPV Code, Section IX; and ASME B31.3 Normal Fluid Service Category	Yes	Yes	Yes	Yes	100% VT and 5% RT; also see Section 40 27 00

SECTION 05 21 19
OPEN WEB STEEL JOIST FRAMING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Institute of Steel Construction (AISC):
   a. Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design.
   b. Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts.
   c. Code of Standard Practice for Steel Buildings and Bridges.
2. American Welding Society (AWS): D1.1, Structural Welding Code - Steel.
3. Steel Joist Institute (SJI):
   a. Standard Specifications and Load Tables: Long Span Steel Joists, LH-Series, and Deep Long Span Steel Joists, DLH-Series.
   b. Recommended Code of Standard Practice for Steel Joists and Joist Girders.

1.02 SUBMITTALS

A. Action Submittals:

1. Plan view layout of joists and bridging.
2. Elevation view of each type of joist showing configuration, chord and web member sizes, panel point dimensions, and chord extensions.
3. Connection and bearing details.
4. Special joist reinforcing and connections for supported items, such as monorails and mechanical equipment.
5. Bridging member sizes and connection details.
6. Procedure for handling, erection, and bracing of steel joists.

B. Informational Submittals:

1. Complete design, including stress and deflection calculations, for joists, joist members, and connections for design load and equipment weight as indicated, plus any construction loads applied by Contractor’s operations.
2. Calculations shall include check of joist chord bending stresses for concentrated loads applied between panel points.
3. Registered Professional Engineer’s stamp, valid in same state as Project, on structural calculations.

4. Joist manufacturer’s installation requirements.
5. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.

1.03 QUALITY ASSURANCE

A. General: Design and fabricate steel joists and bridging to meet requirements of SJI Standard Specifications and Load Tables.

B. Certification: SJI Membership, with certification for joist types as indicated on Drawings.

C. Qualifications for Field Welding: As specified in Section 05 05 23, Welding.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Protect joist paint system from abrasion at steel bands and other joists.

C. Store joists and bridging off ground on wood sleepers.

D. Support joists so there is no danger of tipping, sliding, rolling, shifting or material damage.

PART 2 PRODUCTS

2.01 STEEL JOISTS AND BRIDGING

A. Provide type of joist, chord configuration, and depth as indicated on Drawings.

B. Design and Manufacture:

1. In accordance with the applicable SJI Standard Specifications.
2. Chord Members: Rolled double angle sections only.
3. Provide the following in accordance with SJI Standard Specifications and Load Tables:
    a. Bottom chord bracing and end anchorage for uplift design criteria.
    b. Ceiling extension to within 1 inch of finished wall surface, unless otherwise indicated.
    c. Top chord extension, S type or R type.
    d. Bottom chord extension and stabilizer plates for joist girders.
    e. Full camber, unless otherwise indicated.

C. Joist Bridging:

1. In accordance with applicable SJI Standard Specifications for type of joist.
2. Furnish bridging of minimum size and type.
3. Provide anchorage connection to walls and girders at bridging lines as indicated.

2.02 SHOP PRIMER

A. Surface Preparation and Primer: As specified in Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel joists.

3.02 INSTALLATION

A. Erection: SJI Standard Specifications and approved shop drawings.

B. Welded Connections: As specified in Section 05 05 23, Welding.

3.03 TOUCHUP PAINTING

A. Immediately following erection, remove debris from completed installation.

B. Clean field welds, bolted connections, rust spots, and abraded areas.

C. Repair damaged painted and galvanized surfaces as specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

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

C. Welding:

1. Visually inspect field welds in accordance with AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. An independent testing agency will be retained by Owner to visually inspect field welded connections in accordance with AWS D1.1, Table 6.1, and as specified in Section 05 05 23, Welding.
3. Repair defective welds as specified in Section 05 05 23, Welding.

D. High-Strength Bolted Connections:

1. An independent testing agency will be retained by Owner to perform the following inspection and testing in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts:
   a. Marking identification and conformance to ASTM standards.
   b. Alignment of bolt holes.
   c. Placement, type, and thickness of hardened washers.
   d. Tightening of bolts.
2. Snug-Tightened Connections (N, X): Snug tight condition with plies of joint in firm contact.
3. Preinstallation Test:
   a. Conduct test in accordance with Specification for Structural Joints Using ASTM F3125 or F3148 bolts prior to using bolt tension measuring device.
   b. Select representative sample of not less than three bolts of each diameter, length, and grade.
   c. Include DTIs and flat hardened washers as required to match actual connection assembly.
4. Nondestructive Testing (NDT): Inspect bolted connections and perform corrections as required to meet code acceptance criteria per RCSC Specification for Structural Joints Using High-Strength Bolts.
5. Defective Connections: Correct and reinspect defective and improperly tightened high-strength bolted connections. Retest pretensioned bolts as necessary to demonstrate compliance of completed work.

END OF SECTION

SECTION 05 31 00
STEEL DECKING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Iron and Steel Institute (AISI): Specifications for the Design of Cold Formed Steel Structural Members.
2. American Welding Society (AWS): D1.3, Structural Welding Code - Sheet Steel.
3. ASTM International (ASTM):
   a. A611, Standard Specification for Structural Steel (SS), Sheet, Carbon, Cold-Rolled.
   b. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   c. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   d. A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
4. Steel Deck Institute (SDI):
   a. ANSI/SDI C-2017, Standard for Composite Steel Floor Decks.
   b. ANSI/SDI NC-2017, Standard for Non-Composite Steel Floor Decks.
   c. ANSI/SDI RD-2017, Standard for Steel Roof Deck.
   d. ANSI/SDI SD-2022, Standard for Steel Deck.
   e. Roof Deck Design Manual.
   f. Floor Deck Design Manual.
   g. Diaphragm Design Manual.
5. Factory Mutual (FM):
   a. Factory Mutual Approval Guide.
   b. FM Research Corporation (FMRC): Approval Requirements for Steel Roof Deck Construction.
6. International Code Council Evaluation Service, Inc. (ICC-ES): Evaluation Reports for Deck Fasteners.
7. UL: Fire Resistance Directory.

1.02 SUBMITTALS

A. Action Submittals:

1. Plan view layout of decking showing type and section properties of deck panels, reinforcing channels, pans, special jointing, and accessories.
2. Location of openings, deck laps, and deck attachment details.

B. Informational Submittals:

1. Decking manufacturer's installation requirements.
2. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding.
3. Operation manuals for mechanical fastener installation tools.
4. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

1.03 QUALITY ASSURANCE

A. General: For metal decking section properties, meet requirements of AISI Specifications for Design of Cold-Formed Steel Structural Members.

B. Qualifications for Field Welding: As specified in Section 05 05 23, Welding.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store deck bundles on platforms or pallets, with one end elevated to provide drainage.

C. Protect bundles against condensation with a ventilated waterproof covering.

D. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage.

E. Architecturally exposed deck shall be appropriately packaged and protected to prevent damage during shipment.

PART 2 PRODUCTS

2.01 METAL DECKING

A. Provide metal deck as shown on the Drawings.

B. Materials and Finishes:

1. Galvanized Deck:
   a. Sheet steel for galvanized deck and accessories shall conform to ASTM A653 Structural Quality Grade 33 or higher, as shown in Steel Deck Schedule.
   b. Galvanizing shall conform to ASTM A924 with coating class of G60 or G90 as defined in ASTM A653 and as shown in Steel Deck Schedule.

C. Manufacturers:

1. Vulcraft Division of Nucor Co., Brigham City, UT.
2. BHP Steel Building Products, USA, Inc., West Sacramento, CA.
3. Verco Manufacturing, Inc., Phoenix, AZ.
4. United Steel Deck, Inc., Summit, NJ.

2.02 SHOP PRIMER

A. Surface Preparation and Primer: As specified in Section 09 90 00, Painting and Coating.

2.03 ACCESSORIES

A. Provide pour stops, column closures, end closures, cover plates, girder fillers, ridge and valley plates, finish strips, reinforcing channels, and other accessories as required for complete installation.

B. Accessories shall be minimum 22-gauge, except edge forms shall be sized as required by the deck manufacturer, unless shown otherwise on Drawings.

2.04 MECHANICAL FASTENERS

A. Self-Drilling Screws: Provide as shown on Drawings.

B. Powder Driven Fasteners: Provide as shown on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.

3.02 INSTALLATION

A. Locate deck bundles to prevent overloading of support framing members.

B. Install at right angles to supporting members in a three span minimum lay-up, unless shown otherwise, and in accordance with Specification and manufacturer's installation recommendation.

C. Bearing: 1-1/2 inches, minimum.

D. Endlaps: Minimum of 2 inches and located over supports.

E. Do not stretch sidelaps.

F. Closure Plates:

1. Install closure and cover plate accessories as recommended by the metal deck manufacturer, unless shown otherwise on Drawings.
2. Floor Deck and Form Deck Closures:
   a. Fasten column closures, cell closures, and zee closures to deck to provide tight fitting closures at open ends of ribs and sides of decking.
   b. Fasten cell closures at changes of direction of deck units unless otherwise indicated.

G. Holes and Openings:

1. Cut and fit around roof openings and other work projecting through or adjacent to decking.
2. Locate holes and openings as shown to clear structural framing and bracing members.
3. Reinforcement Around Openings:
   a. Composite Floor Deck and Form Deck: Reinforce openings as indicated on Drawings.

H. Protect deck areas from heavy concentrated loads or wheel traffic with planking or other approved means.

I. Install temporary shoring, if required, to meet strength and deflection limitations, before placing any concrete topping on deck panels.

J. Completed Deck: Free from buckles and irregularities, and in accordance with FM and UL requirements.

3.03 DECK ATTACHMENT

A. Fasten panels as shown on Drawings.

B. Welded Connections: Weld deck sidelaps, attachment to framing, and accessories in accordance with AWS D1.3 and as specified in Section 05 05 23, Welding.

C. Mechanical Fasteners:

1. Self-Drilling Screws:
   a. Install screws in accordance with manufacturer's written instructions and with special installation tool. Do not over-torque.
   b. Remove and redrive screws at sidelaps where upper sheet is not drawn tightly against lower sheet.
2. Powder Driven Fasteners:
   a. Install fasteners in accordance with manufacturer's written instructions and with special installation tool.
   b. Minimum Sidelap Edge Distance: 3/8 inch.
   c. Minimum End/End Lap Distance: 1 inch.
   d. Head Projection: As specified by manufacturer for correct penetration into flange of steel support member.

3.04 TOUCHUP PAINTING

A. Immediately following erection, remove unused deck edge trimmings, screws, fasteners, welding washers, butt ends of welding rods, and debris from completed installation.

B. Clean field welds, bolted connections, rust spots, and abraded areas.

C. Repair damaged painted surfaces as specified in Section 09 90 00, Painting and Coating.

D. Repair damaged galvanized surfaces with zinc-rich spray paint in accordance with ASTM A780; color to match galvanized deck.

E. Use magnetic gauge to determine that thickness of repair is equal to or greater than base painted or galvanized coating.

3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. An independent testing agency will be retained by Owner to perform following inspections.

1. Welded Connections: Visually inspect in accordance with AWS D1.3, Section 7, and as specified in Section 05 05 23, Welding.
2. Mechanical Fasteners: Visually inspect, in accordance with manufacturer’s instructions, for each type of fastener.

C. Repair or replace defective welds and fasteners.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

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

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
   a. Inspection of Hot-Dip Galvanized Steel Products.
   b. Quality Assurance Manual.
3. American Institute of Steel Construction (AISC):
   a. 201, AISC Certification Program for Structural Steel Fabricators – Standard for Steel Building Structures.
   b. 206, AISC Certification Program for Structural Steel Erectors – Standard for Structural Steel Erectors.
   c. 303, Code of Standard Practices for Steel Buildings and Bridges.
   d. 325, AISC Steel Construction Manual.
   e. 326, Detailing for Steel Construction.
   f. 341, Seismic Provisions for Structural Steel Buildings.
   g. 360, Specification for Structural Steel Buildings.
   h. 420, Certification Standard for Shop Application of Complex Protective Coating Systems.
4. American Iron and Steel Institute (AISI): Stainless Steel Types.
5. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
6. American National Standards Institute (ANSI).
   a. A14.3 American National Standard for Ladders – Fixed – Safety Requirements
7. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
8. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
9. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Specification for Gray Iron Castings.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
n. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
o. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
p. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
q. A489, Standard Specification for Carbon Steel Lifting Eyes.
r. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
s. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
t. A563, Standard Specification for Carbon and Alloy Steel Nuts.
u. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
v. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

w. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
x. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
y. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
z. A992/A992M, Standard Specification for Structural Steel Shapes.
aa. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
cc. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
dd. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
ee. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ff. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
gg. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
hh. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
ii. F436, Standard Specification for Hardened Steel Washers.
jj. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
kk. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ll. F594, Standard Specification for Stainless Steel Nuts.
mm. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
nn. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
oo. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

10. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910.23, Ladders.
    b. 29 CFR 1910.28, Duty to Have Fall Protection and Falling Object Protection.

c. 29 CFR 1910.29, Fall Protection Systems and Falling Object Protection-Criteria and Practices.
d. 29 CFR 1926.105, Safety Nets.
e. 29 CFR 1926.502, Fall Protections Systems Criteria and Practices.

11. Specialty Steel Industry of North America (SSINA):
a. Specifications for Stainless Steel.
b. Design Guidelines for the Selection and Use of Stainless Steel.
c. Stainless Steel Fabrication.
d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.

B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals. Corrosive area includes areas exposed to corrosive atmosphere such as hydrogen sulfide from wastewater.

C. Exterior Area: Location not protected from weather by building or other enclosed structure.

D. Interior Dry Area: Location inside building or structure where floor is not subject to moisture, liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to moisture, liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Metal fabrications, including welding and fastener information.

B. Informational Submittals:

1. U-Channel Concrete Inserts:
   a. Manufacturer's product description.
   b. Allowable load tables.
2. Pre-engineered Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.23 requirements, ANSI-ASC A14.3 requirements and specifications herein.
3. Passivation method for members.
4. Galvanized coating applicator qualifications.
5. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.

B. Package stainless steel items to provide protection from carbon impregnation.

C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

D. Store fabricated items in dry area, not in direct contact with ground.

1.06 SPECIAL GUARANTEE

A. Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of floor hatches found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for ASTM A36/A36M steel), limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

B. Unless otherwise indicated, meet the following requirements:

Item	**ASTM Reference**
Aluminum – Plates and Shapes:	
Plates	B209, Alloy 6061-T6
Shapes	B308/B308M, Alloy 6061-T6
Aluminum – Fasteners:	
Bolts	F468, Alloy 2024-T4
Nuts	F467, Alloy 2024-T4
Washers	
Cast Iron:	
Cast Iron:	A48/A48M, Class 35
Stainless Steel – Plates and Shapes:	
Angles and Bars	A276, AISI Type 316 (316L for welded connections), 30 kips per square inch minimum yield stress
Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections), 30 kips per square inch minimum yield stress
Shapes – Rolled	A276, AISI Type 304 (304L for welded connections), 30 kips per square inch minimum yield stress A1069 (Laser-fused process), 30 kips per square inch minimum yield stress
Shapes – Built-up	A276, AISI Type 304 (304L for welded connections), 30 kips per square inch minimum yield stress A1069 (Laser-fused process)

Item	ASTM Reference
Stainless Steel – Anchors and Fasteners:	
Anchor Bolts and Rods	F593, AISI Type 316, Group 2 Condition CW
Bolts	F593, AISI Type 316, Group 2 Condition CW
Nuts	F594, AISI Type 316, Condition CW
Threaded Rods	F593, AISI Type 316, Group 2 Condition CW
Washers	
Welded Anchor Studs	F593, AISI Type 316, Group 2 Condition CW
Steel – Plates and Shapes:	
Hollow Structural Sections (HSS) – Round	A500/A500M, Grade C
Hollow Structural Sections (HSS) – Square and Rectangular	A500/A500M, Grade C
Pipe which is Part of Structure	A500/A500M, Grade C
Plates and Other Shapes	A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes
Wide Flange Shapes	A992/992M
Steel – Anchors and Fasteners:	
Anchor Bolts and Rods	F1554, Grade 36 or Grade 55 with weldability supplement S1.
Bolts	A307
High-Strength Bolts	F3125, Grade A325-N,Type 1
Eyebolts	A489
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Nuts	A563
Threaded Rods	A36/A36M
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Steel – Thrust Ties for Steel Pipe:	
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Threaded Rods	A193/A193M, Grade B7

C. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-In-Place Anchor Bolts:

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

B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High-density polyethylene.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE AND MASONRY ANCHORS

A. See Section 05 05 19, Post-Installed Anchors.

2.04 STUD SHEAR CONNECTORS

A. Headed anchor studs (HAS), or threaded anchor studs (TAS),or stud shear connectors, as indicated on Drawings.

1. Carbon Steel: ASTM A108, Standard Quality Grades 1010 through 1020, inclusive either semikilled or killed aluminum or silicon dioxidation, unless indicated otherwise.
2. Stainless Steel: ASTM F593, AISI Type 316, Condition CW, where indicated.

B. Manufacturers:

1. Nelson Stud Welding, FabriSteel Co., Elyria, OH.
2. Stud Welding Associates, Inc., Elyria, OH.

2.05 PIPE SLEEVES

A. As specified in Section 40 27 01, Process Piping Specialties.

2.06 STEEL LINTELS AND SHELF ANGLES

A. ASTM A36/A36M, hot-dip galvanize after fabrication in accordance with ASTM A123/A123M.

2.07 EMBEDDED STEEL SUPPORT FRAMES GRATING

A. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.

B. Welded anchors for stainless steel support frames shall also be stainless steel.

2.08 U-CHANNEL CONCRETE INSERTS

A. Rolled ASTM A240/A240M, AISI Type 316 stainless steel, 0.105-inch-thick, 1-5/8 inches wide by 1-3/8 inches deep, with stainless steel anchors at 10-inch maximum spacing, styrofoam fillers, and end caps.

B. Nut and Bolt Hardware: Type 316 stainless steel, 5/8-inch minimum diameter, unless indicated otherwise. Manufacturer’s standard to match insert.

C. Manufacturers and Products:

1. Power-Strut, Wayne, MI; PS 349 Series.
2. B-Line Systems, Inc., Highland, IL; B32 Series.
3. Halfen Anchoring Systems, Converse, TX; Channel Type 4141HTA or HZA Dynagrip.

2.09 HATCH SAFETY NET

A. General:

1. Conforms to ASSE A10.11 and OSHA 29 CFR Part 1926.105.
2. Size to fit hatch opening where indicated.

B. Components and Accessories:

1. Rails and Slide Rings: Aluminum 6061-T6 extruded rails and aluminum-alloy 713.0 slide rings.
2. Corner Hooks and Eyebolts: AISI Type 316 stainless steel.

3. Netting: Polyester, 5-inch by 5-inch net openings; 5,000 pounds minimum breaking strength.
4. Bolts, Nuts, and Concrete Anchors: AISI Type 316 stainless steel.

C. Manufacturer and Product: Safe Approach Inc., Auburn, ME; Hatch Net 121.

2.10 LADDERS

A. Fabricate ladders with rails, rungs, landings, and cages to meet applicable requirements of OSHA, 29 CFR Part 1910.23, and ANSI-ASC A14.3.

1. Design ladder for concentrated load of 200 pounds imposed by user concentrated at points that will cause maximum stress in structural member being considered.
2. Include weight of ladder and attached appurtenances together with live load in design of rails and fastenings.
3. Self-closing gates at landings.

B. Flat Bar Ladder:

1. Punch rails, pass rungs through rails, and weld on outside.
2. Weld brackets to ladder for fastening ladder to wall.
3. Unless otherwise noted, Hot-dip galvanize steel after fabrication in accordance with ASTM A123/A123M and ASTM A385/A385M.
4. Where stainless steel is required, ASTM A276, AISI Type 316L stainless steel.

C. Aluminum Pre-engineered Pipe Ladder:

1. Rungs:
   a. Aluminum extrusions of Alloy 6063-T6.
   b. Nonslip grip surface, 1-inch wide flat top, and semicircular bottom with mill finish.
2. Side Rails: ASTM B429/B429M, Alloy 6063-T6, 1-1/2 inches, Schedule 40 pipe with anodized finish, AA M32-C22-A41.
3. Ladder Attachments and Cage Assembly Fasteners: Stainless steel.
4. Welded, pop riveted, or glued construction is not acceptable.
5. Fabricate to longest length as practical but not to exceed 24 feet.
6. Furnish support attachments to side rails at 6 feet maximum spacing.
7. Manufacturer: Thompson Fabricating Co. Inc., Tarrant, AL.

D. Ladder Safety Post:

1. Telescoping tubular, spring balanced and automatically locking in raised position, with release lever for unlocking.
2. Post:
   a. Unless otherwise noted, material shall be the same type as ladder construction.
      1) Hot-dip galvanized steel in accordance with ASTM A123/A123M.
      2) Stainless steel, AISI Type 304.
   b. Aluminum.
3. Hardware: Stainless steel, AISI Type 316.
4. Furnish dissimilar metal protective coatings at connections.
5. Manufacturer and Product: Bilco Co., New Haven, CT; "Ladder Up" to fit ladder rungs.

2.11 SAFETY CLIMB DEVICE

A. General:

1. Conforms to ANSI-ASC A14.3 and OSHA 29 CFR Part 1910.27.
2. Belt and harness shall withstand minimum drop test of 250 pounds in 6-foot free fall.
3. Fall Prevention System Material: Stainless steel, AISI Type 316.

B. Components and Accessories:

1. Main Components: Sleeve or trolley, safety harness, and carrier or climbing rail.
2. Unless otherwise specified, material shall be same type as ladder construction.
   a. **S**tainless steel, AISI Type 316, mounting brackets and hardware.
3. Removable extension kit with tiedown rod or trolley gate, mandrel, and carrier rail for ladders under manholes and hatches.

C. Manufacturers and Products:

1. Miller by Honeywell, Franklin, PA; Miller Saf-T-Climb.
2. TS Products, Cambridge, Ontario, Canada; TS Safety Rail System.

2.12 FALL ARREST ANCHORS

A. General:

1. Conforms to OSHA 29 CFR Part 1926.502.
2. Minimum Breaking Strength: 5,000 pounds.
3. Material: Stainless steel, AISI Type 304.

B. Components and Accessories:

1. Forged combination eye and base assembly with headed anchor bolt, backer plate, lock washer, and nut.
   a. Suitable for embedment in concrete.
2. D-Ring anchorage plate with zinc-plated steel D-Ring and Type 304 stainless steel plate.
   a. Suiteable for embedment in concrete.

C. Manufacturers and Products:

1. Thaler Metal Industries, New Braunfels, TX; FARA Wall Anchor.
2. MSA Safety Incorporated, Cranberry Township, PA; 5K MEGA Swivel Anchorage Connector Kit, Stainless.

2.13 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

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

2.14 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.

5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.
4. Stainless Steel Built-up Shapes: Fabricate built-up shapes in accordance with ASTM A1069/A1069M.

C. Welding:

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

D. Painting:

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

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.

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

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

G. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for use in contact with potable water. Cover full bearing surfaces.

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

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

2.15 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.

B. Hot-Dip Galvanizing:

1. An independent testing agency, will be retained by Owner to inspect and test hot-dip galvanized fabricated items in accordance with ASTM A123/A123M and ASTM A153/A153M.
2. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123/A123M and ASTM A153/A153M.
3. Reject and retest nonconforming articles in accordance with ASTM A123/A123M and ASTM A153/A153M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer's recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.
5. Do not remove mill markings from concealed surfaces.
6. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
7. Snug-tighten bolts, unless otherwise specified.

B. Steel: Fabrication, erection, connections, bolted and welded construction shall be in accordance with AISC Steel Construction Manual and AWS D1.1.

C. Stainless Steel:

1. Fabrication, erection, connections, bolted and welded construction shall be in accordance with AWS D1.6 and the following SSINA standards:
   a. Specifications for Stainless Steel.
   b. Stainless Steel Fabrication.
   c. Stainless Steel Fasteners.
2. Do not field weld unless approved by Engineer in writing.

D. Aluminum:

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

E. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

F. Steel Lintels and Shelf Angles: Provide as required for support of masonry and other construction not attached to structural steel framing, unless otherwise shown on Drawings.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Locate and hold anchor bolts in place with templates at time concrete is placed.

B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 U-CHANNEL CONCRETE INSERTS

A. Provide as indicated for pipe supports and where otherwise shown on Drawings.

B. Except for interior dry areas, use plastic clips or similar dielectric material to isolate channel anchors from concrete reinforcing steel.

3.04 SAFETY CLIMB DEVICE SYSTEM

A. Provide for each ladder where unbroken height between levels exceeds 24 feet, or at lesser height where indicated on Drawings.

B. Install in accordance with manufacturer's instructions.

C. Furnish additional accessories required to complete system for each ladder.

D. Furnish one harness for each ladder equipped with safety climb device.

E. Furnish pivot section at platforms, landings, and roofs.

F. When installed to required height, fall prevention system shall be rigid and an integral part of the structure.

3.05 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel, and Uncoated Steel:

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

B. Aluminum

1. Coat surfaces of aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
2. Allow coating to dry before installation of the material.
3. Protect coated surfaces during installation.
4. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

C. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

D. Stainless Steel:

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

3.06 PAINTING

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

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

C. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09 90 00, Painting and Coating.

3.07 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Furnished Quality Assurance:

1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing.
2. Contractor responsibilities and related information on special inspection, observation, and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control:

1. Inspection and testing required in Section 01 45 16.13, Contractor Quality Control.
2. Manufacturer's Certificate of Compliance per Section 01 61 00, Common Product Requirements, for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 61 00, Common Product Requirements and Section 01 88 15, Anchorage and Bracing.

C. Stud Shear Connectors:

1. At start of each production period, conduct the following test to determine proper generator, control unit, and stud welding gun settings, in accordance with AWS D1.1/D1.1M, Chapter 7:
   a. Weld two test studs and visually inspect for full 360-degree flash.
   b. Bend test studs 30 degrees from vertical for headed anchor studs (HAS). Torque test threaded anchor studs (TAS) studs per AWS D1.1/D1.1M, Section 7.6.6.2.
   c. Test studs will be acceptable if there is no failure of welds.
   d. If weld fails, repeat test until two consecutive test studs test to be satisfactory.
2. During production, if visual inspection reveals weld does not exhibit full 360-degree flash or that stud has been repaired by welding, conduct the following test in accordance with AWS D1.1/D1.1M, Chapter 7:
   a. Bend HAS studs or stud shear connectors approximately 15 degrees from vertical, away from missing portion of flash. For TAS studs, torque test per AWS D1.1/D1.1M, Section 7.6.6.2.
   b. Studs meeting this test without exhibiting cracks in weld will be considered acceptable and left in bent position.
   c. Replace studs failing test.
3. Special inspection shall be provided by Owner where indicated in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing.

3.08 FASTENER SCHEDULE

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

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise	
Typical Unless Otherwise Specified	Stainless steel headed anchor bolts	
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless otherwise specified with equipment	
Typical Unless Otherwise Specified	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors		
4. Anchors Cast in Grout-Filled Concrete Masonry Units		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts	
Typical Unless Otherwise Specified	Hot-dip galvanized steel headed anchor bolts, or stainless steel sleeve anchors	

Service Use and Location	Product	Remarks
5. Connections for Structural Steel Framing		
Typical Unless Otherwise Specified	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.
6. Connections for Steel Fabrications and Wood Components		
Typical Unless Otherwise Specified	Hot-dip galvanized carbon steel bolted connections	
7. Connections of Aluminum Components		
Typical Unless Otherwise Specified	Stainless steel bolted connections, unless otherwise specified with equipment	
8. All Others		
Typical Unless Otherwise Specified	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

SECTION 05 52 16
ALUMINUM RAILINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. Aluminum Association, Incorporated (AA): DAF45, Designation System for Aluminum Finishes.
2. American Concrete Institute (ACI) 318, Building Code Requirements for Structural Concrete.
3. American Iron and Steel Institute (AISI).
4. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. E894, Standard Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
   d. E935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
   e. E985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
5. International Code Council (ICC): International Building Code (IBC).
6. Occupational Safety and Health Act (OSHA): 29 CFR 1910, Code of Federal Regulations.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: ICC report on evaluation of manufactured concrete anchor systems.

B. Railings: This term includes guardrail systems, handrail systems, platform railing systems, ramp-rail systems, and stair-rail systems. Railings may be comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

C. Special Inspection: As defined by the ICC IBC.

D. Toeboards: Vertical barrier at floor level usually erected on railings along exposed edges of floor or wall openings, platforms, or ramps to prevent miscellaneous items from falling through.

1.03 DESIGN REQUIREMENTS

A. Structural Performance of Railing Systems: Design, test, fabricate, and install railings to withstand the following structural loads without exceeding allowable design working stress or allowable deflection. Apply each load to produce maximum stress and deflection in railing system components.

1. Top Rail: Capable of withstanding the following load cases applied:
   a. Concentrated load of 200 pounds applied at any point and in any direction in accordance with ICC IBC and OSHA.
   b. Uniform load of 50 pounds per linear foot applied in any direction in accordance with ICC IBC.
   c. Concentrated load need not be assumed to act concurrently with uniform loads in accordance with ICC IBC.
2. In-Fill Area of Railing Systems:
   a. Capable of withstanding a horizontally applied normal load of 50 pounds applied to 1 square foot at any point in system including panels, intermediate rails, balusters, and openings and space between railings.
   b. Horizontal concentrated load need not be assumed to act concurrently with loads on top rails of railings.
3. Toeboard: Capable of withstanding, without failure, force of at least 50 pounds applied in downward or outward direction at any point along toeboard.
4. Calculated lateral deflection at top of posts shall not exceed 1 inch.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Project-specific scaled plans and elevations of railings and detail drawings. Include railing profiles, sizes, connections, anchorage, size and type of fasteners, and accessories.
   b. Manufacturer’s literature and catalog data of railing and components.

c. Design Data: Calculations or test data using specified design performance loads and including the following:
   1) Bending stress in, and deflection of, posts in accordance with ASTM E985 as modified herein.
   2) Design of post base connection.
   3) Documentation that concrete anchors have been designed in accordance with one of the following:
      a) ACI 318, Chapter 17.
      b) ICC Evaluation Services Report for selected anchor.

2. Samples: Rail sections, 6 inches long showing each type of proposed connection, proposed finish, and workmanship.
3. Each fitting including wall brackets, castings, toeboard, and rail expansion joints.

B. Informational Submittals:

1. Manufacturer's assembly and installation instructions.
2. Special Inspection: Manufacturer's instructions for Special Inspection of post-installed anchors.
3. Test Reports: Test data may supplement load calculations providing data covers complete railing system, including anchorage:
   a. Test data for railing and components showing load and deflection as a result of load, in enough detail to prove railing is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 1910, using design loads specified. Include test data for the following:
      1) Railing and post connections.
      2) Railing wall connections.
      3) Railing expansion joint connections.
      4) Railing system gate assembly, including latch, gate stop, and hinges. Both gate latch and stop to support required loads applied independent of each other.
   b. Testing of anchorages shall be in accordance with ASTM E894 and ASTM E935 using applied loads in accordance with ICC IBC.
   c. Deflection Criteria: In accordance with ASTM E985 and design loads specified, except as follows: maximum calculated lateral deflection at top of posts shall not exceed 1 inch.
   d. Aluminum Rail Piping: Test data showing yield strength of pipe as delivered equals or exceeds specified values.
4. Manufacturer's written recommendations describing procedures for maintaining railings including cleaning materials, application methods, and precautions to be taken in use of cleaning materials.

1.05 QUALITY ASSURANCE

A. Qualifications: Calculations required for design data shall be stamped by a registered civil or structural engineer licensed in state where Project will be constructed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package and wrap railings to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping to extent possible until railing is completely installed.

B. Delivery:

1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment.
2. Deliver toeboards loose for field assembly.
3. Deliver clear anodized railing pipe and posts with protective plastic wrap.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Thermal Movements: Allow for thermal movement resulting from the following maximum range in ambient temperature in design, fabrication, and installation of railings to prevent buckling, opening up of joints, over stressing of components, connections and other detrimental effects. Base design calculation on actual surface temperature of material as a result of both solar heat gain and night time sky heat loss. Temperature change is difference between high or low temperature and installation temperature.

1. Temperature Change Range: 70 degrees F, ambient; 100 degrees F, material surfaces.

PART 2 PRODUCTS

2.01 ALUMINUM RAILINGS

A. General:

1. Furnish pre-engineered and prefabricated railing systems as shown on Drawings.
2. Railing systems using pop rivets or glued railing construction are not permitted.
3. Sand cast accessories and components are not permitted.
4. Fasteners shall be AISI Type 304 or Type 316 stainless steel, unless otherwise noted.

B. Rails, Posts, and Formed Elbows:

1. Extruded Alloy 6105-T5, 6061-T6, or equivalent.
2. Tensile Strength: 38,000 psi, minimum.
3. Yield Strength: 35,000 psi, minimum.
4. Nominal Wall Thickness: 0.145 inch, minimum.
5. Posts and railings shall be nominal 1-1/2-inch diameter (1.90-inch outside diameter).

C. Accessories:

1. Fittings and Accessories:
   a. Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements.
   b. Gauge metal components are not acceptable for load-resisting components.
   c. Fittings shall match color of pipe in railings.
2. Miscellaneous Extruded Aluminum Parts: Alloy 6063-T6, Alloy 6061-T6, or Alloy 6105 T5 aluminum, or equivalent, and of adequate strength for all loads.
3. Castings for Railings:
   a. Cast Al-mag with sufficient strength to meet load and test requirements.
   b. Anodizable grade finish with excellent resistance to corrosion when subjected to exposure of sodium chloride solution intermittent spray and immersion.
4. Post Anchorages:
   a. Refer to standard details for types of post anchorages and minimum requirements.
   b. Bolts at anchorages shall be minimum 1/2-inch diameter.
5. Wall Brackets: Adjustable wall fitting, with provision for minimum three 3/8-inch diameter AISI Type 304 or Type 316 stainless steel bolts or concrete anchors.
6. Rail Terminals (including Wall Returns): Aluminum wall fitting with provision for three 3/8-inch Type 304 fasteners.
7. Railing System Gate:
   a. Extruded aluminum rail components.
   b. Hardware Manufacturers and Products:
      1) Julius Blum & Co., Inc., Carlstadt, NJ; No. 782/3 gate hinges with springs, and No. 784 gate latch and stop.

2) CraneVeyor Corp., South El Monte, CA; No. C4370b gate hinges with spring, No. C4369 gate latch, and No. C4368 gate stop.
3) Moultrie Manufacturing Co., Moultrie, GA; Part No. W60006.

8. Toeboards:
   a. Molded or extruded Alloy 6063-T6 or Alloy 6061-T6 aluminum.
   b. Provide slotted holes for expansion and contraction where required.

D. Finishes:

1. Pipe and Post: In accordance with AA DAF45, designation AA-M32-C22-A41.
2. Cast Fittings and Toeboards: In accordance with AA DAF45, designation AA-M10-C22-A41.

2.02 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:

1. Elastic Locknuts, Steel Flat Washers, Round Head Machine Screws (RHMS): AISI Type 304 or Type 316 stainless steel.
2. Flat Washers: Molded nylon.

B. Bolts and Nuts for Bolting Railing to Metal Beams: ASTM A193/A193M and ASTM A194/A194M, Type 304 or Type 316 stainless steel.

C. Concrete Anchors:

1. Stainless steel, AISI Type 304 or Type 316.
2. Post-installed anchors in accordance with Section 05 05 19, Post-installed Anchors, unless otherwise specified herein.
3. Bolt Diameter: 1/2-inch, minimum.

2.03 FABRICATION

A. Shop Assembly:

1. Post Spacing: Maximum 6-foot horizontal spacing.
2. Railing Posts Bolted to Metal or Concrete:
   a. In lieu of field cutting, provide approved fitting with sufficient post overlap, containing provisions for vertical adjustment.
   b. Field fit-up is required.

3. Free of burrs, nicks, and sharp edges when fabrication is complete.
4. Welding is not permitted.

B. Shop/Factory Finishing:

1. Use same alloy for uniform appearance throughout fabrication for railings.
2. Railing and Post Fittings: Match fittings with color of pipe in railing.

C. Shop Assembly:

1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
2. Fit dowels tightly inside posts.

D. Repair of Defective Work: Remove stains and replace defective Work.

PART 3 EXECUTION

3.01 GENERAL

A. Field fabrication of aluminum railing systems is not permitted.

B. Where required, provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on actual structure.

C. Install railing with base that provides plus or minus 1/4-inch vertical adjustment inside base fitting. If adjustment is required in field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.

D. Modification to supporting structure is not permitted where railing is to be attached.

E. Mount railings only on completed walls. Do not support railings temporarily by means not satisfying structural performance requirements.

F. Protection from Entrapped Water:

1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
2. For posts mounted in concrete, bends, and elbows occurring at low points, drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in plane of rail.

3.02 RAILING INSTALLATION

A. Assembly and Installation: Perform in accordance with manufacturer's written recommendations for installation.

B. Expansion Joints:

1. Maximum intervals of 54 feet on center and at structural joints.
2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
3. Fasten to one side using 3/8-inch diameter set-screw. Place set-screw at bottom of pipe.
4. Locate joints within 12 inches of posts. Locate expansion joints in rails that span expansion joints in structural walls and floors supporting the posts.

C. Posts and Rails:

1. Surface Mounted Posts:
   a. Bolt post baseplate connectors firmly in place.
   b. Shims, wedges, grout, and similar devices for railing post alignment not permitted.
2. Set posts plumb and aligned to within 1/8 inch in 12 feet.
3. Set rails horizontal or parallel to slope of steps to within 1/8 inch in 12 feet.
4. Install posts and rails in same plane.
5. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail.
6. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.
7. Support 1-1/2-inch rails directly above stairway stringers with offset fittings.

D. Wall Brackets: Support wall rails on brackets spaced maximum 5 feet on centers as measured on the horizontal projection.

E. Toeboard:

1. Provide at railings, except where 4-inch or higher concrete curbs are installed, at gates, or at stairways unless shown otherwise.
2. Accurately measure in field for correct length; after railing post installation cut and secure to posts.

3. Dimension between bottom of toeboard and walking surface not to exceed 1/4 inch.
4. Install plumb and aligned to within 1/8 inch in 12 feet.
5. Attach toeboards to posts via clamp that complies with design requirements while facilitating expansion and contraction. Do not screw directly to post or base.

F. Railing System Gate: Install in accordance with manufacturer's installation instructions.

3.03 FIELD FINISHING

A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in Section 09 90 00, Painting and Coating.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Post-installed anchors supporting railing systems require special inspection.

B. Owner-Furnished Quality Assurance, in accordance with ICC IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

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

3.05 CLEANING

A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.

B. Do not use acid solution, steel wool, or other harsh abrasive.

C. If stain remains after washing, restore in accordance with railing manufacturer's recommendations or replace stained railings.

END OF SECTION

SECTION 05 53 00
METAL GRATINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
   d. B210/B210M, Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
   e. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. National Association of Architectural Metal Manufacturers (NAAMM):
   a. MBG 531, Metal Bar Grating Manual.
   b. MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
   b. Grating Anchorage: Show details of anchorage to supports to prevent displacement from traffic impact.
   c. Product data for grating, grating clips, anchors, accessories, and other manufactured products specified herein.
   d. Manufacturer’s specifications, including coatings, surface treatment, and finishes.

B. Informational Submittals:

1. Special handling and storage requirements.
2. Installation instructions.

1.03 DELIVERY, STORAGE, AND HANDLING

A. As far is practical, factory assemble items.

B. Package and clearly tag parts and assemblies that are, due to necessity, shipped unassembled.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Alabama Metal Industries Corporation (AMICO), Birmingham, AL.
2. IKG, Houston, TX.
3. Ohio Gratings, Inc., Canton, OH.

2.02 GRATING MATERIALS

A. Carbon Steel:

1. Bearing Bars, Banding, and Rectangular Cross Bars: ASTM A1011/A1011M commercial steel Type II for hot rolled carbon steel sheet and strip, or ASTM A36/A36M.
2. Cross Bars made from Wire Rods: Not permitted.
3. Finish: Galvanized after fabrication.

2.03 LIGHT-DUTY AND MEDIUM-DUTY METAL BAR GRATING (TYPE A AND TYPE B)

A. General Requirements:

1. Maximum Service Load:
   a. Light Duty (Type A): 100 psf uniformly distributed load.
   b. Medium Duty (Type B): 500 psf uniformly distributed load.
2. Maximum Deflection: Span/240 or 1/4 inch, whichever is less.
3. Bearing Bar Spacing:
   a. Light Duty: 1-3/16 inch maximum, center-to-center.
   b. Medium Duty: 15/16 inch maximum, center-to-center.

4. Cross Bar Spacing: 4 inches maximum, center-to-center. For aluminum I-bar grating with depths greater than 2 inches, provide cross bars at 2 inches maximum, center-to-center.
5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 531 or as shown on Drawings.

B. Grating Materials:

1. Aluminum, pressure-locked I-bar grating fabricated by swaging crossbars between extruded I-shaped bearing bars.
2. Galvanized steel welded, rectangular bar grating fabricated by electro-forging cross bars to bearing bars.

C. Surface:

1. Plain, unless Serrated indicated on Drawings.
2. When surface of bars is serrated provide 1/4-inch deeper bearing bars than shown on Drawings to maintain specified load carrying capacity of grating.

2.04 HEAVY-DUTY METAL BAR GRATING (TYPE C)

A. General Requirements:

1. Maximum Service Load: AASHTO H-20.
2. Maximum Deflection: Span/240.
3. Bearing Bar Spacing: 1-7/8 inch maximum center-to-center.
4. Cross Bar Spacing: 4 inches maximum center-to-center.
5. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 532 or as shown on Drawings.

B. Grating Type: Galvanized steel, heavy-duty, rectangular bar grating fabricated by welding crossbars between rectangular bearing bars.

C. Surface:

1. Plain, unless Serrated indicated on the Drawings.
2. When surface of bars is serrated provide 1/4-inch deeper bearing bars than shown on Drawings to maintain specified load carrying capacity of grating.

2.05 ACCESSORIES

A. Embedded Frames: As indicated on Drawings and as specified in Section 05 50 00, Metal Fabrications.

B. Grating Clamps:

1. Use at flanged beam and bolted angle frame supports.
2. Removable from above grating walkway surface.
3. Provide hat bracket, recessed bolt, and bottom clamp of same material as grating.
4. Manufacturers and Products:
   a. Direct Metals Company, LLC, Kennesaw, GA; Grating Clamp.
   b. Grating Fasteners, Inc., Harvey, LA; G-Clip.

C. Anchor Stud and Saddle Clip:

1. Use at embedded angle frame supports with stud anchor and nut recessed below top of grating surface.
2. Removable from above grating walkway surface.
3. Provide Type 316 stainless steel welded threaded stud anchor, nut, washer, and saddle clip.
4. Manufacturers and Products:
   a. Welded Stud Anchor:
      1) Nelson Stud Welding, Inc., Elyria, OH.
      2) Stud Welding Associates, Inc. Elyria, OH.
   b. Saddle Clip:
      1) Direct Metals Company, LLC, Kennesaw, GA; Saddle Clip.
      2) Grating Fasteners, Inc., Harvey, LA; Saddle Clip.
      3) Struct-Fast, Inc., Baltimore, MD; Grate-Fast.

2.06 FABRICATION

A. General:

1. In accordance with NAAMM MBG 531 or NAAMM MBG 532.
2. Do not weld aluminum grating.
3. Conceal fastenings where practical.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Cutouts:
   a. Fabricate in grating sections for penetrations indicated.
   b. Arrange to permit grating removal without disturbing items penetrating grating.
   c. Edge band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
6. Do not notch bearing bars at supports to maintain elevation.

7. Field measure areas to receive grating. Verify dimensions of new fabricated supports and fabricate to dimension required for specified clearances.
8. Section Length: Sufficient to prevent section from falling through clear opening when oriented in the span direction and one end is touching either the concrete or the vertical leg of grating support.
9. Minimum Bearing: 1 inch for grating depth up to 2-1/4 inches and 2 inches for grating depth greater than 2-1/4 inches.
10. Banding and Toe Plates: Same material as grating and welded to bearing bars in accordance with requirements of NAAMM MBG 531 and NAAMM MBG 532.

B. Light-Duty and Medium-Duty Metal Bar Grating: Single grating section shall be not less than 1.5 feet or greater than 3 feet in width or weigh more than 150 pounds.

C. Heavy-Duty Metal Bar Grating: Minimum width of grating sections shall be 2 feet regardless of length and weight, unless otherwise indicated on Drawings.

D. Supports:

1. Same material as grating, except that supports which are to be embedded in concrete shall be Type 316 stainless steel, unless part of an extruded aluminum system.
2. Coordinate dimensions and fabrication with grating to be supported.
3. Coordinate dimensions with increased depth due to serrations.

PART 3 EXECUTION

3.01 INSTALLATION

A. Until grating sections are securely fastened in place, area shall be appropriately barricaded or flagged to alert people working in area of potential fall hazard.

B. Install manufactured products in accordance with manufacturer’s recommendations.

C. Install supports such that grating sections have a solid bearing on both ends, and that grating sections will not rock or wobble under design loads.

D. Install grating supports plumb and level as applicable.

E. Install sections of welded frames with anchors to straight plane without offsets.

F. Field locate and install fasteners to fit grating layout.

G. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.

H. Each grating or plank section shall be easily removable and replaceable.

I. Completed installation shall be rigid and neat in appearance.

J. Protect painted and galvanized surfaces during installation.

K. Repair damaged coatings as specified in Section 09 90 00, Painting and Coating.

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.01 REFERENCES

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

1. American Wood Council (AWC): 2, National Design Specification for Wood Construction.
2. American Lumber Standards Committee's Board of Review (ALSC).
3. American Wood Preservers' Association (AWPA):
   a. U1, User Specification for Treated Wood.
   b. M4, Standard for the Care of Preservative-Treated Wood Products.
4. APA - The Engineered Wood Association (APA):
   a. PRP-108, Performance Standards and Qualification Policy for Structural-Use Panels (Form E445).
5. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
   c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   d. C1177/C1177M, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
   e. C1396/C1396M, Standard Specification for Gypsum Board.
   f. D226/D226M, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   g. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   h. F1667, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
6. Forest Stewardship Council (FSC), Principles and Criteria for Forest Stewardship, Version 4-0 (STD 01 001).
7. International Code Council (ICC):
   a. ESR-1539, Power-Driven Staples and Nails.
   b. International Building Code (IBC).
8. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

9. Southern Pine Inspection Bureau (SPIB): 1003, Grading Rules.
10. Underwriters' Laboratories, Inc. (UL): 723, Standard for Test for Surface Burning Characteristics of Building Materials.
11. U.S. Department of Commerce—Voluntary Product Standard (DOC):
    a. PS 1, Structural Plywood.
    b. PS 2, Performance Standard for Wood-Based Structural-Use Panels.
    c. PS 20, American Softwood Lumber Standard.

1.02 SUBMITTALS

A. Action Submittals:

1. ICC Evaluation Service Reports, including the following as a minimum:
    a. Connections and Fasteners.
    b. Wood Treatment.
    c. Nails.
2. Wood treatment manufacturer's instructions for handling, storing, installation, and finishing of treated material.
3. Material Certificates: Showing species and grade selected for dimension lumber for each use.
    a. Material certificates for dimensional lumber in compliance with allowable unit stresses. Show species and grade selected for each use as well as design values approved by the ALSC's Board of Review.
    b. For each type of preservative-treated wood product, include certification by treatment plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
    c. For waterborne-treated products include statement that moisture content of treated materials was reduced to levels indicated prior to shipment to Site.
4. Material test reports from testing laboratory showing and interpreting test results in accordance with test methods UL 723, NFPA 255, and ASTM E84, relative to fire-retardant treated wood products.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Upon delivery to Site, immediately place materials in area protected from weather. Do not store seasoned materials in wet or damp areas.

B. Protect sheet materials from breaking corners and damaging surfaces while unloading.

C. Store materials a minimum of 6 inches above ground on framework or blocking and cover with waterproof covering, providing for adequate air circulation and ventilation. Store sheet materials flat, not on edge.

D. Protect fire-retardant materials against high humidity and moisture during storage and erection.

E. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

F. Store materials for which maximum moisture content is specified in areas where humidity can be controlled.

PART 2 PRODUCTS

2.01 GENERAL

A. Lumber Standards:

1. In accordance with DOC PS 20 and applicable grading rules and wood species certified by ALSC.
2. Design values for wood members equal to those published in supplement to AWC 2.
3. Stamp or brand each unexposed piece of lumber with grade, species, and moisture content at time of mill surfacing.
4. Furnish exposed lumber pieces with grade stamps applied to ends or back of each piece. If completely exposed, and permitted by local building jurisdiction, omit grade stamps entirely.

B. Lumber sizes shown on Drawings are nominal, unless shown otherwise. Provide actual sizes as required by DOC PS 20 for use.

C. Dressed lumber S4S, unless shown otherwise on Drawings.

D. Moisture content of lumber not to exceed 19 percent, unless otherwise specified and marked “DRY”.

E. Each plywood panel identified with designated grade trademark of APA.

2.02 LUMBER

A. Framing Lumber: Douglas Fir-Larch, No. 1 or better unless indicated otherwise below:

Usage	Minimum Grade
Plates, sills, blocking, furring, braces, and nailers	Douglas Fir-Larch No. 2, Hemlock, Southern Pine Stud grade, nondense

2.03 CONSTRUCTION PANELS

A. Plywood Backing Panel: Mounting electrical, telephone, and like equipment; provide fire-retardant treated plywood panel with grade designation, APA C-D Plugged Exposure 1, in thickness shown on Drawings, or, if not shown on Drawings, not less than 15/32 inch.

B. Gypsum Sheathing:

1. Glass-Mat Gypsum Sheathing Board (GMSB):
   a. In accordance with ASTM C1177/C1177M.
   b. Size: 1/2-inch thick.
   c. Manufacturer and Product: G-P Gypsum Corp., Dens-Glass Gold.

2.04 PRESERVATIVE WOOD TREATMENT BY PRESSURE PROCESS

A. Where lumber or plywood is indicated as preservative-treated wood, in accordance with AWPA U1 and AWPA M4, mark and grade each treated item in accordance with SPIB 1003 or WWPA G5.

1. Kiln-dry after treatment to maximum moisture content of 19 percent.
2. Treat wood in contact with roofing or flashing.
3. Treat wood in contact with masonry or concrete.
4. Treat wood less than 18 inches above grade.

B. Aboveground Materials:

1. Pressure treat items with waterborne preservatives to a minimum retention of 0.25 per cubic foot.
2. Interior Use: After treatment, kiln-dry lumber and plywood to maximum moisture content of 19 percent and 15 percent respectively.
3. Treat the following items:
   a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
c. Wood framing members less than 18 inches above grade.
d. Wood floor plates installed over concrete slabs directly in contact with earth.

C. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces to comply with AWPA M4. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

D. Treated lumber and plywood labeled and tested by Underwriters' Laboratories, Inc. shall show performance rating.

2.05 HARDWARE

A. Fasteners and connectors in contact with preservative-treated or fire-retardant-treated wood shall be hot-dipped zinc-coated galvanized steel or stainless steel in accordance with ASTM A153/A153M.

B. Conform to ASTM F1667.

C. Nails:

1. Conform to ASTM F1667.
2. Steel common nails or alternatives listed in rough carpentry section of General Structural Notes found on Drawings.
3. Use hot-dipped zinc-coated nails wherever exposed.
4. Use deformed shank nails for fastening underlayment.

D. Staples: Conform to ASTM F1667, galvanized where exposed.

E. Power Driven Fasteners: Conform to ICC ESR-1539.

F. Bolts and Screws: Conform to ASTM A307, galvanized where exposed.

G. Fasteners for Gypsum Sheathing Board:

1. Galvanized roofing nails 3/8-inch head to 7/16-inch head, 1-3/4 inches long.
2. Staples No. 11 or No. 16-gauge, 7/16 inch by 1-1/2 inches with divergent points.
3. Type S or W No. 6, 1-1/4 inches long drywall screws; meeting the requirements of ASTM C1002.

2.06 MISCELLANEOUS

A. Construction Adhesives: Elastomeric glue conforming to ASTM D3498 for gluing subfloor to joists.

B. Roofing Felt: Asphalt-saturated organic felt conforming to ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify surfaces to receive rough carpentry materials are prepared to exact grades and dimensions.

3.02 GENERAL

A. Lay out, cut, fit, and install rough carpentry items. Anchor sufficiently to ensure rigidity and permanence.

B. Install items accurate to dimension, true to line, level, and square unless shown otherwise on Drawings. Provide for installation and support of other Work.

C. Discard units of material with defects that impair quality of rough carpentry construction and that are too small to use in fabricating rough carpentry with minimum joints or optimum joint arrangement.

D. Countersink nailheads on exposed carpentry work and fill holes.

E. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.

F. Field treat field cuts and holes in pressure-treated lumber with preservative in accordance with AWPA M4.

G. Holes: 1/16 inch larger than nominal bolt diameter, except provide holes for cast-in-place anchor bolts 3/16 inch larger than nominal bolt diameter.

1. Enlarge tight holes requiring forcible driving of bolts by reaming.

H. Provide washers under bolt heads and nuts bearing on wood.

3.03 INSTALLATION

A. Sills and Plates:

1. Set level and flush with outside face of foundation or as shown on Drawings.
2. Anchor with 1/2-inch diameter bolt embedded at least 7 inches into concrete with a minimum of two bolts per piece and with one bolt located within 12 inches of each end of one piece and spaced not more than 6 feet apart.
3. Provide minimum 0.229-inch by 3-inch by 3-inch washer between sill plate and nut.

B. Miscellaneous Framing:

1. Fire Stops:
   a. Stud Walls: 2 inches thick by depth of member blocking at each floor level and top story ceiling level, so placed that the maximum dimension of any concealed space is not over 10 feet.
   b. Floor and Ceiling Framing: 2 inches thick by depth of wood member blocking, fitted to fill openings from one space to another to prevent drafts.
   c. Chimneys and Fireplaces: Keep wood framing minimum of 2 inches from outside face of masonry and 4 inches from fireplace back wall.
2. Framing for Mechanical Work:
   a. Frame members for passage of pipes and ducts to avoid cutting structural members.
   b. Do not cut, notch, or bore framing members for passage of pipes or conduits without concurrence of Engineer. Reinforce framing members where damaged by cutting.

3.04 PRESERVATIVE-TREATED WOOD PRODUCTS

A. Provide preservative-treated wood for framing, blocking, furring, nailing strips built into exterior masonry walls, wood in contact with concrete or masonry and in conjunction with gravel stops, and built-up roofing.

B. Apply two brush coats of same preservative used in original treatment to sawed or cut surfaces of treated lumber.

3.05 FIRE-RETARDANT TREATED WOOD

A. Provide fire-retardant treated lumber and plywood for backing panels at electrical, telephones, and like equipment.

B. Use FR-S rated wood on interior only.

C. Use exterior rated wood outside and where relative humidity is above 80 percent.

END OF SECTION

SECTION 07 14 00
FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.01 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Copies of manufacturer's literature for products proposed.
2. Samples:
   a. Cured membrane and coating system applied to 12-inch square by 1/4-inch-thick plywood or similar rigid base.
   b. Sample of each color and coating to be used on Project.

B. Informational Submittals:

1. Certification: Compliance with product requirements specified.
2. Sample copy of guarantee to be provided. Upon completion and acceptance of the Work required by this section, submit an executed copy of the guarantee.
3. Applicator approval letter from membrane manufacturer.

1.02 QUALITY ASSURANCE

A. Applicator: Approved and licensed by fluid applied waterproofing manufacturer.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project Site in sealed, undamaged containers. Identify each container with material name, date of manufacture, and lot number.

B. Store material in dry area out of direct sunlight. Storage area temperature shall not exceed 90 degrees F.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Perform Work only when existing and forecasted weather conditions are within limits established by manufacturer of materials and products used.

B. Proceed with installation only when substrate construction and preparation work is complete and in condition to receive waterproofing.

1.05 SPECIAL GUARANTEE

A. 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 Owner, removal and replacement of Work specified in this Specification section found defective during a period of 3 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

PART 2 PRODUCTS

2.01 MEMBRANE

A. Polyurethane elastomer-based fluid applied waterproofing membrane:

1. Manufacturers and Product:
   a. Gaco Wester, Seattle, WA; LM-60.V.
   b. Carlisle Coatings and Waterproofing, Sapulpa, OK; CCW-525.
   c. Sika, Corp., Louis, MO; HLM 5000.
   d. W.R. Grace & Co., Cambridge, MA; Procor 20.
   e. Pecora Corp., Harleyville, PA; Duramem V500.

B. Pre-applied waterproofing membrane:

1. Manufacturers and Product:
   a. Sika, Corp., Louis, MO; SikaProof A.
   b. W.R. Grace & Co., Cambridge, MA; Preprufe 300R.
   c. W.R. Meadows, Inc., Hampshire, IL; Precon.
   d. Polyguard Products, Inc., Ennis, TX; Underseal Underslab Membrane.

2.02 RELATED MATERIALS

A. As follows, compatible with components produced by membrane manufacturer:

1. Primers: As recommended by membrane manufacturer for type of substrate involved.
2. Sealants: Low modulus, unmodified polyurethane or as recommended by membrane manufacturer.
3. Backer Rod: Expanded polyethylene rod as manufactured by Dow Chemical, Ethafoam.

4. Flashing Reinforcement: Woven, uncoated fiberglass mesh on 0.050-inch thick precured neoprene.
5. Geocomposite Drainage Sheet: Approved by membrane manufacturer.

PART 3 EXECUTION

3.01 CONDITIONS OF SURFACES

A. Verify curing methods used for concrete are compatible with membrane system.

3.02 PREPARATION

A. Cleaning:

1. Thoroughly clean surfaces to receive membrane following membrane manufacturer's recommendations.
2. Treat as necessary to remove laitance, loose material on surface, grease, oil, and other contaminants that will affect bond of the membrane.
3. Vacuum clean or clear water wash surfaces and allow to dry completely.

B. Fill voids and control joints with sealant and overcoat with nonflow membrane material. Fill or coat visible shrinkage cracks to minimum 2 inches either side of crack.

C. Use drop cloths or masking as required for protection of adjacent surfaces.

3.03 FLASHINGS-FLUID APPLIED

A. Unless Drawings establish more restrictive requirements, the following minimum requirements apply:

1. Fill construction joint voids at intersections of vertical and horizontal walls with backer rod and sealant in accordance with requirements of membrane manufacturer.
2. Nonreinforced Flashing:
   a. Install nonreinforced flashing at construction joints not subject to movement, at all intersecting surfaces that are structurally and rigidly connected, and at all piping or other penetrations through membraned surface that do not require reinforced flashing.
   b. Apply 50-mil minimum dry film thickness of membrane for 4 inches minimum onto adjacent surfaces.

c. At intersections of membrane with vertical walls, piping penetrations, and at projections through horizontal membrane, extend flashing coat to a height not greater than finished horizontal surface, with due allowance for installation of sealant work. Trowel a 1-inch-high, 45-degree cant at meeting angle using nonflowing membrane material.

d. At projections through a vertical membrane, extend flashing coat 4 inches minimum onto penetrating element.

3. Reinforced Flashing:

a. Apply flashing reinforcement over cracks, expansion and control joints, and at changes of plane where adjacent surfaces are not structurally and rigidly connected and also at penetrations through a membrane surface.

b. Apply 50-mil dry film thickness embedment coat of membrane to surfaces to be flashed. Extend 6 inches minimum out onto adjacent deck surface.

c. Embed reinforcement in wet coating. Embedment coating should extend 2 inches beyond reinforcement.

d. At intersections of membrane with vertical walls, extend embedment coat and reinforcement to a height not greater than finished horizontal surface with due allowance for installation of sealant work. Trowel a 1-inch high, 45-degree cant at meeting angle using nonflowing coating material.

3.04 MEMBRANE

A. Install, following safety and weather conditions required by manufacturer or as modified by applicable rules and regulations of federal, state, and local authorities having jurisdiction.

B. Following manufacturer’s instructions, apply membrane material with a calibrated notched squeegee, trowel, or approved spray equipment to produce a 50-mil minimum dry thickness.

C. Extend membrane over previously flashed areas.

D. Use self-leveling membrane material up to a 5 percent slope.

E. Use nonflow membrane material for vertical surfaces and surfaces over a 5 percent slope.

F. Allow membrane to cure overnight. At temperatures less than 75 degrees F and relative humidities less than 50 percent, extend curing time.

3.05 PROTECTION

A. Protect cured vertical membranes exposed to backfilling operations with geocomposite drainage sheet.

B. Butt all geocomposit drainage sheets; do not overlap.

C. Adhere or bond geocomposite drainage sheet to membrane as recommended by membrane manufacturer.

3.06 CLEANING

A. Clean stains from adjacent surfaces with toluene, 1-1-1, trichloroethane, xylene, commercial tar remover, or as recommended by the membrane manufacturer.

B. Remove foreign matter from finished membrane surface.

3.07 APPLICATION SCHEDULE

A. Fluid applied waterproofing membrane:

1. Apply waterproofing membrane and geocomposite drainage sheet to vertical exterior surfaces of cast-in-place concrete structures below finish ground level that enclose spaces that may be occupied, such as stairways, galleries, pump rooms, mechanical and electrical equipment rooms, and other areas shown. Do not include water-holding basins.
2. Apply membrane from top of footings to 6 inches below finished grade.

B. Pre-applied waterproofing membrane:

1. Apply waterproofing membrane under floor slabs in cast-in-place concrete structures below finish ground level that enclose spaces that may be occupied, such as stairways, galleries, pump rooms, mechanical and electrical equipment rooms, and other areas shown.
2. Apply membrane, per manufacturers installation details and instructions, to form a watertight seal with vertical membrane.

END OF SECTION

SECTION 07 19 00
WATER REPELLENTS

PART 1 GENERAL

1.01 REFERENCES

A. Environmental Protection Agency (EPA): Method 24, Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's product data for water repellent including description, limitations to coating, chemical properties and percentage of solids.

B. Informational Submittals:

1. Manufacturer's current application instructions for water repellent.
2. Evidence of applicator certification by product manufacturer.
3. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
4. Manufacturer's Certificate of Compliance in accordance with Section 01 33 00, Submittal Procedures.

1.03 QUALITY ASSURANCE

A. Qualifications: Applicator certified by product manufacturer.

B. Mockup:

1. Apply water repellent following manufacturer's application instructions to not less than 20 square feet of substrate material that matches actual job conditions. Determine the optimum coverage rate required for application.
2. After sample treatment has cured (approximately 12 hours to 24 hours), water test to verify that substrate is coated with sufficient water repellent to effectively repel moisture from the surface.
3. Verify that application of water repellent materials will produce no surface stains or discoloration, and obtain Engineer's acceptance.

4. Maintenance: Maintain mockup during construction for workmanship comparison; remove and legally dispose of mockup when no longer required.
5. Incorporation: Mockup may be incorporated into final construction upon Owner's approval.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials in manufacturer's original sealed containers.

B. Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

1. Lids must be kept tightly sealed. Do not allow moisture to enter containers.
2. Store containers in a dry place, upright and airtight at temperatures of 45 degrees F (7 degrees C) and not exceeding 100 degrees F (38 degrees C).

1.05 PROJECT CONDITIONS

A. Surface, air, and material temperatures shall not be lower than 40 degrees F or higher than 95 degrees F during application unless otherwise permitted by manufacturer's instructions. Do not apply when temperature is expected to fall below 40 degrees F within 12 hours following application.

B. Weather: Clear with no precipitation during application or expected for 4 hours following application.

C. Provide positive ventilation throughout the application.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this specification section found defective during a period of 10 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

B. Conditions: Applied product will retain its water repellent effects during the Special Guarantee period.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Applied Water Repellant: Material to restrict moisture absorption in material being treated, as recommended by manufacturer for a specific substrate.

B. Characteristics:

1. UV resistant.
2. Single component.
3. Water based.
4. Minimum Active Siloxane/Silane Content: By weight, 40 percent.
5. Will not alter appearance of masonry or change the surface texture.
6. VOC content less than 350 grams per liter using EPA Method 24.
7. No fillers, stearates, or paraffin.
8. Clear color.
9. Ultra-low viscosity.
10. Breathable.

2.02 MANUFACTURERS AND PRODUCTS:

A. Master Builders Solutions; MasterProtect H 400.

B. Evonik Industries; Protectosil, CHEM-TRETE 40 VOC.

C. Tnemec Co., Inc.; Chemprobe Coating Systems, Prime-A-Pell Plus.

D. Textured Coatings of America, Inc. (TEX-COTE); RAINSTOPPER 140W.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Verify that surfaces are solid, dry, and free of dirt, efflorescence, oil, wax, frozen matter, loose particles, cracks, pits, laitance, curing compounds, and other foreign matter that would block absorption of water repellent.

B. Verify that curing of sealants is complete.

C. Clean masonry surfaces to make them acceptable for application.

D. Protect and mask adjacent surfaces during application.

3.02 APPLICATION

A. Follow product manufacturer's instructions and recommendations, including application apparatus and techniques, and coverage rates.

B. Provide uniform coverage over entire surface of concrete masonry veneer on exterior of buildings.

3.03 FIELD QUALITY CONTROL

A. Notify Engineer 48 hours prior to application.

B. After water repellent has dried (24 hours, low humidity, medium temperature (70 degrees F to 90 degrees F) and 48 hours, high humidity, low temperature (50 degrees F to 69 degrees F), test surfaces with a water spray. Recoat areas that indicate water absorption.

3.04 CLEANING

A. At completion, remove from the Job Site excess material, debris, and waste. Dispose of water repellent containers according to state and local environmental regulations.

B. Upon completion of Work, clean window glass and other splattered surfaces.

3.05 PROTECTION

A. Protect adjacent shrubs, metal, wood trim, glass, asphalt, and other building hardware from overspray. Do not permit spray mist or liquid to drift onto surrounding properties or parking lots. Avoid contact with automobile paint and windshields. Clean up immediately after application using cleaners approved by product manufacturer.

B. Protect installed product's finish surfaces from damage during construction.

END OF SECTION

SECTION 07 21 00
THERMAL INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   b. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s product literature identifying products proposed for use.
   b. Drawings or letter indicating proposed locations of holes for injection of foam-in-place insulation in exposed, unpainted walls.

1.03 DELIVERY, STORAGE, AND HANDLING

A. On packaging clearly identify manufacturer, contents, brand name, applicable standard, and R-value.

B. Store materials off ground and keep them dry. Protect against weather, condensation, and damage.

PART 2 PRODUCTS

2.01 CAVITY WALL INSULATION SYSTEM

A. Description:

1. Air Space Maintenance and Drainage Material with Integral Extruded Polystyrene Board Cavity Insulation.
2. Masonry mat mortar bridging control factory bonded to rigid, cellular, extruded polystyrene thermal insulation to comply with ASTM C578, Type IV.

3. The mat shall be fluid conducting, non-absorbent, mold and mildew resistant polymer mesh consisting of 100 percent recycled plastic with binder.
4. Mat is to be a non-woven textile product in random pattern and have voids no greater than 1/4 inch in diameter.
5. Insulation system is to be designed for substantially continuous installation behind the full-height of all masonry veneer.

B. Drainage Mat Thickness: Select masonry mat thickness of 1-1/4 inches to allow no more than 1/2-inch tolerance between the masonry mat and masonry wythe.

C. Sizes: 16 inches by 8 feet.

D. Manufacturers and Products: Archovations, Inc.; CavClear Insulation System.

2.02 RIGID INSULATION

A. Expanded Polystyrene Foam:

1. ASTM C578, Type IX.
2. Flame Spread: Less than 25 when tested in accordance with ASTM E84.
3. Thickness: 1-1/2 inches Cavity wall, R 7.6 Minimum.
4. Manufacturers and Products:
   a. Owens Corning; Foamular CW-25 (XPS).
   b. Dupont Styrofoam; CAVITYMATE Plus.
   c. Kingspan; GreenGuard Type IV XPS Cavity Board.
   d. “Or-equal.”

B. Adhesives and Fasteners: As recommended by insulation manufacturer.

2.03 MASONRY INSERT INSULATION

A. Molded Expanded Polystyrene Inserts:

1. 1. ASTM C578, Type I.
2. Fabricate to fit standard two-core concrete masonry units of 6-inch, 8-inch, 10-inch, and 12-inch width, as applicable.
3. Minimum Density: 1 pound per cubic foot when tested in accordance with ASTM C303.
4. R-Value at 1 inch Thickness:
   a. At 40 degrees F: 4.17.
   b. At 75 degrees F: 3.92.

5. Moisture Resistance:
   a. Water Vapor Transmission: 0.80 perm inches to 2.80 perm inches when tested in accordance with ASTM E96/E96M.
   b. Absorption: Less than 2 percent by volume when tested in accordance with ASTM C272/C272M.
6. Flame Spread: Less than 5 when tested in accordance with ASTM E84.
7. Pre-install at concrete masonry unit plant in accordance with manufacturer's instructions prior to delivery to Site.
8. Manufacturer and Product: Concrete Block Insulating Systems, Inc.; Korfil Standard U-Shaped Insulation Inserts.

2.04 CAVITY WALL SPRAY FOAM INSULATION SYSTEM

A. Description:

1. Closed-cell spray polyurethane foam (SPF).
2. Two-component, medium-density, Class 1 rated.
3. Manufacturer and Product: Johns Manville; JM Corbond III.

PART 3 EXECUTION

3.01 CAVITY WALL INSULATION SYSTEM

A. Install in accordance with the following:

1. Install insulation system continuously in the full-height of exterior masonry cavities during construction of exterior wythe; follow manufacturer's installation instructions.
2. Verify that air space width is no more than 1/2-inch greater than masonry mat and insulation thickness.
3. Install horizontally between joint reinforcement.
4. Stagger end joints in adjacent rows.
5. Butt adjacent pieces to moderate contact.
6. Use insulation sealant on all insulation joints.
7. Fit to perimeter construction and penetrations without voids.
8. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.02 RIGID INSULATION

A. Install in accordance with the following:

1. Install boards in location and in thickness as shown.
2. Cut insulation with saw, knife, or other sharp tool to fit tightly around obstructions.

3. Butt insulation boards together tightly at joints.
4. Where thickness required exceeds 1-1/2 inches, install two layers of boards.
5. Apply to masonry or concrete with adhesive recommended by insulation manufacturer:
    a. Adhere first layer to substratum, then adhere second layer to first, staggering joints.
    b. Follow manufacturer's recommendations for preparing surfaces and applying adhesive.

3.03 CAVITY WALL SPRAY FOAM INSULATION

A. Install in accordance with the following:

1. Fill masonry wall cavity in above-grade wall cavities as shown.
2. Clean out cavity of all loose debris, grout, and mortar.
3. Fill cavity with two-component SPF in ratio and at rate recommended by manufacturer.
4. Cavity shall be completely full when fully expanded and cured.

END OF SECTION

SECTION 07 26 16
BELOWGRADE VAPOR RETARDERS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI): 302, Guide for Concrete Floor and Slab Construction.
2. ASTM International (ASTM):
   a. D412, Standard Test Method for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
   b. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
   c. D1709, Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
   d. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
   e. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
   f. E154, Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or a Ground Cover.
   g. E1643, Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
   h. E1745, Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
   i. F1249, Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s material specifications.

B. Informational Submittals:

1. MSDS for proposed materials.
2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers’ Field Services.
3. Manufacturer’s written instructions for preparation, installation/application, repair, protection and maintenance.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from weather, excessive temperature and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.

PART 2 PRODUCTS

2.01 UNDERSLAB VAPOR RETARDER

A. Meet or exceed ASTM E1745, Class A, with the following properties:

1. Water Vapor Permeance: 0.03 perm maximum when tested in accordance with ASTM E96/E96M or ASTM F1249.
2. Tensile Strength: 45-foot-pounds per inch minimum, when tested in accordance with ASTM D882.
3. Puncture Resistance: 2,200 grams minimum, when tested in accordance with ASTM D1709.
4. Thickness: 10 mils minimum, in accordance with ACI 302.

B. Manufacturers and Products:

1. Fortifiber Building Systems Group; Moistop Ultra 15.
2. Reef Industries, Inc.; Griffolyn 15 mil Green.
3. Stego Industries, LLC; Stego Wrap, 15 mil Class A Vapor Retarder.

2.02 ANCILLARY MATERIALS

A. Fasteners, Tape, Adhesive, or Sealant: As recommended by vapor retarder manufacturer.

B. Pipe Boots: Manufacturer's recommended prefabricated or field fabricated item.

PART 3 EXECUTION

3.01 PREPARATION

A. Examine conditions of substrates and other conditions under which work is to be performed. Do not proceed with work until satisfactory conditions are obtained.

3.02 INSTALLATION

A. Underslab Vapor Retarder:

1. Apply in accordance with manufacturer's instructions.
2. After base for slab has been leveled and tamped, apply vapor retarder with roll width parallel to direction of concrete pour.
3. Lap vapor retarder over footings and seal to foundation walls.
4. Overlap joints 6 inches and seal with tape.
5. Seal penetrations with pipe boots.
6. Repair damaged areas with patches of vapor retarder, overlapping damaged area by 6 inches and sealing sides of patch with tape.

3.03 CLEANING

A. Upon completion of vapor retarder installation, remove waste materials and debris resulting from this operation and dispose offsite.

END OF SECTION

SECTION 07 54 23
THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes Vapor Barrier, Cover board, insulation, and membrane roofing**,** base flashings and counterflashings.

1.02 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
2. American Wood Protection Association (AWPA): U1, Use Category System: User Specification for Treated Wood.
3. ASTM International (ASTM):
   a. C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   b. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
   c. D471, Standard Test Method for Rubber Property—Effect of Liquids.
   d. D573, Standard Test Method for Rubber—Deterioration in an Air Oven.
   e. D751, Standard Test Methods for Coated Fabrics.
   f. D1149, Standard Test Methods for Rubber Deterioration-Cracking in an Ozone Controlled Environment.
   g. D1204, Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
   h. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   i. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
   j. E108, Standard Test Methods for Fire Tests of Roof Coverings.
   k. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.

4. FM Global (FM):
   a. DS 1-28, Design Wind Loads.
   b. DS 1-29, Roof Deck Securement and Above-Deck Roofing Components.
   c. 4450, Approval Standard for Class I Insulated Steel Deck Roofs.
5. International Code Council (ICC): International Building Code (IBC).
6. National Roofing Contractors Association: NRCA Roofing and Waterproofing Manual.
7. Single Ply Roofing Institute (SPRI): ES-1, Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems.
8. Underwriters Laboratories, Inc. (UL):
   a. 790, Standard Test Methods for Fire Tests of Roof Coverings.
   b. 1897, Uplift Tests for Roof Covering Systems.
9. U.S. Department of Defense Military Standard (MIL): 3010, Test Procedures for Packaging Materials.

1.03 DESIGN REQUIREMENTS

A. General: Installed roofing membrane system shall remain watertight; and resist specified wind uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Roofing materials shall be compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

C. Installer must comply with current code requirements based on authority having jurisdiction.

D. Wind Uplift Performance: Roofing system shall be identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist wind uplift pressure calculated in accordance with ASCE 7.

E. Low-slope Membrane Roof Edge Securement: Conform to SPRI ES-1 for wind speeds determined from applicable edition of ICC IBC code.

1.04 PERFORMANCE REQUIREMENTS

A. Roof Assembly Classification: FM Class 1 Construction, windstorm classification of I-90, in accordance with FM DS 1-28.

B. Uplift Resistance: UL 90 psf uplift pressure resistance.

C. Vapor Retarder Permeance: Maximum 1 perm(57 ng/Pa/s/sq m) when tested in accordance with ASTM E96/E96M.

D. Fire-rated Roof Construction:

1. Rating as indicated on Drawings.
2. Tested Rating: Determined in accordance with ASTM E119.

E. Roof Assembly Fire Classification:

1. Fire-test-response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency:
   a. Exterior Fire-test Exposure: Class A; ASTM E108, for application and roof slopes indicated.
   b. Roof Assembly with Foam Insulation: Passes FM 4450 or UL 1256.

F. Surface Burning Characteristics:

1. Foam Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.05 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s data sheets for each product to be provided.
2. Detail drawings of roofing system plans, elevations, sections, details, and details of attachment to other Work, including:
   a. Base flashings and membrane terminations.
   b. Tapered insulation, including slopes.
   c. Crickets, saddles, and tapered edge strips, including slopes.
   d. Insulation fastening and adhesive patterns.
3. Verification Samples: Provide for each product specified.
4. Project-specific details of roof penetrations and perimeter conditions.
5. Layout and details of fully adhered system.
6. List of materials proposed for use; include roofing materials, accessories, insulation, and fasteners.
7. Manufacturer’s specifications selected for use; include description of complete system from deck up.
8. Documentation that anchoring system meets uplift requirements.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
2. Manufacturer's installation instructions.
3. Letter or other documentation from roofing materials manufacturer stating that installer has been trained and approved to apply roof system.
4. Sample copy of guarantee to be provided.
5. Record of Preroofing Conference.
6. Inspection reports for inspections conducted by membrane manufacturer's representative; include written instructions or recommendations as conditions to special guarantee.
7. Operation and Maintenance Data:
    a. As specified in Section 01 78 23, Operation and Maintenance Data.
    b. Include sketches where applicable, recommendations for periodic inspection, care, and maintenance.
    c. Identify common causes of damage with instructions for temporary patching until permanent repair can be made.
8. Manufacturer's Certificate of Proper Installation per Section 01 43 33, Manufacturers' Field Services, (or alternately, test results or calculations) that assure item's and its anchorage's design criteria meets requirements of Section 01 88 15, Anchorage and Bracing, for loads provided in Section 01 61 00, Common Product Requirements.
9. Proposed Maintenance Agreement.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with NRCA Roofing and Waterproofing Manual.

B. Fire Rated Roof Construction: 1-hour rating.

1. Tested Rating: Determined in accordance with ASTM E119.

C. Roof Assembly Fire Classification: Minimum Class A when tested in accordance with ASTM E108 or UL 790.

1. Roof Assembly with Foam Insulation: Passes FM 4450 or UL 1256.

D. Surface Burning Characteristics:

1. Foam Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

E. Apply label from agency approved by authority having jurisdiction to identify each roof assembly component.

1.07 QUALITY CONTROL

A. Installer Qualifications:

1. Trained and approved by roof membrane manufacturer.
2. Experience: 3 years, minimum, in the installation of the specific roofing and flashing system specified.

B. Materials, including insulation used in roofing system shall be furnished by or approved by manufacturer whose roofing system is selected for use.

1.08 PREROOFING CONFERENCE

A. Conference Requirements:

1. Attendees: Engineer, roofing installer, roofing manufacturer, installers of related Work, and other entities concerned with roofing performance included, where applicable, Owner’s insurer, test agencies, governing authorities, and Owner.
2. Agenda: Follow outline in NRCA’s Waterproofing Manual. Include acceptability of deck, roofing system, materials, manufacturer’s specifications selected, flashing details, roof guarantee, and protection of furnished roofing system.
3. Documentation: Record discussion and agreements. Furnish copy to each attendee invited.

B. Membrane manufacturer’s inspections as required to meet conditions of guarantee.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in their original, unopened containers, clearly labeled with manufacturer’s name, brand name, and such identifying numbers as are appropriate.

B. Storage:

1. Store materials at temperatures between 60 degrees F and 80 degrees F. Should they be exposed to lower temperatures, restore to 60 degrees F prior to use.
2. Store rigid roof insulation materials on clean, raised platform.
3. Do not store uncured flashing membrane on roof or at temperatures exceeding 75 degrees F.

C. Protect materials against wetting, moisture absorption, and construction traffic.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Weather Limitations: Proceed with installation only when current and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and guarantee requirements.

B. Temperature:

1. Install roofing when ambient temperature is 50 degrees F or above.
2. When temperature is below 50 degrees F, install only with approval or and under supervision of membrane manufacturer.

1.11 COORDINATION

A. Coordinate Work with installation of associated roof penetrations and metal flashings, as Work of this section proceeds.

1.12 SPECIAL GUARANTEE

A. Product: 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 roofing membrane, flashing, insulation, and accessories found defective during a period of 30 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

B. Coverage and Conditions:

1. Costs for repairs required to maintain roofing system, flashing, expansion joint covers, and roof vents in watertight condition.
2. Natural deterioration of roofing system as a result of ordinary wear and tear by elements.
3. Defects as a result of faulty materials or workmanship during application.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fully Adhered TPO Roofing:

1. Johns Manville; TPO – 80 mil (basis of design).
2. Carlisle Syntec Systems – 80 mil Extra.
3. Elevate; UltraPly Platinum 80 mil TPO.
4. GAF; EverGuard TPO 80-mil.
5. GenFlex Roofing Systems; EZ TPO.

2.02 ROOFING SYSTEM

A. Roofing system shall meet these Specifications, and approval and warranty of membrane manufacturer to provide a fully adhered complete TPO system including the following:

1. Membrane.
2. Roof insulation.
3. Cover board.
4. Flashing.
5. Adhesives.
6. Fasteners.
7. Accessory materials.

2.03 MEMBRANE MATERIALS

A. Reinforced thermoplastic polyolefin sheet, 0.080 inch thick with the following properties:

Properties	Test Method	Specification
Thickness Tolerance	ASTM D751	Plus or minus 10%
Breaking Strength (min)	ASTM D751, Grab Method	300 pounds
Elongation at Break	ASTM D412	30 %
Tear Strength (min)	ASTM D751	70 pounds
Ozone Resistance	ASTM D1149, 70 hours at 100 degrees F	No cracks or other affect
Heat Aging	ASTM D573, 28 days at 212 degrees F retention of tensile	Maintain 100% of original breaking strength
Water Absorption (change in mass)	ASTM D471, 158 degrees F for 7 days	1%
Hydrostatic Resistance (min)	ASTM D751, Method A	430 psi
Puncture Resistance	MIL Std 3010	380 pounds
Dimensional Stability (% change max.)	ASTM D1204	+ 0.4%

B. Membrane Sheet Size: Minimum width 60 inches by length of largest sheet possible, determined by project conditions.

C. Color: White.

2.04 ACCESSORY MATERIALS

A. Adhesives and Fasteners:

1. Surface Conditioner: Compatible with membrane.
2. Membrane cover board, and insulation adhesives and fasteners as recommended by membrane manufacturer.
3. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

B. Sheet Flashing: Manufacturer's internally reinforced or scrim reinforced, smooth-backed membrane with same thickness and color as sheet membrane.

C. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, with anchors.

D. Nailers: Preservative treated wood as specified in Section 06 10 00, Rough Carpentry.

E. Miscellaneous Accessories: Provide pourable sealers, primers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, cover strips, and other accessories required for full installation.

2.05 RIGID ROOF INSULATION BOARD

A. Average Aged R-value for Total Thickness of Rigid Insulation: Minimum R-25.

B. Any one of the following insulation materials may be used on this Project provided roofing materials manufacturer will guarantee roofing system.

1. Polyisocyanurate Foam Board:
   a. ASTM C1289, Type II with FM Class I approval.
   b. Minimum Size: 2 feet by 4 feet.
   c. Manufacturers and Products:
      1) Atlas Roofing Corp.; AC Foam II.
      2) Celotex; H-T AP.
      3) GAF; GAFTEMP Isotherm.
      4) Johns Manville; E’NRG’Y 2.
2. Tapered Polyisocyanurate Foam Board System:
   a. Factory precut or field tapered insulation board, minimum 1 inch thick with top surface cut to a uniform, continuous slope of 1/4 inch per foot.
   b. Fabricate miters and edges to match abutting blocks.
   c. Manufacturers and Products:
      1) Atlas Roofing Corp.; AC Foam III.
      2) GAF EnergyGuard Tapered.
      3) Johns Manville; Tapered ENRGY 3.

2.06 COVER BOARD

A. Manufacturers and Products:

1. Johns Manville; ProtectorR HD.
2. Georga-Pacific; Densdeck.
3. “Or-equal.”

2.07 ROOF WALKWAY

A. Manufacturers and Products:

1. Johns Manville; TPO Walkpad.
2. Stevens; EP Walkway Pad.

PART 3 EXECUTION

3.01 PREPARATION

A. Surfaces to be adhered shall be dry before and throughout entire application.

B. Notify Engineer and manufacturer’s representative at least 48 hours before installation of vapor retarder, insulation, membrane, and roofing system.

C. Inspection:

1. Verify work of other trades that penetrates roof deck or requires roof access has been completed.
2. Ensure deck is firm, dry, free of foreign material, and reasonably smooth.
   a. Differential height between adjacent roof deck members of more than 1/8 inch is not acceptable.
   b. Repair joints greater than 1/4 inch wide.
3. Report immediately to Engineer cracks, breaks, holes, or other unusual irregularities in surface.

D. Nailers:

1. Install wooden nailers at gravel stops or drip edges on outside perimeter of building.
2. Anchor nailer with a suitable fastener with minimum withdrawal resistance of 100 pounds.
3. Stagger fasteners 6 inches on center within 8 feet of outside corner and 12 inches on center along other perimeter areas.
4. Nailer Thickness: Choose to match top surface of adjacent construction.

3.02 INSTALLATION

A. In accordance with membrane manufacturer's standard details for flashing and termination conditions not shown.

B. In accordance with Article Performance Requirements for uplift conditions.

C. In accordance with applicable recommendations of FM DS 1-29.

D. Insulation:

1. Keep insulation dry before and during application.
2. Install rigid insulation where and to thickness necessary for R-value shown in two or more layers, staggering joints.
3. Lay insulation with longest dimension perpendicular to direction of membrane seams with joints staggered over roof area to be covered.
4. Butt boards as closely as possible with no gaps over 1/4 inch.
5. Mechanically fasten insulation to deck following roofing membrane manufacturer's instructions.
6. Do not install more insulation each day than can be covered with membrane before end of day or start of inclement weather.

E. Cover Board:

1. Apply cover board to tapered rigid insulation substrate with longest dimension perpendicular to membrane seams with joints staggered over roof area to be covered.
2. Fasten cover board with adhesive to tapered insulation in accordance with roofing membrane manufacturer's instructions.

F. Membrane:

1. Install membrane and flashing in accordance with manufacturer's recommendations and instructions.
2. Fully adhere membrane to cover board substrate with adhesive in accordance with manufacturer's recommendations and instructions.
3. Heat weld joints following manufacturer's instructions.

G. Flashing: Install perimeter, curb, vents, expansion joints, drains, and other detail flashing as shown on manufacturer's standard detail drawings and as follows:

1. Heat weld flashing to membrane and attach to other surfaces following manufacturer's instructions.
2. Install pipe flashing, expansion joints, and roof drains in accordance with manufacturer's standard details and instructions.

H. Flashing: Install perimeter, curb, vents, expansion joints, drains, and other detail flashing as shown on manufacturer's standard detail drawings and as follows:

1. Heat weld flashing to membrane and attach to other surfaces following manufacturer's instructions.
2. Install pipe flashing, expansion joints, and roof drains in accordance with manufacturer's standard details and instructions.

I. Temporary and Night Seals:

1. Provide water cutoffs under the following circumstances:
   a. Where and when a danger exists that water caused by precipitation may get under new roofing membrane.
   b. At end of each day.
2. Make by securely setting end of membrane in 6-inch-wide continuous application of cement and weight adhered edge to prevent displacement of cutoff.
3. Remove temporary water cutoffs prior to proceeding with next work period by cutting off and disposing of portion of membrane that has been in contact with cement.

J. Walkways: Adhere to membrane with membrane manufacturer's bonding adhesive.

3.03 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and Certification of Proper Installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

3.04 CLEANING

A. Remove spots and smears of asphalt or other material from flashings, gravel stops, and other surfaces not intended to be coated with such material. During removal, do not damage surfaces. Use solvents, if necessary, to clean surfaces.

3.05 PROTECTION

A. Limit traffic of personnel and equipment on completed roof to that deemed essential for completion of Project.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   c. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   d. A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   e. B32, Standard Specification for Solder Metal.
   f. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   g. B370, Standard Specification for Copper Sheet and Strip for Building Construction.
   h. C920, Standard Specification for Elastomeric Joint Sealants.
   i. C1311, Standard Specification for Solvent Release Sealants.
   j. D1187/D1187M, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
   k. D4586/D4586M, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
2. Federal Specifications (FS): QQ-L-201F(2), Lead Sheet.
3. FM Global (FM): Loss Prevention Data Sheet 1-49, Perimeter Flashing.
4. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): 1793, Architectural Sheet Metal Manual.

1.02 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Fabricate and install roof edge flashing capable of resisting the following forces according to recommendations in FM Loss Prevention Data Sheet 1-49.

C. Fabricate and install roof edge flashing capable of resisting the developed edge and corner positive and negative wind pressures based on the structural design criteria shown on the Project structural drawings.

D. Thermal Movements:

1. Provide sheet metal flashing and trim that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures for preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.
   a. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.
2. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
3. Base engineering calculation on surface temperatures of materials as a result of both solar heat gain and nighttime-sky heat loss.

E. Water Infiltration: Provide sheet metal flashing and trim that does not allow water infiltration to building interior.

1.03 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA 1793. Conform to dimensions and profiles shown, unless more stringent requirements are indicated.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Show joints, types and location of fasteners, and special shapes.
   b. Catalog data for stock manufactured items.
2. Samples: Color Samples for items to be factory finished.

1.05 DELIVERY, HANDLING, AND STORAGE

A. Inspect for damage, dampness, and wet storage stains upon delivery to Site.

B. Remove and replace damaged or permanently stained materials that cannot be restored to like-new condition.

C. Carefully handle to avoid damage to surfaces, edges, and ends.

D. Do not open packages until ready for use.

E. Store materials in dry, weathertight, ventilated areas until immediately before installation.

1.06 SPECIAL GUARANTEE

A. Product: 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 factory-applied fluoropolymer coating, finish, and accessories found defective during a period of 20 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

B. Conditions:

1. Finish: No cracking, blistering, flaking, chipping, checking, chalking, peeling, or fading.
2. All Components: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.01 METAL

A. Galvanized Sheet Steel: ASTM A924/A924M, Grade A or ASTM A653/A653M, G90 zinc coating, commercial quality copper bearing steel, thickness 0.0239-inch (24 U.S. Standard gauge), unless otherwise shown.

B. Prefinished Galvanized Steel Sheet: ASTM A924/A924M, Grade A or ASTM A653/A653M, G90 zinc coating; 24-gauge (0.02-inch) core steel, shop prefinished with fluoropolymer coating (Kynar polyvinylidene fluoride resin) coating; color to match existing buildings.

C. Aluminum Sheet: ASTM B209, Alloy 5005-H34, alloy and temper as required for application and finish with anodic coating in 0.70-mil thickness.

D. Lead Sheet: FS QQ-L-201F(2), Grade B solid lead, minimum weight 4 pounds per square foot, soft temper, except hard temper for flanges.

E. Stainless Steel: ASTM A666, Type 304 or Type 316, soft temper; No. 2D, dull finish, 0.018 inch thick, unless otherwise shown.

F. Copper: ASTM B370, Temper Designation Standard H00, cold-rolled 1/8 hard, 16 ounces per square foot.

2.02 REGLETS AND COUNTERFLASHING

A. For Concrete:

1. Stainless steel, 0.015 inch.
2. Manufacturers and Products:
   a. Fry Reglet Corp.; Fry Springlok Type CO and Springlok Flashing.
   b. Cheney Flashing Co.; Type A reglet and Snap Lock Cap Flashing.

B. For Masonry:

1. Stainless steel, 0.015 inch.
2. Manufacturers and Products:
   a. Fry Reglet Corp.; Fry Springlok Type MA and Springlok Flashing.
   b. Cheney Flashing Co.; Type B reglet and Snap Lock Cap Flashing.

C. Surface Mounted:

1. Stainless steel, 0.015 inch.
2. Manufacturers and Products:
   a. Fry Reglet Corp.; Fry Springlok Type SM and Springlok Flashing.
   b. Cheney Flashing Co.; Type D reglet and Snap Lock Cap Flashing.

2.03 DOWNSPOUTS, SCUPPERS, AND CONDUCTOR HEADS

A. Prefinished Galvanized Steel Sheet: ASTM A924/A924M, Grade A or ASTM A653/A653M, G90 zinc coating; 24-gauge (0.02-inch) core steel, shop prefinished with fluoropolymer coating (Kynar polyvinylidene fluoride resin) coating; color to match existing buildings.

2.04 ANCILLARY MATERIALS

A. Solder: ASTM B32, alloy composition Sn 50 and Sn 60 for stainless steel.

B. Soldering Flux: ASTM B32, Type RA.

C. Isolation Paint: ASTM D1187/D1187M, asphalt.

D. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil thick minimum polyester.

E. Plastic Roof Cement: ASTM D4586/D4586M, Type II.

F. Elastomeric Sealant: 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.

G. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.

H. Fasteners:

1. Galvanized Steelwork: Steel, galvanized per ASTM A153/A153M or stainless steel fasteners.
2. Zinc or Aluminum Work: Stainless steel or aluminum; reglet fasteners may be galvanized or cadmium-plated steel.
3. Stainless Steelwork: Stainless steel.
4. Nails: Roofing nailhead, 10-gauge spiral or ring shank, lengths as required to penetrate wood at least 3/4 inch or as required in Article Performance Requirements.

2.05 FABRICATION OF FLASHING

A. Field measure prior to fabrication.

B. Fabricate in accordance with SMACNA 1793 that applies to design, dimensions, metal, and other characteristics of item indicated.

1. Counter Flashing Systems: Figure 4-3.

C. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

D. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

E. Seams:

1. Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
2. Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

F. Reinforcements and Supports: Provide same material as flashing, unless other material is shown. Steel, where shown or required, shall be galvanized or stainless.

G. Rigid Joints and Seams: Make mechanically strong. Solder galvanized and stainless steel metal joints. Do not use solder to transmit stress.

H. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

I. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1-inch deep, filled with butyl sealant concealed within joints.

J. Fabricate sheet metal in 10-foot maximum lengths, unless otherwise indicated.

K. Provide watertight closures at exposed ends of counterflashing.

L. Fabricate corners in one-piece with legs extending 30 inches each way to field joint. Lap, rivet, or solder corner seams watertight. Apply sealant if necessary.

M. Neutralize soldering flux.

N. Solvent clean sheet metal. Surfaces to be in contact with roofing or otherwise concealed shall be coated with isolation paint.

O. Pipe Penetrations through Roof: As specified in Section 07 54 23, Thermoplastic Membrane Roofing.

P. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

Q. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

1. Thickness: As recommended by SMACNA 1793 and FM Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

2.06 FABRICATION OF DOWNSPOUTS, SCUPPERS, AND CONDUCTOR HEADS

A. Form downspouts and gutters in maximum lengths as practicable to sizes and shapes indicated on Drawings:

1. Telescope end joints 1-1/2 inches and lock longitudinal joints of downspouts.
2. Provide elbows at bottom where downspouts empty onto splash blocks.
3. Fit downspouts into cast iron boots or drainpipes where indicated on Drawings; neatly caulk or cement joints.

B. Form scuppers and conductor heads to shapes and sizes indicated on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set and cant strips and reglets in place.

B. Verify nailing strips and blocking are properly located.

C. Verify membrane termination and base flashings are in place, sealed, and secure.

3.02 INSTALLATION

A. Flashing:

1. General:
   a. Install sheet metal roof flashing and trim to comply with performance requirements and SMACNA 1793.
   b. Provide concealed fasteners where possible, set units true to line, and level as indicated.
   c. Install work with laps, joints, and seams that will be permanently watertight.
2. Cast Stone Coping Cap Flashing:
   a. Fabricate from 28 Gauge (0.015”) Type 304 stainless steel. Flat stock in 10 feet-0 inch lengths.
   b. Provide 1/2-inch 45 degree hemmed drip edge on the exterior face of the parapet wall.
   c. On interior face parapet wall, fabricate the hemmed edge to clip over the stainless steel roofing counter flashing.
   d. Lap the metal flashing sections a minimum of 4 inches, Use two beads of non-skinning butyl sealant.
   e. Provide Type 304 stainless steel Split tailed stone anchors and other accessories shown in the project details in order to provide a complete coping anchoring system.

B. Prefabricated Metal Systems:

1. Follow system manufacturer’s printed instructions.
2. Place color variations in pieces so no extremes are next to each other.

C. Downspouts, Scuppers, and Conductor Heads: Anchor downspouts to wall with straps of same material as downspouts. Install gutters, scuppers, and conductor heads as indicated on Drawings.

3.03 FINISH

A. Exposed Surfaces of Flashing and Sheet Metalwork: Free of dents, scratches, abrasions, or other visible defects, and clean and ready for painting where applicable.

3.04 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a 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.

END OF SECTION

SECTION 07 70 01
ROOF SPECIALTIES AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Movement and Control Association International (AMCA).
2. American Architectural Manufacturers Association (AAMA).
3. ASTM International (ASTM):
   a. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
   b. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
4. FM (Factory Mutual) Global (FM).
5. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings of each item specified showing materials, details, flashing, anchorage, and relation to adjacent structure.
2. Catalog cuts of each item specified item.

B. Informational Submittals: Manufacturer’s Certificate of Compliance per Section 01 61 00, Common Product Requirements, (or alternately, test results or calculations) that assure items and its anchorage’s design criteria meets requirements of Section 01 88 15, Anchorage and Bracing, for loads provided in Section 01 61 00, Common Product Requirements.

1.03 SEQUENCING AND SCHEDULING

A. Coordination: Schedule and coordinate work of this section with work of Sections 07 54 23, Thermoplastic Membrane Roofing, 22 40 00, Plumbing Fixtures, and Section 07 62 00, Sheet Metal Flashing and Trim.

PART 2 PRODUCTS

2.01 ROOF CURBS

A. Prefabricated Galvanized Steel: Minimum 12-inch-high curb with treated wood nailer liner panel, and factory installed insulation as required for conditions shown on Drawings.

B. Metal Gauge and Reinforcement: To suit imposed loads of equipment to be supported.

C. Fabricate curbs to fit roof slope.

D. Manufacturers and Products:

1. Pate Co.; PC-2.
2. ThyCurb; Model TC-3.
3. RPS Corporation; RC-2A.
4. RPS Corporation; ER-2A.

2.02 PIPE CURB ASSEMBLY

A. Prefabricated Galvanized Steel: Minimum 12-inch-high curb for pipe penetrations of roof, complete with cover, factory installed insulation and accessories as required for conditions shown on Drawings.

B. Fabricate to fit roof slope and furnish covers to suit pipe penetrations indicated on Drawings.

C. Manufacturers and Products:

1. Pate Co.; PCA-2, with cover.
2. ThyCurb; Model TC-3, with cover.
3. RPS Corporation; Pipe Portal System.

2.03 VENT PIPE FLASHING

A. Prefabricated flashing with elastomeric collar and white thermoplastic base, sized to fit vent pipe.

B. Manufacturer and Product: Oatey; No-Caulk Roof Flashing.

2.04 ROOF HATCHES

A. Material: Aluminum, 11-gauge with factory-insulated curb and cover.

B. Manufacturers and Products:

1. Size: 3 feet by 2.5 feet:
   a. Bilco; S-50.
   b. Babcock-Davis; BRHT Series.
   c. JL Industries; RHDA.

2.05 ANCILLARY MATERIALS

A. Sealing Tape: Polyisobutylene sealing tape.

B. Isolation Paint: ASTM D1187, asphalt.

C. Coat aluminum surfaces in contact with concrete or dissimilar metals as specified in Section 09 90 00, Painting and Coating.

D. Isolation Tape: Butyl or polyisobutylene, internally reinforced, or 20-mil-thick minimum polyester.

E. Plastic Roof Cement: ASTM D4586, Type II.

F. Fasteners: Stainless steel of type required.

PART 3 EXECUTION

3.01 PREPARATION

A. Examine surfaces and structures to receive the Work of this section.

B. Take measurements at Site and fabricate work to suit. No changes shall be made in supporting structure to accommodate this Work.

3.02 INSTALLATION

A. General:

1. Install roof specialties and accessories as detailed in approved shop drawings and in conformance with manufacturer’s instructions, recommendations, and standards.
2. Use appropriate pipe curb assembly, pipe seal, flexible base pipe seal, or vent pipe flashing where pipe, conduit, or cable, etc., penetrate roofing membrane.

3. Factory Finished Units: Place color variations in pieces so no extremes are next to each other.
4. Make Work weathertight and free of expansion and contraction noise.
5. Maintain separation between aluminum surfaces and concrete or dissimilar metals as specified in Section 09 90 00, Painting and Coating.

B. Roof Hatches: Install to operate freely and not rattle when closed or open.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C661, Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   b. C834, Standard Specification for Latex Sealants.
   c. C920, Standard Specification for Elastomeric Joint Sealants.
   d. C1193, Standard Guide for Use of Joint Sealants.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Surface preparation instructions. Indicate where each product is proposed to be used.
2. Samples: Material proposed for use showing color selected from manufacturers standards or custom color to match precast coping cap.

B. Informational Submittals:

1. Installation instructions.
2. Documentation showing applicator qualifications.
3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
4. Special guarantee.

1.03 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum of 5 years’ experience installing sealants in projects of similar scope.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Ambient Temperature: Between 40 degrees F and 80 degrees F (4 degrees C and 27 degrees C) when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

1.05 SPECIAL GUARANTEE

A. Product: 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 section found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

B. Conditions: No adhesive or cohesive failure of sealant.

C. Sealed Joints: Watertight and weathertight with normal usage.

PART 2 PRODUCTS

2.01 SEALANT MATERIALS

A. Characteristics:

1. Uniform, homogeneous.
2. Free from lumps, skins, and coarse particles when mixed.
3. Nonstaining, nonbleeding.
4. Hardness of 15 minimum and 50 maximum, measured by ASTM C661 method.
5. Immersible may be substituted for nonimmersible.

B. Color: Unless specifically noted, match color of the principal material or material adjoining area of application. Custom color may be required for the material adjacent to the precast coping cap.

C. Type 1—Silicone, Nonsag, Nonimmersible:

1. Silicone base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Capable of withstanding movement up to 50 percent of joint width.
3. Manufacturers and Products:
   a. Dow Corning Corp.; No. 790.
   b. General Electric; Silpruf.
   c. BASF; Sonneborn, Omniseal-50.

D. Type 2—Multipart Polyurethane, Self-leveling, Immersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
   a. BASF; Sonneborn, SL-2.
   b. Pecora Corp.; Urexspan NR-200.
   c. Tremco; THC-900/901.
   d. Sika Chemical Corp.; Sikaflex 2c SL.

E. Type 3—Multipart Polyurethane, Nonsag, Immersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products:
   a. Pecora; DynaTrol II.
   b. Tremco; Dymeric 240.
   c. BASF; Sonneborn NP-2.
   d. Sika Chemical Corp.; Sikaflex 2c NS.

F. Type 4—Multipart Polyurethane, Nonsag, Nonimmersible:

1. Polyurethane base, multicomponent, chemical curing; ASTM C920, Type M, Grade NS, Class 25.
2. Manufacturers and Products:
   a. BASF; Sonneborn NP-2.
   b. Pecora Corp.; Dynatrol II.
   c. Tremco; Dymeric 240.
   d. Sika Chemical Corp.; Sikaflex 2c NS.

G. Type 5—One-part Polyurethane, Immersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS or P, Class 25.
2. Capable of being continuously immersed in water.
3. Manufacturers and Products for Nonsag:
   a. Sika Chemical Corp.; Sikaflex-1a.
   b. Tremco; Vulkem 116.
4. Manufacturers and Products for Self-leveling:
   a. BASF; MasterSeal, SL-1.
   b. Tremco; Vulkem 45.
   c. Sika Chemical Corp.; Sikaflex 1c SL.

H. Type 6—One-part Polyurethane, Nonimmersible:

1. Polyurethane base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 25.
2. Manufacturers and Products:
   a. Pecora Corp.; Dynatrol 1 XL.
   b. Tremco; Dymonic.
   c. BASF; Sonneborn, NP-I.

I. Type 7—Multipart Polysulfide, Immersible:

1. Polysulfide base, two-component, chemical curing; ASTM C920, Type M, Grade P or NS, Class 25.
2. Capable of being continuously immersed in water.
3. For use above grade and below grade.
4. Manufacturers and Products:
   a. W. R. Meadows; Deck-O-Seal Gun Grade, two-part.
   b. BASF; Sonolastic, two-part Polysulfde.

J. Type 8—One-part Polysulfide, Nonsag, Nonimmersible:

1. Polysulfide base, single-component, moisture curing; ASTM C920, Type S, Grade NS, Class 12 1/2.
2. Capable of withstanding movement up to 20 percent of joint width.
3. Manufacturer and Product: W. R. Meadows; Deck-O-Seal, one-part.

K. Type 9—One-part Acrylic Terpolymer, Nonsag, Nonimmersible:

1. Acrylic base, single-component, solvent curing; ASTM C834 nonsag.
2. Capable of withstanding movement up to 7.5 percent of joint width; Shore “A” hardness of 55 maximum.
3. Manufacturer and Product: Tremco; Mono 555.

L. Type 13—Tape Sealant:

1. Compressible polyurethane foam impregnated with polybutylene or polymer-modified asphalt.
2. Color: Black.
3. Size: 3/4 inch wide by length required by expanded thickness recommended by manufacturer for particular application.
4. Manufacturers and Products:
   a. Emseal Joint Systems, Ltd.; AST—High Acrylic.
   b. Dayton Superior; Polytite Standard.
   c. PARR Technologies; PARR Sealant EP-7212-T.

2.02 BACKUP MATERIAL

A. Nongassing, extruded, closed-cell round polyurethane foam or polyethylene foam rod, compatible with sealant used, and as recommended by sealant manufacturer.

B. Size: As shown or as recommended by sealant material manufacturer. Provide for joints greater than 3/16 inch wide.

C. Manufacturers and Products:

1. BASF; Sonneborn, Sonolastic Closed-cell Backing Rod.
2. Tremco; Closed-cell Backing Rod.
3. Pecora Corporation; Green Rod.

2.03 ANCILLARY MATERIALS

A. Bond Breaker: Pressure sensitive tape as recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Primer: Nonstaining type recommended by sealant manufacturer to suit application.

2.04 PREFORMED SEALS

A. Preformed Compressible Joint Seals:

1. Widths Up to 5 Inches:
   a. BASF, Watson Bowman Acme Div.; Wabo Weatherseal II.
   b. Emseal Joint Systems Limited; Colorseal.
   c. LymTal International; Iso-flex Joint System.
2. Other Widths: Series or model recommended by seal manufacturer.

PART 3 EXECUTION

3.01 GENERAL

A. Use of more than one material for the same joint is not allowed unless approved by sealant manufacturer.

B. Install joint sealants in accordance with ASTM C1193.

C. Horizontal and Sloping Joints up to 1 Percent Maximum Slope: Use self-leveling (Grade P) joint sealant.

D. Steeper Sloped Joints, Vertical Joints, and Overhead Joints: Use nonsag (Grade NS) joint sealant.

E. Use joint sealant as required for the applicable application and as follows:

Joint Size	Sealant Type
Less than 1"	1, 2, 3, 4, 5, 6, 7, 8,or 9
Less than 2"	1, 2, 3, 4, or 7
Over 2"	Follow manufacturer’s recommendation

3.02 PREPARATION

A. Verify that joint dimensions, and physical and environmental conditions, are acceptable to receive sealant.

B. Surfaces to be sealed shall be clean, dry, sound, and free of dust, loose mortar, oil, and other foreign materials.

1. Mask adjacent surfaces where necessary to maintain neat edge.
2. Starting of work will be construed as acceptance of subsurfaces.
3. Apply primer to dry surfaces as recommended by sealant manufacturer.

C. Verify joint shaping materials and release tapes are compatible with sealant.

D. Examine joint dimensions and size materials to achieve required width/depth ratios.

E. Follow manufacturer’s instructions for mixing multi-component products.

3.03 INSTALLATION

A. Use joint filler to achieve required joint depths, to allow sealants to perform intended function.

1. Install backup material as recommended by sealant manufacturer.
2. Where possible, provide full length sections without splices; minimize number of splices.
3. Tape sealant may be used as joint filler if approved by sealant manufacturer.

B. Use bond breaker where recommended by sealant manufacturer.

C. Seal joints around window, door and louver frames, expansion joints, control joints, and elsewhere as indicated.

D. Joint Sealant Materials: Follow manufacturer's recommendation and instructions, filling joint completely from back to top, without voids.

E. Joints: Tool slightly concave after sealant is installed.

1. When tooling white or light color sealant, use a water wet tool.
2. Finish joints free of air pockets, foreign embedded matter, ridges, and sags.

F. Tape Sealant: Compress to 50 percent of expanded thickness and install in accordance with manufacturer's instructions.

3.04 PREFORMED SEALS

A. Prepare joint surfaces clean and dry, free from oil, rust, laitance, and other foreign material.

B. Construct joints straight and parallel to each other and at proper width and depth.

C. Apply joint sealant manufacturer's approved primer and adhesive in accordance with manufacturer's instructions.

D. Install seal in accordance with manufacturer's instructions.

3.05 CLEANING

A. Clean surfaces next to the sealed joints of smears or other soiling resultant of sealing application.

B. Replace damaged surfaces resulting from joint sealing or cleaning activities.

3.06 JOINT SEALANT SCHEDULE

A. This schedule lists the sealant types acceptable for each joint location. Use as few different sealant types as possible to meet the requirements of Project.

Joint Locations	Sealant Type(s)
Expansion/Contraction and Control Joints At:	
Concrete Walls (except water-holding and belowgrade portions of structures)	1, 3, 4, 5, 6
Concrete Floor Slabs (except for water-holding Structures)	2, 5
Concrete Walls and Slabs immersed in water and/or below grade	7
Slabs Subject to Vehicle and Pedestrian Traffic	2, 5
Masonry Walls	1, 3, 4, 5, 6, 7, 13
Precast Concrete Wall Panels	3, 4, 5, 12, 13
Material Joints At:	
Metal Door, Window, and Louver Frames (Exterior)	1, 5, 6, 8
Metal Door, Window, and Louver Frames (Interior)	1, 5, 6, 8, 9
Wall Penetrations (Exterior)	1, 5, 6, 8
Wall Penetrations (Interior)	1, 5, 6, 8
Floor Penetrations	5, 6, 7
Ceiling Penetrations	1, 3, 4, 5, 6, 7
Roof Penetrations	5
Sheet Metal Flashings	5
Precast Copping	5
Precast Concrete	1, 3, 4, 5, 6, 7
Other Joints:	
Threshold Sealant Bed	5

END OF SECTION

SECTION 08 11 16
ALUMINUM DOORS AND FRAMES

PART 1 GENERAL

1.01 REFERENCES

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

1. The Aluminum Association, Incorporated (AA): Designation System for Aluminum Finishes.
2. American Architectural Manufacturers Association (AAMA): 605.2, Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
3. ASTM International (ASTM): B209/B209M, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

1.02 SUBMITTALS

A. Action Submittals:

1. Applicable information for each type of door and frame, including:
   a. Frame conditions and complete anchorage details, supplemented by suitable schedules covering doors and frames.
   b. Glass and louver opening sizes and locations in doors.
   c. Connections of door frames to structural steel framing concealed in frames.
   d. Location and field splice joints for frames too large to ship in one piece; indicate complete instructions for making field splices.
   e. Joints required to accommodate expansion joint movement.
   f. Relate to door numbers used in Contract Drawings.

B. Informational Submittals: Third party testing documentation or manufacturer’s literature qualifying door assembly as meeting required developed wind pressures for Project as shown on the Components and Cladding Wind Surface Pressures table on the Structural Drawings.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Properly identify each item with number used in Contract Drawings.

B. Store doors upright, in protected dry area, at least 1 inch off ground or floor and at least 1/4 inch between individual pieces.

1.04 DESIGN REQUIREMENTS

A. Wind Loads: Provide door assemblies and their anchorage to the wall structure that are capable of withstanding the positive and negative wind load pressures shown on the Components and Cladding Wind Surface Pressures table on the Structural Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cline Aluminum Doors, Inc., Bradenton, FL; Series 100BE.

B. United States Metals and Manufacturing Corp., South Bend, IN; D9 Series.

C. Glazing:

1. 1-inch insulating units with (2) fully tempered 1/4-inch glass.
2. Non-removable stops of extruded aluminum Alloy 6063-T5.
3. Vinyl inserts for sealing.

2.02 MATERIALS

A. Aluminum Frames:

1. Extruded from 6063-T5 aluminum alloy meeting ASTM B209.
2. Minimum Wall Thickness: 0.125 inch.
3. Mechanically fastened corners.
4. Reinforcements: 6061-T6 aluminum of 1/4-inch minimum thickness.
5. Size and Profile: 5 inches by 1-3/4 inches, with open or closed back and applied stop with integral weatherstripping.
6. Concealed fasteners or welding are preferred to through-the-face fasteners.

B. Flush Aluminum Doors: 6063-T5 extrusions and 5005-H14, smooth face sheets.

1. Minimum component thicknesses as follows:
   a. Base Sheets: 0.090 inch.
   b. Beveled Lock Rail Edge: 0.125 inch.
   c. Hinge Rail Edge: 0.190 inch.
   d. Internal Grid Sections: 0.080 inch.

2.03 MISCELLANEOUS ITEMS

A. Filler or Transom Panels: Furnish of same construction and finish as door.

B. Furnish manufacturer's standard core filler, anchors, fasteners, and other ancillary items.

C. Louvers: Manufacturer's standard in sizes as scheduled, with screens at exterior doors.

2.04 FACTORY FINISHING REQUIREMENTS

A. Aluminum Door and Frame Finish: Clear anodized AA MA2C22A41.

PART 3 EXECUTION

3.01 INSTALLATION

A. Frames:

1. Installation: Maintain scheduled dimensions, hold head level, and maintain jambs plumb and square.
2. Secure anchorages and connections to adjacent construction.
3. Wherever possible, leave frame spreader bars intact until frames are set perfectly square and plumb and anchors are securely attached.
4. Install following manufacturer's recommendations.

B. Doors:

1. Follow manufacturer's recommendations.
2. Hardware: In accordance with manufacturer's templates and instructions.
   a. Adjust operable parts for correct function.
   b. Remove hardware, with exception of prime coated items, tag, box, and reinstall after finish paint work is completed.

3.02 PROTECTION

A. Protect installed doors and frames against damage from other construction work.

3.03 SCHEDULES

A. For tabulation of door and frame characteristics, such as size, type, detail, and finish hardware requirements, see Door and Hardware Schedule on the Drawings.

END OF SECTION

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   b. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. Intertek Testing Services (Warnock Hersey Listed) (WH): Certification Listings.
3. National Association of Metal Manufacturers (NAAMM).
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   c. MG 1, Motors and Generators.
5. National Fire Protection Association (NFPA):
   a. 80, Standard for Fire Doors and Other Opening Protectives.
   b. 252, Standard Methods of Fire Tests of Door Assemblies.
6. UL:
   a. Building Materials Directory.
   b. 10B, Standard Safety for Fire Tests of Door Assemblies.
   c. 325, Standard Safety for Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
2. Product Data: General construction, component connections and details, wiring diagram and electrical equipment.
3. Samples: Submit two door slats, 12-inch by 12-inch (300 by 300 mm) in size illustrating shape, color and finish texture.

B. Informational Submittals:

1. Certificate of Compliance per Section 01 43 33, Manufacturer's Field Services (or alternately, test results or calculations) that assure item's and its anchorage's design criteria meets requirements of Section 01 88 15, Anchorage and Bracing for loads provided in Section 01 61 00, Common Product Requirements.
2. Third party testing documentation or manufacturer's literature qualifying door model as meeting required developed wind pressures. Miami-Dade Notice of Approval (NOA) documentation is acceptable as third party evidence of certification.
3. Manufacturer's Instructions: Indicate installation sequence and procedures, and adjustment and alignment procedures.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data, include lubrication requirements and frequency, and periodic adjustments required.
5. Seismic Anchorage and Bracing:
   a. Drawings and product data as required by Section 01 88 15, Anchorage and Bracing.
   b. Calculations as required by Section 01 88 15, Anchorage and Bracing.
   c. Installer's factory authorization.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 3 years' experience.
2. Installer: Company specializing in performing work of this section approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Cookson Co.; Thermiser insulated Roll Up Door.
2. Overhead Door Co.; Insulated WindStorm model 423.

2.02 GENERAL

A. Wind Loads: Design door assembly to withstand wind/suction load matching the structural drawings, with maximum deflection of 1/120, and without damage to door or assembly components.

B. Operation: Design door assembly including operator, to operate for not less than10,000 cycles.

C. Products Requiring Electrical Connection: Listed and classified by UL or another testing firm acceptable to authority having jurisdiction.

D. Surface Burning Characteristics, Foam Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

2.03 COMPONENTS

A. Curtain: Conform to following:

1. Steel Slats:
   a. Interlocking, minimum 24 gauge (0.75 mm) thick of ASTM A653/A653M steel, minimum galvanized coating designation G60 (Z275) in accordance with ASTM A653/A653M.
   b. Type: Single thickness Sandwich slat construction with manufacturer's standard insulated core with maximum U-value of 0.16 and backing to match face slat, thermally separated from face slat.
   c. Color: Factory-applied fluoropolymer coating as selected from manufacturers premium color options.
2. Nominal Slat Size: 2 inches wide by required length.
3. Slat Ends: Each slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
4. Curtain Bottom: Fitted with angles, channels, or tubes to provide reinforcement and positive contact with floor in closed position.

B. Guides:

1. Minimum 3/16 inch (5 mm) thick; galvanized steel conforming to ASTM A653/A653M, minimum galvanized coating designation G60 (Z275) in accordance with ASTM A653/A653M.
2. Furnish continuous angles of profile to retain door in place, mounting brackets of same metal.

C. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension.

D. Hood Enclosure Square shape, minimum 24 gauge (0.75 mm) thick.

E. Hardware:

1. Locks: Furnish locks to allow **[B: doors] [C: shutters]** to be secured.
   a. Electric Doors: Manufacturer's standard cylinder locking system to secure door; interlock with motor to prevent motor from operating when lock is activated.
2. Cylinders: Minimum six-pin cylinders Furnished under Section 08 71 00, Door Hardware installed as part of Work of this section.
3. Handle: Inside center mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position; interior and exterior handle.
4. Weatherstripping (Exterior Assemblies): Moisture and rot proof, resilient type for complete weathertight installation.
   a. Rubber, neoprene, or vinyl water seal at hood to prevent airflow around coil on exterior doors.
      Weather seal sealing strip on guide to close space between guide and curtain on exterior doors.

F. Electric Operation:

1. Electric motor operated unit with manual override in case of power failure.
2. UL 325, side mounted, totally enclosed, nonventilated or fan-cooled motor.
3. Motor Enclosure: NEMA MG1 Type 4 enclosure.
4. Motor Rating: Continuous duty.
5. Motor Voltage: 230/460 volts three-phase, 60 Hz.
6. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
7. Controller Enclosure: NEMA 250 Type 4.
8. Door Speed: 12 inches per second (300 mm/s).
9. Brake: Adjustable friction clutch type, activated by motor controller.
10. Control Station: Standard three button (Open-Stop-Close)momentary control for each operator, 24-volt circuit, surface mounted.
11. Safety Edge: Manufacturer's standard safety edge and weatherseal located at door bottom, full width, sensitized type, wired to reverse upon striking object.

2.04 FINISHES

A. Curtain Slats: Steel, galvanized with A60 zinc coating in accordance with ASTM A653/A653M, prefinished with shop applied fluoropolymer.

B. Steel Guides and Hood Enclosure: Galvanized with A60 zinc coating in accordance with ASTM A653/A653M, prefinished with shop applied fluoropolymer.

2.05 SOURCE QUALITY CONTROL

A. Attach label from agency approved by authority having jurisdiction to identify each fire rated door.

1. Oversize Door Certification: Provide UL Certificate of Inspection or comparable certification acceptable to authorities having jurisdiction, in lieu of label for oversize door assemblies exceeding 120 square feet (11.15 square m) or 24 feet (7.3 m) in any dimension.

B. Apply label from agency approved by authority having jurisdiction to identify each foam plastic insulation board.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

B. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

C. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

D. Complete wiring from disconnect to unit components and from fire alarm system to door operator.

E. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 92 00, Joint Sealants.

F. Install perimeter trim and closures.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent Work.

B. Maximum Variation from Plumb: 1/16 inch.

C. Maximum Variation from Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft (3 mm per 3 m) straight edge.

3.04 ADJUSTING

A. Adjust door, hardware and operating assemblies for smooth and noiseless operation.

B. Test smoke activated assemblies for proper activation.

3.05 CLEANING

A. Leave door and components clean.

B. Remove labels and visible markings.

3.06 SCHEDULE

A. Reference Specification Section 08 71 00, Door Hardware and door and hardware schedule on Drawings for additional information.

END OF SECTION

SECTION 08 45 00
TRANSLUCENT ROOF ASSEMBLIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Architectural Manufacturers Association (AAMA):
   a. 2604, Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions & Panels.
   b. 1503, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections.
2. ASTM International (ASTM):
   a. C297/C297M, Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions.
   b. D572, Standard Test Method for Rubber-Deterioration by Heat and Oxygen.
   c. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   d. D1002, Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal).
   e. D1037, Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
   f. D2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
   g. D3163, Standard Test Method for Determining Strength of Adhesively Bonded Rigid Plastic Lap-Shear Joints in Shear by Tension Loading.
   h. D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
   i. E72, Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
   j. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   k. E283, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

l. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.
m. E1105, Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference.

3. International Code Council (ICC): AC 04, Acceptance Criteria for Sandwich Panels.
4. International Code Council – Evaluation Services (ICC-ES)
5. Military Specifications (MIL): DOD-P-15328D, Primer (Wash) Pretreatment (Formula #117 for Metals).
6. National Fenestration Rating Council (NFRC): 100, Procedure for Determining Fenestration Product U-Factors.
7. Underwriters Laboratories, Inc. (UL): UL 972, Standard for Burglary Resisting Glazing Material.

1.02 DESIGN REQUIREMENTS

A. Design translucent panel system to accommodate expansion and contraction within system components caused by a cycling temperature range of plus 100 degrees F to 0 degree F without causing detrimental effects to system or components.

B. Design and size members to withstand dead loads and live loads caused by snow, hail, and pressure and suction of wind acting perpendicular to panel system as calculated in accordance with applicable building codes and specified design criteria.

C. System shall accommodate, without damage to system or components or deterioration of perimeter seal(s):

1. Movement within system; movement between system and perimeter framing components; dynamic loading and release of loads; and deflection of structural support framing.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
a. Plans, elevations including gridlines in each panel, sections, details, and attachment to other work.

b. Anchorage and bracing drawings and/or catalog information, as required by Section 01 88 15, Anchorage and Bracing, for loads provided in Section 01 61 00, Common Product Requirements.

2. Samples:
   a. Assembled panel at least 14 inches by 24 inches, with specified translucent facings and selected extrusion finishes. Include full size pieces showing joinery, anchorage, expansion provisions, and flashing.
   b. Aluminum extrusions finished with scheduled or specified colors for finish selection.

B. Informational Submittals:

1. Structural analysis data, including loads transmitted to building structural frame as required by design, prepared and sealed by a qualified professional engineer.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing, for loads provided in Section 01 61 00, Common Product Requirements. Submit with Action Submittal for the same item.
3. ICC-ES Evaluation Report for specific system proposed.
4. Manufacturer’s written approval of installer.
5. Product Test Reports: Certified test reports performed by independent testing organizations qualified per ASTM E699 for each type and class of panel system. Reports shall verify material will meet performance requirements of this Specification. Previously completed test reports shall be acceptable if current and indicative of products used on this Project.
   a. Test reports required are:
      1) Flame Spread and Smoke Development (ASTM E84).
      2) Burn Extent (ASTM D635).
      3) Color Difference (ASTM D2244).
      4) Impact Strength (Falling Ball Method).
      5) Adhesive Bond Strength (ASTM C297 and ASTM D1002).
      6) Accelerated Aging (ASTM D1037).
      7) Lap shear test (ASTM D3163).
      8) Tensile Strength (ASTM C297/C297M modified).
      9) Abrasion/Erosion Resistance (ASTM D4060).
      10) Beam Bending Strength (ASTM E72).
      11) Assembly U-Factor (NFRC 100).
      12) Condensation Resistance Factor (AAMA 1503).
      13) Air Leakage (ASTM E283).

6. Maintenance Data: Cleaning and refinishing instructions and recommended products.
7. Qualifications: Translucent panel manufacturer and panel erector shall show, upon request, proof of their ability to perform the Work.
8. Sample guarantee.

1.04 QUALITY ASSURANCE

A. Panel System Manufacturer: Listed by International Code Council as compliant with ICC AC04 Sandwich Panels. Current ICC-ES Evaluation Report for specific system shall affirm system can be installed in compliance with International Building Code.

B. Installer: Provide panel manufacturer's letter of approval stating that the installer is approved for the installation of named manufacturer's product(s).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store translucent panels on long edge, several inches above ground, blocked and under cover to prevent warping.

B. Ship units assembled and ready for erection.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of 20 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

B. Conditions:

1. Leakage of water to interior.
2. Structural failures including system deflection exceeding L/100 at midpoint of clear span.
3. Deterioration of metal finishes beyond normal weathering, including checking, crazing, peeling, chalking or fading.
4. Deterioration of exterior skins from windblown abrasives.
5. Delamination of coating from face sheet.
6. Delamination of panel sheets from panel structural cores.
7. Discoloration of exterior face of more than 3.0 Delta E Adams Units according to ASTM D2244.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials and products specified in this section shall be products of:

1. Kalwall Corp., Manchester, NH.
2. Major Industries, Wausau, WI.

2.02 MATERIALS

A. Translucent Fiberglass Face Sheets:

1. Strength: Exterior face sheet shall be uniform in strength and repel impact equal to 60 foot-pounds without fracture or tear.
2. Interior flamespread rating no greater than 50 and smoke developed no greater than 250, when tested in accordance with ASTM E84. Burn extent by ASTM D635 shall be no greater than 1 inch.
3. Exterior: Crystal, 0.070 inch thick.
4. Interior: White, 0.045 inch thick.
5. Free of ridges and wrinkles, which prevent proper surface contact in bonding to aluminum grid core. Clusters of air bubbles/pinholes that collect moisture and dirt will not be acceptable.
6. Exterior Face:
   a. Shall not change color more than 3.0 units (DELTA-E by ASTM D2244) after 5 years' outdoor weathering South Florida at 5 degrees facing south, determined by average of at least three white samples.
   b. Shall have permanent glass veil erosion barrier and high performance thermoset acrylic protective surface (minimum thickness 1.2 mils) for maximum resistance to erosion and weather, applied in factory under controlled temperature conditions. Plastic overlay films are not acceptable. This coating shall be fully field refinishable if damaged.
7. Uniform in color.

B. Grid Core: Noncombustible aluminum I-beams, thermally broken at flat panels, 6063-T6, mechanical interlocking of muntin-mullion and perimeter, 7/16 inch width.

C. Adhesive:

1. Heat and pressure resin type.
2. ICBO approved for use in sandwich panel construction.

3. Minimum Strength:
    a. Tensile:
        1) After two exposures to six cycles each of aging conditions in accordance with ASTM D1037:
            a) 750 psi by ASTM C297/C297M.
    b. Shear:
        1) After five separate aging conditions in accordance with ASTM D1002:
            a) 50 Percent Relative Humidity at 73 Degrees F: 540 psi.
            b) 182 Degrees F: 100 psi.
            c) Accelerated Aging by ASTM D1037 at Room Temperature: 800 psi.
            d) Accelerated Aging by ASTM D1037 at 182 Degrees F: 250 psi.
            e) 500-hour Oxygen Bomb by ASTM D572: 1,400 psi.

D. Battens and Perimeter Closure Systems:

1. Thermally Broke Battens and Closures: Extruded 6063-T6 and 6063-T5 aluminum screw clamp-tite closure system using 2-inch battens.
2. Fasteners: Stainless steel screws.

E. Flexible Sealing Tape: Manufacturer’s standard; preapplied to closure system at factory under controlled conditions.

F. Corrosion-Resistant Finish: Fluoropolymer fortified thermoset acrylic/urethane system that meets performance requirements of AAMA 2604.

1. Uniform in appearance.
2. Factory Applied Under Controlled Conditions:
    a. Aluminum wash-primed in accordance with MIL DOD-P-15328D.
    b. Even over entire exposed aluminum surface.
    c. Minimum Dry Thickness: 2 mils (0.002 inch).
3. Remain adhered to aluminum substrate with no blistering or peeling.
4. Color change shall be no greater than 3 DELTA-E Adams Units after 10 years’ outdoor exposure at 5 degrees from vertical, facing south in South Florida.
5. Resistant to most chemicals including acids, alkalies, gases, salt solutions, and water.
6. Color as selected from manufacturer’s standard color range.

2.03 ROOF PANEL FABRICATION

A. Translucent Roof Panels (TRP): True structural composite flat sandwich panels of face sheets bonded to thermally broken grid core of mechanically interlocking aluminum I-beams. Laminate faces to grid under controlled process of heat and pressure. Tape bond systems are not allowed.

1. Uniform Thickness: 2-3/4 inches.
2. “U” Value: 0.29.
3. Light Transmission: 20 percent.
4. Shading Coefficient: 0.27.

B. Grid Pattern: Nominal 12 inches by 24 inches flat panels.

C. Design: Self-supporting Pyramid with 45-degree standard slope as shown on Drawings.

1. Loadings: Support (a) Dead load of roof panels to meet wind loading shown on structural Drawings.
2. Deflection Limits:
   a. 1.9 inches at 30 pounds per square foot for 10-foot clear span.
   b. 0.10-inch set deflection 5 minutes after load release when tested in conformance with ASTM E72.

D. Size: Outside curb dimensions 5 feet -0 inch by 5 feet-0 inches.

E. Assemble and seal panels at factory when practical for shipment.

F. Include lifting eyes as an integral part of panel frame.

PART 3 EXECUTION

3.01 PREPARATION

A. Prepare openings, including isolating aluminum system, from dissimilar materials that may cause damage by electrolysis.

3.02 ERECTION

A. Erect insulated translucent panel systems in strict accordance with manufacturer’s instructions. Fasten and seal in strict accordance with manufacturer’s shop drawings. Clean aluminum before applying sealants.

B. After other trades have completed work on adjacent material, carefully inspect translucent panel unit installation, ensure no shifting or rattling, and make adjustments necessary to ensure proper installation and weathertight conditions.

3.03 CLEANING

A. Leave translucent panels in undamaged condition and ready for final cleaning.

B. Clean both faces of panels in accordance with manufacturer’s instructions.

3.04 PROTECTION OF COMPLETED WORK

A. Install marker tape across panels secured to frames or structure. No tape or marking allowed on panels after final cleaning.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.01 REFERENCES

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

1. Builders Hardware Manufacturer's Association (BHMA):
   a. A156.1, Butts and Hinges.
   b. A156.3, Exit Devices.
   c. A156.4, Door Controls - Closers.
   d. A156.13, Mortise Locks & Latches.
   e. A156.16, Auxiliary Hardware.
   f. A156.18, Materials and Finishes.
2. International Code Council (ICC): A117.1, Accessible and Usable Buildings and Facilities.
3. Underwriters Laboratories, Inc. (UL): Fire Protection Equipment List.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Manufacturer's literature for each item of finish hardware required herein, clearly marked.
   b. Finish Hardware Schedule: Furnish complete and detailed schedule, show product items, numbers, and finishes for hardware for each separate opening.
   c. Special Tools: Provide listing and description of usage.

B. Informational Submittals:

1. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
2. Manufacturer's Field Service Report.
3. Certification of Hardware Consultant.
4. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

1.03 QUALITY ASSURANCE

A. Qualifications of Supplier: Recognized supplier of architectural finish hardware, with warehousing facilities, who has been furnishing hardware in vicinity of Project for not less than 5 years, and who is, or who employs, architectural hardware consultant.

B. Qualifications of Architectural Hardware Consultant (AHC): Certified by Door and Hardware Institute.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Before delivery, clearly identify and tag each item of hardware with respect to specified description and location of installation.

B. Provide secure storage for finish hardware until installation is made.

1.05 EXTRA MATERIALS

A. Special Tools: Two sets for installation and maintenance of hardware.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide end products of one manufacturer for each product in order to achieve standardization for appearance, maintenance, and replacement.

B. Finishes: BHMA A156.18.

2.02 FASTENERS

A. Stainless steel.

2.03 BUTT HINGES

A. BHMA A156.1.

B. Quantity per Door Leaf (Minimum):

Door Height	Hinges
Up to 5'-0"	1 pair
5'-1" to 7'-7"	1-1/2 pair
7'-8" to 10'-0"	2 pairs
10'-1" to 12'-6"	2-1/2 pairs

C. Hinge Height (Minimum):

Door Width	Hinge Height
Up to 3'-0"	4-1/2"
3'-1" to 4'-0"	5"
Over 4'-0"	6"

D. Width: Minimum for clearance of trim and 180-degree swing.

E. Exterior Hinges: Nonremoveable pin.

F. Joint Tolerance: 0.012 inch maximum, gauged in CLOSED position.

G. Finish: Satin stainless steel No. 630.

H. Types and Manufacturers:

No.	Type Description	McKinney
H1	Heavy Weight Five Knuckle , stainless steel	MPB99 x NRP 4-1/2" x 4-1/2" US32D

2.04 LOCKS AND LATCH SETS

A. Mortise Locks: BHMA A156.13, Series 1000, Grade 1.

1. Materials: Brass or stainless steel.
2. Trim: Wrought or forged lever handles and roses.
3. Core Cylinders: Interchangeable, removable; minimum of six pins.
4. Bolt Throw: 5/8 inch minimum.
5. Lever Backset: 2-3/4 inches.
6. Manufacturers and Products:
   a. Corbin Russwin; LWM.
   b. Sargent; LSJ.
   c. Schlage; 03.
   d. Best 40H.

B. Tactile Warning: Knurl knob backs and lever handles for touch identification; ICC A117.1, Section 4.29.3.

C. Finish: Satin stainless steel No. 630.

D. Locks and Latches: Match existing in manufacturer, design, finish, and keying

E. Types and Manufacturers:

No.	Type Description	Best	Sargent	Schlage	BHMA
L1	Lock by exit device manufacturer; furnish cylinders for keying to other locks as required				
L2	Lock by roll up coiling door manufacturer; furnish cylinders for keying to other locks as required				

F. Keying:

1. Lock Cylinders: Operate by master key system that allows for future expansion.
2. Keylocks: Key new locks into existing BEST master key system.
3. Keys: Two per lock; tag with schedule information.
4. Master Keys: Four; send by registered mail to Owner.

2.05 CONSTRUCTION KEY SYSTEM

A. Removable construction core system for locks.

B. See Article Manufacturer's Services under Part 3, Execution.

2.06 CONSTRUCTION KEY SYSTEM

A. Assemble permanent cylinders with construction inserts and ship with all lock sets.

B. Change Keys: Pack in separately identified envelopes and ship.

C. Construction Keys: Pack in cartons marked "packing list" and ship.

D. On completion of job, deliver construction keys to Owner.

2.07 EXIT DEVICES

A. BHMA A156.3.

B. Trim:

1. Levers: Sargent ETJ; Corbin Russwin L9M.

C. Finish:

1. Exit Device: Satin chromium-plated No. 626.

D. Types and Manufacturers:

No.	Type Description	Sargent
EX1	Wide Stile Surface Vertical Rod Exit Device with Exterior Trim for Active Leif.	HC-PE8713 x WEx US32D
EX2	Wide Stile mortise lock exit device	PE8900 x WEx

2.08 CLOSERS

A. BHMA A156.4.

B. Size closers in accordance with manufacturer's standards. Mount regular arm closers on pull side of doors. Mount parallel arm closers on push side of doors. On pair of doors provide closer on active leaf only, unless noted otherwise.

C. Finish: Satin chromium-plated No. 626.

D. Types and Manufacturers:

No.	Type Description	Sargent
C1	Heavy Duty Parallel Arm with Compression Stop	351 CPS EN

2.09 BOLTS

A. BHMA A156.16.

B. Finish: Bright nickel US26D.

C. Types and Manufacturers:

No.	Type Description	Sargent
B1	Top and Bottom Flush Bolts	988 Surface Bolts

2.10 THRESHOLDS

A. Thresholds: One-piece full width of opening; extend beyond jamb where indicated.

B. Provide with stainless steel machine screws in threaded expansion anchors at concrete.

C. Finish: Mill finish aluminum, unless indicated otherwise.

D. Types and Manufacturers:

No.	Type Description	Pemco
T1	Saddle Threshold	170A 76"
T2	Saddle Threshold	170A 36"

2.11 WEATHERSTRIP

A. Finish: Clear anodized aluminum, unless indicated otherwise.

B. Seal Types and Manufacturers.

No.	Type Description	
W1	Weatherstripping furnished by door manufacturer	Wool Pile Weather Strip PVC Bulbs at door head, and meeting stiles of pairs

C. Door Sweep Types and Manufacturer Types and Manufacturers:

No.	Type Description	Pemco
R1	Door Sweep	345AV x 40"
R2	Door Sweep	345AV x 84"

D. Overlapping Astragals Types and Manufacturers:

No.	Type Description	Pemco
A1	Astragals	355CV 80"

2.12 MISCELLANEOUS ITEMS

A. Provide as indicated in Door and Hardware Schedule:

No.	Type Description	Notes
M1	Nameplate as specified in Section 10 14 00, Signage	Text noted in Door and Hardware Schedule
M2	Cylinder	Sargent Verify Existing Keyway
M3	Tactile Egress Sign as specified in Section 10 14 00, Signage	Location noted on door and hardware schedule.

2.13 SILENCERS

A. At metal frame of each hinged door that does not have seals scheduled.

B. Three at single leaves and two at pairs.

C. Silencer Types and Manufacturers:

No.	Type Description	Rockwood
S1	608-RKW	2842 US26D

2.14 TEMPLATES

A. Fabricate to template hardware applied to metal doors and frames.

B. Ensure that required templates are furnished to various manufacturers for fabrication purposes.

C. Templates: Make available not more than 10 days after receipt of approved Hardware Schedule.

2.15 EXIT DOORS

A. Exit Doors: Always openable from inside by simple turn of lever handle or push on panic bar without use of key or any special knowledge or effort, to include each leaf of door pairs.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Make Work neat and secure, develop full strength of components, and provide proper function.

C. Prevent marring, scratching, or otherwise damaging adjacent finishes during hardware installation.

D. Latchbolts:

1. Install to engage in strikes automatically, whether activated by closers or manually.
2. In no case shall additional manual pressure be required to engage latchbolt in strike.

E. Stops and Holders: Set to allow doors to open as far as possible.

F. Wall Mounted Hardware: Install over solid structural backing or solid blocking in hollow walls.

G. Thresholds:

1. Cope ends neatly to profile of jamb.
2. Set in sealant and seal ends to jambs.

H. Key Control System Cabinet: Install where shown.

I. Hardware: Adjust for easy, noise-free operation.

J. Replace damaged hardware items.

3.02 MOUNTING DIMENSIONS

A. Standard Door Hardware Locations: As recommended and published by Door and Hardware Institute, except as noted or detailed otherwise.

B. Door Silencers: Install 3 inches from top and bottom of jamb and 1 inch above strike at single doors, and 3 inches from edges of doors in head for pairs of doors.

C. Nameplates: Attach to doors or walls adjacent to doors 5 feet 6 inches above floor using self-sticking removable adhesive.

3.03 MANUFACTURER'S SERVICES

A. Deliver permanent lock cores to Site.

B. Remove temporary construction cores and insert permanent cores.

C. Inspect each lock set to ensure permanent cores are operating satisfactorily.

D. Deliver to Owner change and control keys for permanent system.

E. Return temporary construction cores to manufacturer.

F. Furnish manufacturer's representative for the following services at Site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:

1. One person-day for installation assistance, inspection, and Manufacturer's Certificate of Proper Installation.
2. One person-day for functional testing.

3.04 PROTECTION

A. Cover and protect exposed surfaces of hardware during installation and until Substantial Completion.

B. Fit, dismantle, and reinstall finish hardware as required for finish painting work.

C. Protect and prevent staining of hardware during construction in accordance with manufacturer's recommendations.

D. Remove protective measures and permanent lock cylinders installed prior to final cleaning.

3.05 DOOR AND HARDWARE SCHEDULE

A. Door and Hardware Schedule Drawings, Door and Hardware Schedule, is guide to functional requirements of each opening.

B. Provide finish hardware as scheduled. Sizes omitted shall be as recommended by manufacturer.

3.06 HARDWARE SETS

HW1:	**Item**	**Type**
Door	8EA Hinge	H1
35101A	1 SET Flush Bolt	B1
	1 EA Mortise Exit Device	EX1
	1 EA Cylinder	M2
	2 EA Surface Closer	C1
	1 EA Threshold	T1
	1 EA Gasketing	W1
	2 EA Door Sweep	R2
	1 EA Astragal	A1
	1 EA Tactile Egress Sign	M3

HW-2:	Item	Type
Doors	3 EA Hinge	H1
35100A	1 EA Mortise Exit Device	EX1
35100B	1 EA Cylinder	M2
	1 EA Surface Closer	C1
	1 EA Threshold	T2
	1 EA Gasketing	W1
	1 EA Door Sweep	R2
	1 EA Tactile Egress Sign	M3
HW-3:	**Item**	**Type**
Door	3 EA Hinge	H1
35101B	1 EA Mortise Exit Device	EX2
	1 EA Cylinder	M2
	1 EA Surface Closer	C1
	1 EA Threshold	T2
	1 EA Gasketing	W1
	1 EA Door Sweep	R2
	1 EA Tactile Egress Sign	M3
	1 EA Room Name Plate	M1
HW-4:	**Item**	**Type**
Doors	1 EA Manufacturer's dead lock	L2
35100C	1 EA Cylinder	M2
35101D		

END OF SECTION

SECTION 08 90 00
LOUVERS

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Movement and Control Association (AMCA): 500-L, Laboratory Methods of Testing Louvers for Rating.
2. The Aluminum Association, Incorporated (AA): Designation System for Aluminum Finishes.
3. ASTM International (ASTM):
   a. D1187, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
4. Underwriters Laboratories, Inc. (UL): Building Materials Directory.

1.02 DESIGN REQUIREMENTS

A. Installed Louvers: Capable of resisting developed positive and negative wind pressures (psf), based on the structural criteria shown on the design Drawings.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Large scale details of louvers, anchorage, and relationship to adjoining construction.
   a. Manufacturer’s Literature:
      1) Descriptive and performance data of louvers, including standard drawings and louver-free area.
2. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing.
3. Samples: Manufacturer’s standard finishes and colors.

B. Informational Submittals:

1. Factory test data.
2. Certificates of AMCA ratings.
3. Installation instructions.
4. Maintenance procedures.
5. Special Guarantee.

1.04 SPECIAL GUARANTEE

A. Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as Special Guarantee. Special Guarantee shall provide for correction, or at option of Owner, removal and replacement of special fluorocarbon or baked-on finish found defective during a period of 20 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. Louvers: Rated and tested in accordance with AMCA 500-L.

B. Louver sizes are based on 50 percent free area and 800 fpm maximum velocity through free area. If louvers furnished do not meet these parameters, Contractor is responsible for resizing louvers and wall openings, and for making other adjustments to allow for larger openings.

2.02 FIXED STORMPROOF LOUVERS (TYPE SP)

A. Frame: Extruded aluminum channel, 0.081 inch thick, 5 inches deep, with concealed mullions.

B. Blades: Extruded aluminum, 0.081 inch thick, Z-shaped, 35-degree to 45-degree pitch angle, spaced 2 inches to 4.25 inches on center.

C. Pressure Loss: AMCA certified rating of no greater than 0.10-inch WC.

D. Sizes: As shown on Drawings.

E. Screen: Inside mounted, painted aluminum, 1/2-inch mesh.

F. Finish: Kynar 500 fluorocarbon coating.

G. Color: To be selected from manufacturers full color range.

H. Manufacturers and Products:

1. Construction Specialties; Model RSH 5700.
2. Ruskin; Model ELF-375DXH.
3. Greenheck; Model EHH-501.

2.03 SIGHTPROOF DRAINABLE LOUVER (TYPE SPL)

A. Frame: Extruded aluminum channel, 0.081 inch thick, 5 inches.

B. Blades: Extruded aluminum, chevron type, minimum 0.081 inch thick, 35-degree to 45-degree pitch angles, with integral drain gutters, spaced 2 inches to 4 inches on center.

C. Sizes: As shown on Drawings.

D. Finish: Kynar 500 fluorocarbon coating.

E. Color: To be selected from manufacturers full color range.

F. Manufacturers and Products:

1. Construction Specialties; Model B5157.
2. Ruskin; Model – ELF520DD.
3. Greenheck; Model SED-501.

2.04 ACCESSORIES

A. Anchors and Fasteners: Stainless steel.

B. Flashings: Match louver frame.

C. Isolation Tape: Tremco 440, 3M EC1202, or Presstite 579.6.

PART 3 EXECUTION

3.01 EXAMINATION

A. Check openings to ensure dimensions conform to Drawings.

B. Ensure openings are free of irregularities that would interfere with installation.

C. Do not install louvers until defects have been corrected.

3.02 INSTALLATION

A. Install louvers as shown on reviewed Shop Drawings. Coordinate with heating or ventilation ductwork to be connected.

B. Follow procedures in manufacturer’s recommended installation instructions.

C. Install insulated blank-off panels where indicated, completely closing space between ducts and louver frames.

D. Separate aluminum from other metals with isolation tape or paint.

3.03 CLEANING

A. After erection, protect exposed portions from damage by machines, paint, lime, acid, cement, or other harmful compounds.

B. Remove protective materials and clean with plain water, water with soap, or household detergents.

END OF SECTION

SECTION 09 51 23
ACOUSTICAL TILE CEILINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A641/A641M, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   b. C635/C635M, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
   c. C636/C636M, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
   d. E1264, Standard Classification for Acoustical Ceiling Products.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detailed layout of grid indicating hanger spacing, fastening and splicing details, change in level details, and access location.
   b. Anchorage and bracing drawings and/or catalog information, as required by Section 01 88 15, Anchorage and Bracing, for loads shown on General Structural Notes on the Drawings.
2. Samples:
   a. One 12-inch square of each acoustical unit material to illustrate range of appearance.
   b. One full-size Sample of each suspension system member and molding.
   c. Mark with name of manufacturer and specific design and technical data.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing, for loads shown on General Structural Notes on the Drawings.
2. Manufacturer’s recommendation for installation of system.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials with manufacturer's labels indicating brand name, pattern, size, thickness, and fire rating.

B. Store materials in original protective packaging to prevent soiling, physical damage, or wetting.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Where acoustical materials are to be installed, maintain humidity of 65 percent to 75 percent in area for 25 hours before, during, and 25 hours after installation.

B. Maintain a uniform temperature of 55 degrees F to 70 degrees F during installation of materials.

1.05 EXTRA MATERIAL

A. Provide acoustical units from same production run as installed equal to 5 percent of area for each product.

PART 2 PRODUCTS

2.01 SUSPENSION SYSTEMS

A. Components, Materials, and Accessories: Product of a single manufacturer.

B. ASTM C635/C635M, Intermediate Duty:

1. Exposed Tee Grid: Fire-rated spaced to fit lay-in panels.
   a. Manufacturers and Products:
      1) Armstrong; Prelude.
      2) USG Corp.; Donn Brand DXL fire-rated grid.
2. Main and Cross Members:
   a. Double web design, cold-rolled steel, minimum thickness of 0.020-inch, electrozinc-coated and factory-painted low-sheen satin white finish.
   b. Exposed Flange Width: 15/16-inch.
3. Edge Molding:
   a. Minimum 0.020-inch steel, channel- or angle-shaped.
   b. Flange Width: 15/16-inch, minimum.
   c. Finish to match main members.

4. Hanger Wire: ASTM A641/A641M, minimum 12-gauge, galvanized, soft-annealed, mild steel wire.
5. Wire Ties: ASTM A641/A641M, 18-gauge, galvanized, annealed steel wire.
6. Furnish manufacturer's hold down clips and accessories required for a complete system incorporating Seismic Design Category indicated in General Structural Notes on the Drawings.

2.02 ACOUSTICAL UNITS

A. ACT 1:

1. Material: Fire-resistive mineral fiber, Class A.
2. In accordance with ASTM E1264, Type IV, Form 2.
3. Pattern: E.
4. Noise Reduction Coefficient (NRC): 0.75 or over.
5. Ceiling Attenuation Class (CAC): 35 minimum.
6. Light Reflectance: LR 0.86 or over.
7. Nominal Size: 24 inches by 24 inches.
8. Edges: Tegular.
9. Finish and Color: Water-repellent membrane, white.
10. Manufacturers and Products:
    a. Armstrong; Item 2231, Calla Health Zone.
    b. U.S.G.; Item 86684, Mars Healthcare 75/35.

PART 3 EXECUTION

3.01 SEQUENCING

A. Lay out grid.

B. Coordinate with mechanical and electrical equipment in framing and cutting material around ceiling penetrations.

C. Install suspension systems after mechanical work above is complete.

D. Install acoustical units.

3.02 INSTALLATION OF SUSPENDED GRID SYSTEM

A. Hang level and in straight alignment directly from structure following ASTM C636/C636M and manufacturer's current printed instructions.

B. Hanger Wires:

1. Space maximum 4 feet on center each direction and securely attach to structure above.
2. Install additional hangers at ends of each suspension member and at light fixtures, 6 inches from vertical surfaces.
3. Do not splay wires more than 5 inches in a 4-foot vertical drop.
4. Provide four-way wire splays at 45 degrees from main runner to support structure for every 144 square feet of ceiling area.
5. Wrap wire minimum three times horizontally, turning ends upward.
6. Where hanger wires cannot be hung vertically from structure above because of ducts, pipes, cable trays, or other interferences, provide steel channel trapezes (minimum 2-inch deep, 16-gauge cold-rolled carrying channels) hung on steel rods or 8-gauge wire from structural members above. Hang ceiling wires from these trapezes or similar members supporting ducts or pipes. Do not hang directly from ducts or pipes.
7. Follow suspension system manufacturer’s instructions for modified installation required for Seismic Design Category indicated in General Structural Notes on the Drawings.

C. Edge Molding:

1. Install at intersection of suspended ceiling and vertical surfaces.
2. Miter corners where moldings intersect or install corner caps.
3. Attach to vertical surface with mechanical fasteners.

D. Provide additional channels, hangers, and trapezes as required to support edges of ceiling around and under mechanical and electrical work.

3.03 INSTALLATION OF ACOUSTICAL UNITS

A. Upon completion of suspended grid system and other concealed work, install with pattern running in one direction.

B. Place material to bear all around on suspension members.

3.04 CLEANING

A. Clean soiled or discolored unit surfaces after installation.

B. Touchup scratches, abrasions, voids, and other defects in painted surfaces.

3.05 SCHEDULE OF CEILING TYPES

A. Areas to Receive Acoustical Ceilings: As indicated on the Reflected Ceiling Plans located on the Drawings.

END OF SECTION

SECTION 09 65 01
RESILIENT BASE

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. F1066, Standard Specification for Vinyl Composition Floor Tile.
   b. F1700, Standard Specification for Solid Vinyl Floor Tile.
   c. F1861, Standard Specification for Resilient Wall Base.

1.02 SUBMITTALS

A. Action Submittals:

1. Samples:
   a. Two full-size tiles for each type of color or pattern of resilient flooring.
   b. Two 2-1/2-inch wide strips of base material.
   c. Two 6-inch long strips of trim materials.

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance.
2. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data.
   b. List of recommended maintenance products, methods, and procedures.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unless otherwise directed by Engineer, store materials in original containers at not less than 70 degrees F for not less than 24 hours immediately before installation.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature in space to receive flooring between 70 and 90 degrees F for not less than 24 hours before and 48 hours after installation.

B. Maintain minimum temperature of 55 degrees F after flooring is installed, except as specified above.

1.05 SEQUENCING AND SCHEDULING

A. Do not install floor coverings until concrete slab has cured for 60 days or until primer material in test patches cannot be scraped or peeled from the slab after drying 24 hours.

1.06 EXTRA MATERIALS

A. Furnish additional floor covering materials from same production run as installed material at the rate of 45 square feet for each 1,000 square feet.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flooring products of the following manufacturers meeting these Specifications may be used on this Project:

1. Rubber Base:
   a. Roppe Rubber Co. (4-inch Rubber Base).
   b. Johnsonite.

B. Rubber base will be supplied cove shape for Epoxy floors and straight base for Carpet Tile. See Finish Schedule and Color Lists on the Drawings.

C. Rubber Base: ASTM F1861, Type TP, Group 2, 0.125-inch thick, coved style, 4 inches high. Color and manufacturer as scheduled or as approved by Architect.

D. Trim and Reducers: Standard rubber or vinyl floor reducer in thickness to suit abutting floor covering by 1-inch wide, tapered or beveled-edge strip; Johnsonite, Reducer Series RRS or Mercer, 633 Tile Reducer.

E. Adhesive: Type and brands of adhesive as recommended by manufacturer of covering material for conditions of installation.

F. Primer and Crack Filler: Type and brand recommended by floor covering manufacturer.

G. Wax: Furnish wax, cleaner, or other finishing material as recommended by floor covering manufacturer for the particular type of flooring material.

H. Floor Filler: Asphalt mastic as manufactured by Armstrong, Lancaster, PA, or National Floor Products Co., Florence, AL.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrate for excessive moisture content and unevenness preventing execution and quality of resilient flooring as specified.

B. Correct defects before installation of resilient flooring.

3.02 PREPARATION

A. Remove dirt, oil, grease, or other foreign matter from surfaces to receive rubber base materials.

B. Ensure that all carpet and other floor materials are completely installed and ready for base.

3.03 INSTALLATION OF BASE

A. Remove defects in wall and floor that would prevent level and true installation of base material.

B. Install base around perimeter of room or space, where shown, and at toe spaces of casework and cabinets.

C. Unroll base material and cut into accurate lengths as desired or as required for minimum number of joints.

D. Match edges of seams or double cut adjoining lengths to give continuous appearance.

E. Install with tight butt joints with no joint widths greater than 1/64-inch.

F. Apply adhesive and firmly adhere to wall surfaces.

G. Press down so bottom cove edge follows floor profile.

H. Ensure top and bottom edges of base are in firm contact with walls and floors.

I. Form internal and external corners by using premolded corners. Other methods, acceptable to Engineer, may be used if premolded corners are not available.

J. Scribe base accurately to abutting materials.

K. Install straight base for carpet and cove base for epoxy flooring and other resilient products.

3.04 INSTALLATION OF TRIM MATERIALS

A. Provide where flooring covering terminates exposing edge of covering.

B. Center reducer under door, where floor covering terminates at a door opening. Fit end edges to door frames and abutting surfaces and other edges to adjoining materials.

C. Apply adhesives and bond securely to substrates in straight true lines. Meet visible and related features of building construction with a maximum deviation of 1/8-inch in 10 feet.

3.05 CLEANING AND PROTECTION

A. Upon completion of the installation of floor covering and adjacent work, and after materials have set, clean surfaces with a neutral cleaner as recommended by manufacturer for type of floor covering material installed.

B. Repair adjacent surfaces damaged by flooring installation.

C. Apply one coat of nonslip wax or other finish as recommended by floor covering manufacturer; buff to a sheen.

D. Protect completed work from traffic and damage until Substantial Completion by covering with plastic sheet, kraft paper, or plywood panels.

3.06 INSTALLATION SCHEDULE

A. Areas to receive resilient flooring, and pattern, are indicated in Interior Finish Schedule on the Drawings.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   b. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.
7. The Society for Protective Coatings (SSPC):
   a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   b. PA 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
   c. SP 1, Solvent Cleaning.
   d. SP 2, Hand Tool Cleaning.
   e. SP 3, Power Tool Cleaning.
   f. SP 5, White Metal Blast Cleaning.
   g. SP 6, Commercial Blast Cleaning.
   h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
   i. SP 10, Near-White Blast Cleaning.
   j. SP 11, Power Tool Cleaning to Bare Metal.
   k. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
   l. SP 13, Surface Preparation of Concrete.
   m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.02 DEFINITIONS

A. Terms used in this section:

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

1.03 SUBMITTALS

A. Action Submittals:

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

B. Informational Submittals:

1. Applicator's Qualification: List of references substantiating experience.
2. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
3. Manufacturer's written verification that submitted material is suitable for the intended use.
4. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
5. Manufacturer's written instructions and special details for applying each type of paint.
6. Samples:
    a. Reference Panel:
        1) Paint:
            a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
            b) Furnish additional samples as required until colors, finishes, and textures are approved.
            c) Approved samples to be the quality standard for final finishes.

1.04 QUALITY ASSURANCE

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

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
    a. Paint manufacturer's instructions.
    b. SSPC PA 10.
    c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

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

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

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

B. Storage:

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

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

C. Each of the following manufacturers is capable of supplying most of the products specified herein:

1. Tnemec.
2. Sherwin Williams.
3. Carboline.
4. PPG.
5. International Paint (includes Akzo-Nobel).

2.02 ABRASIVE MATERIALS

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

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Bituminous Paint	Single-component, coal-tar pitch based
Block Filler	Primer-sealer designed for rough masonry surfaces, 100% acrylic emulsion

Product	Definition
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy Primer—Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61

Product	Definition
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Organic Zinc Rich Primer	Epoxy or moisture cured urethane with 85-percent zinc content in the dry film, meeting the requirements of RCSC Specification for Structural Joints using High Strength Bolts, Class A or Class B, as required.
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required

2.04 MIXING

A. Multiple-Component Coatings:

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

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

2.05 SHOP FINISHES

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

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

C. Shop Coating Requirements:

1. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

D. Pipe:

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

PART 3 EXECUTION

3.01 GENERAL

A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

3.02 EXAMINATION

A. Factory Finished Items:

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

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

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. Field Abrasive Blasting:

1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer’s recommendations, the more stringent shall apply.

B. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 500 square feet by means of a Chlor Test CSN Salts.
2. Surface with chloride levels exceeding 3 µg/square centimeter for submerged surfaces and 5 µg/square centimeter for exposed surfaces shall be treated with a liquid soluble salt remover equivalent to CHLOR*RID (CHLOR*RID International, Chandler, AZ).
3. Follow manufacturer's recommendations and procedures for the use of this product to remove the surface contamination.

C. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
   a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
   b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
   c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
   d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
   e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
   f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.

g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.

i. SP-16, Brush Blasting of Non-Ferrous Metals: A brush-off blast cleaned non-ferrous metal surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Intact, tightly adherent coating is permitted to remain. A coating is considered tightly adherent if it cannot be removed by lifting with a dull putty knife. Bare metal substrates shall have a minimum profile of 19 micrometers (0.75 mil).

2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.
4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
   a. Prepare such that there is:
      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or any area to be painted.
      3) No sharp peaks or ridges along weld bead.
   b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

8. Preblast Cleaning Requirements:
    a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
    b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
    c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
9. Blast Cleaning Requirements:
    a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
    b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
    c. Use only dry blast cleaning methods.
    d. Do not reuse abrasive, except for designed recyclable systems.
    e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
    a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
    b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Brush blast in accordance with SSPC SP 16.
3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

E. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.

3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

F. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
   a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
   b. Brush-off blasting.
   c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

H. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.

1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

I. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. Application of Cosmetic Coat:
   a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
   b. Check compatibility by application to a small area prior to starting painting.
   c. If lifting or other problems occur, request disposition from Engineer.
8. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:

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

B. Acid Etching:

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

C. Solvent Cleaning:

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

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for new, interior and exterior masonry, concrete, and metal, [I: and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.

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

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

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 106 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, Such As Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.

2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
    a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

D. Film Thickness and Coverage:

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

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

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

B. System No. 1 Submerged Metal—Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	NSF High Build Epoxy for highly corrosive environments	3 coats, 3 MDFTPC

1. Use on the following items or areas:
   a. Metal surfaces new and existing below a plane 1 foot above the maximum liquid surface; metal surfaces above the maximum liquid surface that are a part of the immersed equipment; surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel that are embedded in concrete; and the following specific surfaces:
      1) Interior surfaces of steel piping noted in the Piping Schedule.
      2) Interior surfaces of cans for vertical turbine pumps.

C. System No. 3 Submerged Metal—Other:

1. Use on the following items or areas:
   a. Metal surfaces new and existing below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface which are a part of immersed equipment, and the following specific surfaces:
      1) Interior surfaces of steel piping noted in the Piping Schedule.

D. System No. 4 Exposed Metal—Highly Corrosive:

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

1. Use on the following items or areas:
   a. Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather**.**

E. System No. 5 Exposed Metal—Mildly Corrosive:

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

1. Use on the following items or areas:
   a. Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as pipe galleries and similar areas.

F. System No. 6 Exposed Metal—Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust-Inhibitive Primer	1 coat, 2 MDFT
	Alkyd Enamel	2 coats, 4 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, new and existing located inside or outside of structures or exposed to weather, including metal doors and frames, vents, louvers, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim, and the following specific surfaces:
      1) Inside duct stack heads behind diffusers, registers, and grilles with flat black.
      2) Instrumentation and control systems exposed enclosures for process.
   b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.

G. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Coal-Tar Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas: Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles; and the following specific surfaces:

H. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Galvanized surfaces requiring painting.
   b. After application of System No. 10, apply finish coats as required for exposure.

I. System No. 11 Faying Surfaces of Slip Critical Bolted Connections:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Organic Zinc Rich Primer	1 coat, 3 MDFT

1. Use on faying surfaces of slip critical joints as specified and as shown on Drawings.
2. Provide primer in accordance with RCSC Specification for Structural Joints using High-Strength Bolts.

J. System No. 12 Skid-Resistant—Steel:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	Epoxy Nonskid (Aggregated)	1 coat, 16 MDFT

K. System No. 13 Skid-Resistant—Aluminum and FRP:

Surface Prep.	Paint Material	Min. Coats, Cover
Aluminum: In accordance with Article Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation -OR- FRP: In accordance with Article Plastic and FRP Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 16 MDFT

L. System No. 17 Special Coating—Concrete – Exterior Dome of Clearwell:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Sherwin-Williams Loxon XP, or engineered approved equal.	2 coats, 6-8 mils DFT per coat.

1. Use on the following areas:

M. Exterior Dome of Clearwell above grade. System No. 18 Concrete Tank Lining—Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Filler/Surfacer (NSF-approved)	As required to fill voids and level surface
	NSF Epoxy	3 coats, 250 SFPGPC

1. Use on the following items or areas:
   a. Concrete surfaces below a plane 1 foot above maximum liquid surface, and the following specific surfaces: ALL Interior walls of Clearwell, including interior, baffle and exterior.

N. System No. 18a Concrete Exposed Metal Repair Coating—Potable Water and Non-Submerged:

Surface Prep.	Paint Material	Min. Coats, Cover
Brush blast concrete in accordance with Paragraph Concrete Surface Preparation; blast exposed reinforcing steel to Near White Metal, SSPC SP10. See Note 1	NSF Epoxy; finish color white	2 coats, 4 MDFTPC, see Note 2.
Note 1. Surface Preparation Alternative: Mechanical abrade concrete surfaces to meet International Concrete Restoration Association standard 37/32, Concrete Surface Profile No. 3. Mechanically abrade exposed ends of reinforcing steel in accordance with SSPC SP-11. Note 2. Brush out surface voids and irregularities to provide a monolithic film.		

1. Use this system: On saw-cut concrete surfaces that will not receive new concrete to cover exposed ends of rebar and metal embeds. Or alternately, where approved, over ends of and minimum 2 inches around ends of exposed metal and rebar in lieu of entire surface.

O. System No. 21 Skid-Resistant—Concrete:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 160 SFPG

P. System No. 22 Chemical-Resistant Wall, Heavy-Duty—**Concrete**:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Filler/Surfacer	1 coat as required to fill voids and smooth surface; apply to 100 percent of surface.
	High Build Epoxy	1 coat, 160 SFPG
	High Build Epoxy, Gloss	1 coat, 160 SFPG

1. Use on the following items or areas: Fluoride Tank Containment Areas.

Q. System No. 23 Chemical-Resistant Wall—Concrete:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Filler/Surfacer	1 coat , as required to fill voids and smooth surface; apply to 100 percent of surface.
	High Build Epoxy	1 coat, 160 SFPG

1. Use on the following items or areas: Fluoride Tank Containment Areas.

R. System No. 25 Exposed FRP, PVC:

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

1. Use on the following items or areas: All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

S. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete

T. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT

1. For steel pipe and fittings, meet all requirements of AWWA C213.

U. System No. 29A Fusion Bonded, Steel Dowel Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT
TFE Lube, Shop Applied; Grease Lube Alternative, Field Applied Just Prior to Installation	TFE Lube or Grease Lube	1 coat, as required

1. Use on steel expansion joint dowels as specified in Section 03 15 00, Concrete Joints and Accessories.

3.08 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

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

B. System No. 106 Galvanized Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Manufacturer's Recommended Primer	1 coat, as recommended by manufacturer
	Alkyd Enamel (Semigloss)	2 coats, 4 MDFT

1. Use on the following items or areas:
   a. Hollow metal frames and doors.
   b. Exposed interior structure and metal deck.
   c. Exposed steel angles above doors and louvers.
   d. Where indicated on Architectural Schedules on Drawings.

C. System No. 109 Masonry, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Masonry Surface Preparation	Block Filler	1 coat, 75 SFPG
	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Interior CMU walls.
   b. Inside of CMU walls at screen wall.
   c. Where indicated on Architectural Schedules on Drawings.

D. System No. 110 Masonry Sealer:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Masonry Surface Preparation	Acrylic Sealer	2 coats, 100 SFPGPC

1. Use on the following items or areas:
   a. Exterior masonry surfaces.
   b. Exterior precast surfaces.
   c. Where indicated on Architectural Schedules on Drawings.

E. System No. 115 Gypsum Board and Plaster, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Gypsum Board Surface Preparation	Latex Primer/Sealer	1 coat, 350 SFPG
	Acrylic Latex (Semigloss) or Alkyd (Semigloss)	2 coats, 400 SFPGPC

1. Use on the following items or areas:
   a. Restroom shower ceilings.
   b. Where indicated on Architectural Schedules on Drawings.

F. System No. 121 Concrete, Skid-Resistant:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 160 SFPG

1. Use on the following items or areas:
   a. Interior Floor Slabs.
   b. Where indicated on Architectural Schedules on Drawings.

3.09 COLORS

A. Provide as selected by Owner or Design-Builder and as shown in Architectural Schedules on Drawings.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
2. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
   a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
   b. Fire Protection Equipment and Apparatus: OSHA Red.

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

D. Pipe Identification Painting:

1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Pipe Color Coding: **[A: In accordance with Piping Schedule.] [B: As shown in table below.]**
3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
4. Pipe Supports: Painted light gray, as approved by **[C: Owner] [D: Engineer]**.
5. **[E: Fiberglass reinforced plastic (FRP) pipe, polyvinylidene fluoride (PVDF), and polyvinyl chloride (PVC) pipe located inside of buildings and enclosed structures will not require painting, except as noted or scheduled.]**

E. Pipe System Color Code:

Pipe System	Color
Air, Process	Federal Safety Green
Air, Instrument	Federal Safety Purple
Ammonia, Liquid	Federal Safety Orange
Ammonia, Solution	Federal Safety Orange
Alum	Dark Green
Chlorine, Gas	Federal Safety Yellow
Chlorine, Liquid	Federal Safety Yellow
Chlorine, Residual Sampling	Silver/Gray
Chlorine Solution	Federal Safety Yellow

Pipe System	Color
Chlorine Ejector Water	Silver/Gray
Chlorine Vent	Federal Safety Yellow
Compressed Air	Federal Safety Purple
Carbon	Black
Drains and Sludge	Light Brown
Decant	Light Brown
Dewatering	Black
Drains	Black
Effluent, Final	Silver/Gray
Effluent, Primary	Silver/Gray
Effluent, Flushing Water, High Pressure	Dark Green
Effluent, Flushing	Dark Green
Fuel Oil Supply	Federal Safety Orange
Fuel Oil Return	Federal Safety Orange
Flocculation Basin Influent	Buff
Filter Backwash Supply	Medium Blue
Filter Surface Wash Supply	Medium Blue
Hot Flushing Loop	Federal Safety Blue
Headworks	Buff
Lime	White
Mixed Liquor	Silver/Gray
Overflow	Silver/Gray
Plant Service Water	Medium Blue
Potable Water	Light Blue
Polymer/Cationic	Buff
Polymer Nonionic or Anionic	Buff

Pipe System	Color
Raw Sewage	Dark Gray
Rapid Mix Influent	Light Brown
Scum	Light Brown
Sample	Medium Green
Seal Water	Federal Safety Blue
Thickener Dilution Water	Dark Green

3.10 FIELD QUALITY CONTROL

A. Testing Equipment:

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

B. Testing:

1. Thickness and Continuity Testing:
   a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
   b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
   c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188.
   d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
3. Feather edges and repair in accordance with recommendations of paint manufacturer.
4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.11 MANUFACTURER'S SERVICES

A. In accordance with Section 01 43 33, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:

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

3.12 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.13 SUPPLEMENTS

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

1. Paint System Data Sheet (PSDS).
2. Product Data Sheet (PDS).

END OF SECTION

PAINT SYSTEM DATA SHEET

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

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

PAINT PRODUCT DATA SHEET

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

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

Provide manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning:_____

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

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

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

SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
2. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   b. D709, Standard Specification for Laminated Thermosetting Materials.
3. The Chlorine Institute, Inc.: WC-1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.
4. International Code Council (ICC):
   a. A117.1, Accessible and Usable Buildings and Facilities.
   b. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
5. National Fire Protection Association (NFPA):
   a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
   b. HAZ-01, Fire Protection Guide to Hazardous Materials.
6. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
   b. Manufacturer’s literature showing letter sizes and styles, sign materials, and standard mounting details.
2. Samples: One full size for each type of nameplate, sign, and label specified.

B. Informational Submittals: Manufacturer’s installation instructions.

PART 2 PRODUCTS

2.01 DOOR NAMEPLATES

A. Material: Plastic with square corners.

B. Thickness:1/8 inch.

C. Height: 2 inches.

D. Finish: Nondirectional matte.

E. Background: Black.

F. Letters: Raised.

1. Size: 1 inch high.
2. Color: White.
3. Style: Helvetica Regular upper case.
4. Message Text: As shown on Door and Hardware Schedule.
5. Braille Text: Domed or rounded as required by ADA regulations, with 3/8-inch minimum clearance on all sides.

G. Manufacturers and Products:

1. Best Sign Systems, Montrose, CO; Graphic Blast.
2. Andco Industries Corp., Greensboro, NC; 1400 series.

2.02 SIGN TYPES

A. Plastic Sign (Type A):

1. Exterior: Laminated plastic subsurface image type, 3/16 inch thick with high-gloss finish.
2. Interior: Plastic, 1/8 inch thick with nondirectional matte finish and raised letters.
3. Rounded corners.

B. Metal Sign (Type B):

1. Material: Baked enamel finished 20-gauge (minimum) steel or 18-gauge (minimum) aluminum signs.
2. Manufacturers:
   a. Seton Identification Products.
   b. Nutheme Illustrated Safety Co.

C. Fiberglass Sign (Type C):

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

D. Hazardous Material Sign (Type H):

1. Conform to NFPA 704 and NFPA HAZ-01.
2. Material: Adhesive vinyl for curved surfaces.
3. Background, Letters, and Numbers: Die-cut vinyl with pressure sensitive adhesive.
4. Manufacturers:
   a. Brady Signmark.
   b. Emed Co., Inc.

2.03 IDENTIFICATION LABELS

A. Pipe Labels:

1. Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
2. Provided with ties or straps for pipes of 6 inches and over diameter.
3. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
4. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
5. Letters and Arrows: Black on OSHA safety yellow background.
6. Color Field and Letter Height: Meet ASME A13.1.
7. Message: Piping system name as indicated on Piping Schedule.
8. Manufacturers and Products:
   a. Brady Signmark; B-915 BradySnap-On and Strap-On Pipe Markers.
   b. Seton Identification Products; Ultra-mark Pipe Markers.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: Black bold face, 3/4 inch minimum high.
3. Background: OSHA safety yellow.

4. Materials: Aluminum or stainless steel with a baked-on finish suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
5. Size:
   a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 inches maximum long.
   b. Furnish same size base dimensions for all labels.
6. Message: Equipment names and tag numbers as used in sections where equipment is specified.
7. Manufacturers:
   a. Brady Signmark.
   b. Seton Identification Products.

2.04 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

B. Wood Posts: Preservative treated 4 by 4 wood as specified in Section 06 10 00, Rough Carpentry.

C. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.

D. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

A. In accordance with manufacturer’s recommendations.

B. Mount securely, plumb, and level.

3.02 DOOR NAMEPLATES AND PICTORIAL SYMBOLS

A. Attach to doors or walls adjacent to doors with self-sticking removable adhesive. See Door and Hardware Schedule for locations and messages.

B. Mount with bottom of nameplate at 5 feet 6 inches above floor.

3.03 SIGNS

A. General:

1. Fasten to walls or posts, or hang as scheduled.
2. Anchor in place for easy removal and reinstallation with ordinary hand tools.

B. Information, Exit, and Safety Signs:

C. Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.

D. Hazardous Material Sign:

1. Install where required by NFPA No. 704 and IFC, Chapter 27.
2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled, and on sides of stationary tanks.
3. Specific Materials:

Sign Schedule—Hazardous Material Signs

Mark	Material	Health Hazard (Blue)	Flammability Hazard (Red)	Instability Hazard (Yellow)	Special Hazard (White)	Location	Mounting Method	Height to Top
H-1	Hydrofluorossilisis Acid (25% solution)	3	0	0		Tank	Self- Sticking	5'-6"
H-2	Diesel Fuel, No. 2	1	2	0		Tank or Generator Enclosure	Self-Sticking	5'-6"

3.04 IDENTIFICATION LABELS

A. Pipe Labels:

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

B. Equipment Labels:

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

3.05 SPECIFIC SIGN MESSAGES

A. Polymer Fill Station Format and Message:

1. Polymer Fill Station: This station allows for unloading concentrated.

3.06 SUPPLEMENTS

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

1. Sign Schedule: Tabulation of characteristics and mounting information for warning, informational numbered on Drawings. Provide items as scheduled. Meet requirements of Occupational Safety and Health Act (OSHA).
2. Hazardous Material Sign Schedule: Tabulation and mounting information for signs conforming to NFPA 704 and NFPA HAZ-01.

END OF SECTION

Sign Schedule

Sign														
			Size			Mounting			Lettering					
Number[1]	Sign Type[2]	Detail Reference[3]	Width	Height	Color	Location	Method	Height to Top	Height	Style	Color	Message	Faces	Other Requirements
S-1	C	1014-001	20"	14"	White	Door	Screws or Bolts	5'-6"	1" min.	Helvetica	Black	DANGER High Voltage	1	Doors to electrical room
S-2	C-Exterior A-Interior	1014-002	20"	14"	Yellow	Doors	Screws	3'-4"	1" min.	Helvetica	Black	CAUTION Ear Protection Required	3	On the outside of the exterior personnel doors to the pump room. On the inside of the electrical room door.
S-4	C	1014-001	20"	14"	White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	DANGER No Smoking	1	Inside of Generator Screen Wall
S-7	B	1014-001	20"	14"	White	Wall	Bolts	3'-6"	1" min.	Helvetica	Black	DANGER Nonpotable Water Not for Drinking	1	Provide at exterior hose valves
S-12	A	N/A	As required		White	Wall or Post	Bolts	5'-6"	1" min.	Helvetica	Black	Hydrofluorosilicic Acid Fill Station	1	Provide on containment wall at fill station

[1]Numbers refer to a particular sign type with a particular message.
[2]Letters refer to Sign Types specified in this section.
[3]Numbers refer to Design Details that show sign layout.
[4]Verify requirements for this sign with Regulations in state where Project is located.

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES AND SAFETY EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

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

1. National Fire Protection Association (NFPA):
   a. 10, Standard for Portable Fire Extinguishers.
   b. 30, Flammable and Combustible Liquids Code.
2. Occupational Safety and Health Administration (OSHA).
3. Underwriters Laboratories Inc. (UL): Fire Protection Equipment Directory.

1.02 PERFORMANCE REQUIREMENTS

A. Conform to NFPA 10.

B. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for purpose specified and indicated.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fire Extinguishers: Manufacturer’s product data for each item, including sizes, ratings, UL listings, or other certifications, and mounting information.
   b. Product Data: Extinguisher operational features, color and finish, and anchorage details.

B. Informational Submittals:

1. Operation and Maintenance Data: Submit test, refill or recharge schedules and recertification requirements.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Section 01 61 00, Common Product Requirements: Environmental conditions affecting products onsite.

B. Do not install extinguishers when ambient temperatures are capable of freezing extinguisher ingredients.

PART 2 PRODUCTS

2.01 PORTABLE FIRE EXTINGUISHERS

A. Manufacturers:

1. JL Industries.
2. Larsen’s Manufacturing Co.
3. Nystrom Products Co.

B. General:

1. Conform to NFPA 10 for fire extinguishers.
2. Furnish fire extinguishers and cabinets from one manufacturer.
3. UL listed, charged and ready for service.

C. Multipurpose Hand Extinguisher (F. Ext-1):

1. Tri-class dry chemical extinguishing agent.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Agent propelled through hose or opening at top of unit.
5. For use on A, B, and C class fires.
6. Minimum UL Rating: 4A-60B:C, 10-pound capacity.

D. Clean Agent Hand Extinguisher (F. Ext-5):

1. Clean agent with nonozone depleting potential extinguishant.
2. Pressurized, red enameled steel shell cylinder.
3. Activated by top squeeze handle.
4. Colorless, odorless, electrically non-conductive clean agent which discharges as a liquid and flashes to a gas.
5. Environmentally friendly, with zero ozone depletion potential, containing no chlorofluorocarbons, hydrochlorofluorocarbons, or halon.
6. For use on Class A, B, or C fires.
7. Minimum UL Rating: 2A-10B:C, 13-pound capacity.

2.02 ACCESSORIES

A. Extinguisher Brackets: For hand extinguishers not located in cabinets, furnish heavy-duty brackets with clip-together strap for wall mounting, formed steel, chromed finish.

B. Graphic Identification: Provide graphic identification marking for each fire extinguisher type. OSHA approved pictorial markings to indicate the extinguisher uses and nonuses on a single label.

C. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.

1. Metal expansion shields for machine screws at concrete and masonry.
2. Interior: Rust-resistant.
3. Exterior: Stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install where indicated or directed and in accordance with manufacturer's recommendations.

B. Secure cabinets and brackets rigidly to structure.

C. Place extinguishers on wall brackets.

D. Position signage as required by authorities having jurisdiction.

3.02 PORTABLE FIRE EXTINGUISHERS

A. Provide at locations shown or as directed by Engineer.

B. Mount hangers securely in position, following manufacturer's recommendations.

C. Top of Extinguisher: No more than 54 inches above floor.

D. Install wall brackets, maximum 48 inches 1220 mm from finished floor to top of extinguisher handle.

END OF SECTION

PAUL B. KREBS WATER TREATMENT PLANT IMPROVEMENTS

ANNISTON WATER WORKS & SEWER BOARD

PREPARED FOR

ANNISTON WATER WORKS & SEWER BOARD
CITY OF ANNISTON, ALABAMA

VOLUME 2 OF 3

SPECIFICATIONS

For information regarding this project, contact:

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Jacobs Project No. D3698100
SRF Project No. FS010239-02

Jacobs

OCTOBER 2024

BID DOCUMENTS

ANNISTON WATER WORKS & SEWER BOARD

CITY OF ANNISTON, ALABAMA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

PAUL B. KREBS WATER TREATMENT PLANT IMPROVEMENTS

****

ISSUED FOR PERMIT

****

JACOBS

Birmingham, Alabama

October 2024

Project No. D3698100 Copy No. _____

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END OF SECTION

SECTION 22 07 00
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy-Efficient Design of New Buildings except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
   c. C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   d. C547, Standard Specification for Mineral Fiber Pipe Insulation.
3. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

1.02 SUBMITTALS

A. Action Submittals: Product description, include list of materials, thickness for each service scheduled, and locations.

B. Informational Submittals:

1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
2. Manufacturer’s installation instructions.

1.03 QUALITY ASSURANCE

A. Provide standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.

C. UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Stamp or Label:

1. Deliver insulation, jackets, cements, adhesives and coatings with a manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
2. Insulation Packages and Containers: Mark "asbestos-free."

PART 2 PRODUCTS

2.01 GENERAL

A. Insulation Exterior: Cleanable, grease-resistant, nonflaking, and nonpeeling.

B. Conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.

C. Insulation for Fittings, Flanges, and Valves: Premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

D. Fire Resistance:

1. Provide noncombustible insulation, adhesives, vapor barrier materials and other accessories, except as specified herein.
2. Use no fugitive or corrosive treatments to impart flame resistance.
3. Flame proofing treatments subject to deterioration as a result of effects of moisture or high humidity are not acceptable.
4. Fire Hazard Rating for Materials including Facings, Mastics, and Adhesives: Not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with NFPA 255 methods.
5. Materials exempt from fire-resistant rating:
   a. Nylon anchors.
   b. Treated wood inserts.
6. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
   a. Polyurethane insulation.
   b. PVC casing.
   c. Fiberglass-reinforced plastic casing.

2.02 PIPE INSULATION

A. Type P3—Elastomeric (ASTM C534, Minus 40 Degrees F to 220 Degrees F):

1. Flexible, closed cell elastomeric.
2. Nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
3. Water Vapor Transmission: 0.1 perm-inch, or less.
4. Manufacturers and Products:
   a. Armacell; AP Armaflex.
   b. Nomaco; K-Flex LS.

2.03 INSULATION FINISH SYSTEMS

A. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, minimum 0.016-inch thickness, with smooth mill finish.
2. Moisture Barrier: Provide factory-applied moisture barrier, consisting of 40-pound kraft paper with 1-mil-thick low-density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one-or two-piece covers, which includes elbows, tee/valves, endcaps, mechanical line couplings, and specialty fittings.
4. Manufacturer and Product: RPR Products; INSUL-MATE.

PART 3 EXECUTION

3.01 INSTALLATION OF INSULATION

A. Install insulation products in accordance with manufacturer’s written instructions, and in accordance with recognized industry practices.

B. Apply insulation over clean, finish painted, and dry surfaces.

C. Install insulation after piping system has been pressure tested and leaks corrected.

D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

F. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

G. Maintain integrity of vapor barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.

H. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units. Finish cold pipe fittings with white vapor barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

I. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

J. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.

K. Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

L. Insulate valve bodies, flanges, and pipe couplings.

M. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

N. Do not insulate flexible pipe couplings and expansion joints.

O. Do not allow insulation to cover nameplates or code inspection stamps.

P. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

Q. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

R. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

S. Placement:

1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
2. Insulate valves and fittings with sleeved or cut pieces of same material.
3. Seal and tape joints.

T. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

U. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

3.02 INSTALLATION OF INSULATION FINISH SYSTEMS

A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

D. Do not use screws or rivets to fasten the fitting covers.

E. Install removable prefabricated aluminum covers on exterior flanges and unions.

F. Caulk and seal exterior joints to make watertight.

3.03 INSULATION APPLICATIONS

A. Potable Cold Water, Hot Water and Tepid Water:

1. Type P3, elastomeric.
2. 1-inch thickness for all pipe sizes.

B. Pipe Hangers:

1. Type P3, Elastomeric: Rigid insulation section with 9-inch-long, 16-gauge galvanized steel saddle.

3.04 INSULATION FINISH APPLICATIONS

A. Piping Insulation (Concealed Areas): Factory finish.

B. Piping Insulation (Exposed to View, Indoors): Type F3, aluminum.

C. Piping Insulation (Outdoors): Type F3, aluminum.

D. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.05 FIELD QUALITY CONTROL

A. Test factory-applied materials assembled. Field-applied materials may be tested individually.

END OF SECTION

SECTION 22 10 01
PLUMBING PIPING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Gas Association (AGA):
   a. B109.1, Diaphragm Type Gas Displacement Meters (under 500 Cubic Feet Per Hour Capacity).
   b. B109.2, Diaphragm Type Gas Displacement Meters (500 Cubic Feet Per Hour Capacity and Over).
2. American National Standards Institute (ANSI).
3. American Public Works Association (APWA): Uniform Color Code.
4. American Society of Sanitary Engineering (ASSE):
   a. 1010, Performance Requirements for Water Hammer Arresters.
   b. 1050, Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems.
   c. 1070, Performance Requirements for Water Temperature Limiting Devices.
5. ASTM International (ASTM):
   a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
   d. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   f. A179/A179M, Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes.
   g. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   j. A197/A197M, Standard Specification for Cupola Malleable Iron.

k. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
m. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
n. A518/A518M, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
o. A536, Standard Specification for Ductile Iron Castings.
p. A563, Standard Specification for Carbon and Alloy Steel Nuts.
q. A861, Standard Specification for High-Silicon Iron Pipe and Fittings.
r. A888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
s. B32, Standard Specification for Solder Metal.
t. B61, Standard Specification for Steam or Valve Bronze Castings.
u. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
v. B75/B75M, Standard Specification for Seamless Copper Tube.
w. B88, Standard Specification for Seamless Copper Water Tube.
x. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
y. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
z. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
aa. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
bb. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
cc. B306, Standard Specification for Copper Drainage Tube (DWV).
dd. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
ee. C1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
ff. C1460, Standard Specification for Shielded Transition Couplings for use with Dissimilar DWV Pipe and Fittings Above Ground.
gg. C1540, Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
hh. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

ii. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
jj. D2000, Standard Classification System for Rubber Products in Automotive Applications.
kk. D2239, Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
ll. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
mm. D2513, Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
nn. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
oo. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
pp. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
qq. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
rr. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ss. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
tt. E438, Standard Specification for Glasses in Laboratory Apparatus.
uu. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
vv. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ww. F1412, Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.
xx. F1924, Standard Specification for Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing.
yy. F1973, Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems.

6. American Water Works Association (AWWA):
   a. C104/A21.4, Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   e. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
   f. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines, Enamel and Tape, Hot-Applied.
   g. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
   h. C606, Grooved and Shouldered Joints.
   i. C651, Disinfecting Water Mains.
7. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Standard Specification for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   b. 310, Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Strom Drain, Waste, and Vent Piping Applications.
8. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
9. Plumbing and Drainage Institute (PDI): WH 201, Water Hammer Arresters Standard.

1.02 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

   1. International Plumbing Code.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets.
2. Shop Drawings: Show Contractor recommended changes in location of fixtures or equipment.
3. Isometric riser diagrams showing equipment, valves, elevations, and fixtures.

B. Informational Submittals:

1. Changes in location of equipment or piping that affect connecting or adjacent work, before proceeding with the Work.
2. Complete list of products proposed for installation.
3. Test records produced during testing.
4. Operations and maintenance data for all equipment indicating tag numbers.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

A. Piping Schedule: Refer to Section 40 27 00, Process Piping—General.

B. Piping Material: Refer to Piping Data Sheet(s), Article Supplements and Section 40 27 00, Process Piping—General.

2.03 HOSE VALVES AND HYDRANTS

A. HV-1 Hose Valve:

1. Cast bronze globe valve, 3/4-inch size, with NPT screwed ends, union bonnet, rising stem, Teflon disc, hand wheel, and NPT by NST hose thread adapter outlet connection.
2. Rated 150-pound service water pressure, 300-pound WOG.
3. Manufacturers and Products:
   a. Nibco; Catalog No. T-235-Y, Angle No. T-335-Y.
   b. Crane Co.; Catalog No. 7TF, Angle No. 17TF.

2.04 INSULATION

A. As specified in Section 22 07 00, Plumbing Piping Insulation.

2.05 VALVES

A. General:

1. Furnish complete with necessary operating hand wheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, and wrenches.
2. Renewable Parts Including Discs, Packing, and Seats: Types as recommended by valve manufacturer for intended service.
3. Units shall have name of manufacturer and size of valve cast on body or bonnet or shown on a permanently attached plate in raised letters.

B. Design Features:

1. Brass and bronze components, including appurtenances in contact with water.
2. Alloys containing less than 16 percent zinc and 2 percent aluminum.
3. Alloys are of the following ASTM designations:
   a. B61, B62, B98/B98M (Alloy A, B, or D), B139 (Alloy A), B164, B194, and B127.
   b. Stainless steel Alloy 18-8 may be substituted for bronze as an option with approval of Engineer.
4. Gland Bolts on Iron Body Valves: Bronze, fitted with brass nuts.

C. Thermostatic Mixing Valve Assembly:

1. Function: Provide tepid water at 3 gpm to 50 gpm.
2. Components:
   a. High flow mixing valve for 15 gpm to 50 gpm.
   b. Low flow mixing valve for 3 gpm to 7 gpm.

c. Pressure reducing valve.
d. Pressure gauge.
e. Isolation valve.
f. Thermometer.
g. Pipe fittings.

3. Compliance: ASSE 1071
4. Self-contained; no electrical requirements.
5. Performance: With 140 degrees F hot inlet and 60 degrees F cold inlet, deliver 85 degrees F at inlet pressures between 30 psig and 100 psig. Set outlet at 85 degrees F.
6. Manufacturers and Products:
   a. Leonard; Model TM-800-LF, or equal.

2.06 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hose:

1. Furnish 50-foot lengths of 3/4-inch and 50-foot lengths of 1-1/2-inch, EPDM black cover and EPDM tube, reinforced with two textile braids. Furnish each length with brass male and female NST hose thread couplings to fit hose nozzle(s) and hose valve(s) specified.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
   a. Goodyear.
   b. Boston.

PART 3 EXECUTION

3.01 GENERAL

A. Install plumbing systems to meet applicable plumbing code.

B. Field Obstructions:

1. Drawings do not attempt to show exact details of piping. Provide offsets around obstructions.
2. Do not modify structural components, unless approved by Engineer.

C. Provide unions in piping systems at connections to equipment.

D. Provide isolation ball valves at all equipment, fixtures, and apparent locations to isolate individual branches for maintenance or repair efficiently.

E. Provide shielded transition couplings, insulating dielectric unions and flanges between ferrous and nonferrous piping and where otherwise required for electrically insulated connection.

F. Pipe air release valves, water-lubricated bearings, and other appurtenances having water effluent with copper tubing to nearest drain.

G. Provide isolation valves and strainers at pressure regulators.

H. Trench Excavation and Backfill: See Civil Specifications.

3.02 INSTALLATION

A. Rigid PVC or CPVC:

1. Cut, make up, and install in accordance with pipe manufacturer's recommendations.
2. Ream, clean, and remove burrs from cut ends before joining pipe.
3. Lay in trench by snaking pipe from one side to other.
4. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and final use.
5. Do not lay pipe when temperature is below 40 degrees F or above 90 degrees F when exposed to direct sunlight.
6. Shield ends to be joined from direct sunlight prior to and during laying operation.
7. Use strap wrenches only for tightening threaded plastic joints. Do not over tighten fittings.

B. Water System Balancing: Provide a qualified registered engineer or firm specializing in testing and balancing to adjust domestic water system. Balance system for required water flows at each plumbing fixture, terminal device, and recirculating hot water loop.

C. Valves: Install in accordance with manufacturer's recommendations.

D. Miscellaneous Piping Specialties: Install in accordance with manufacturer's recommendations.

E. Measuring Devices: Install in accordance with manufacturer's recommendations.

3.03 SANITARY AND WASTE DRAINS AND VENTS PIPING

A. Installation:

1. Set piping above floor slab true and plumb.
2. Set exposed risers as close to walls as possible.
3. Slope drain lines at minimum 2 percent slope, unless otherwise noted. Vent lines shall be installed level or sloped, with no low spots.
4. Where vent stacks pass through roof slab, fit with flashing sleeve secured to roof.
5. Extend vents minimum 1 foot above roof.
6. Provide cleanouts where shown and where required by code.

3.04 HVAC CONDENSATE PIPING

A. Set piping true and plumb.

B. Slope piping 1/8 inch per foot minimum.

3.05 WATER SUPPLY PIPING

A. Water supply piping includes potable (W1), hot water (HW), tepid water (TW) and non-potable (W2) systems.

B. Flush water piping systems clean of internal debris, clean faucet aerators, and adjust plumbing fixture valves for manufacturer’s recommended flow.

C. Do not run water piping through electrical rooms, stairwells, or immediately over or within a 3-foot horizontal clearance of electrical panels, motor starters, or environmental control panels.

D. Provide exterior water piping with minimum 3 feet of cover or install below frost line, whichever is greater.

E. Hose Valves and Hydrants: Attach handle with setscrew and provide manufacturer’s recommended gravel fill around drain hole of post hydrants.

F. Provide valve operators with position indicators, where indicated, to show position of valve disc or plug.

G. Provide bypass with globe valve for emergency throttling around each reducing valve.

H. Protect buried copper and steel pipe and fittings with a single wrap of coal-tar saturated felt in accordance with AWWA C203.

I. Vacuum Breakers 2 Inches and Smaller: Install minimum 6 inches above flood line of equipment they serve.

J. Provide manual air vents at high points in domestic hot water system.

3.06 INSULATION

A. As specified in Section 22 07 00, Plumbing Piping Insulation.

3.07 HANGERS AND SUPPORTS

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

B. Hanger Rod Sizing and Spacing for:

1. Steel Pipe:

Pipe Size	Max. Hanger Spacing (feet)	Min. Rod Size (inches)
1 inch and smaller	6	1/4
1-1/4 through 2-1/2 inches	8	1/4
3 and 4 inches	10	3/8
6 inches	12	3/8
8 inches	12	1/2

2. Copper Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: 2 feet less per size than for steel pipe, except pipe 1-1/4 inches and smaller shall be supported every 6 feet.
3. Cast Iron Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: Locate hanger rods at each pipe joint and change of direction, 10-foot maximum spacing.
4. Plastic Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: As recommended by manufacturer and required by applicable plumbing code for flow and temperature in pipe.
   c. No metal portion of hanger shall contact pipe directly.

C. Attach Support Rods For Horizontal Piping:

1. To steel beams with I-clamps.
2. To concrete slabs with wedge anchors.
3. To wood with thickness of 2-1/2 inches or more with bolts or angle clips.

D. Trapeze Hangers:

1. Trapeze hangers may be used in lieu of individual hangers where horizontal piping is arranged with two or more parallel lines.
2. Attach lines to horizontal with U-bolts or one-hole clamps.

E. Vertical Piping:

1. Support by channel type support system and pipe clamps on 10-foot maximum centers.
2. Copper and Plastic Piping: Isolate from channels and pipe clamps with pipe isolators.

F. Insulated Piping: Furnish galvanized protection shield and oversized hangers under insulated piping.

G. Provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 INTERIM CLEANING

A. Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping during fabrication and assembly.

B. Examine piping to assure removal of foreign objects prior to assembly.

C. Conventional commercial cleaning methods of cleaning are acceptable if method and cleaning material does not corrode, deform, swell, or otherwise alter physical properties of material being cleaned.

3.09 TESTING

A. General:

1. Conduct pressure and leakage tests on newly installed pipelines.
2. Provide necessary equipment and material, and make taps in pipe, as required.

3. Resident Engineer will monitor tests. Provide 24-hour advance notice of start of testing.
4. Test Pressures: As specified herein and in Piping Schedule.
5. Test Records: Make records of each piping system installation during test to document the following:
    a. Date of test.
    b. Description and identification of piping tested.
    c. Test fluid.
    d. Test pressure.
    e. Resulting pressure.
    f. Remarks, including:
        1) Leaks (type, location).
        2) Repairs made on leaks.
    g. Certification by Contractor and signed acknowledgment by Engineer that tests have been satisfactorily completed.

B. Testing New Pipe Connected to Existing Pipe: Isolate new pipe with grooved end pipe caps, spectacle blinds, or blind flanges.

C. Preparation and Execution:

1. Buried Pressure Piping:
    a. An initial service leak test may be conducted with a partially backfilled trench and the joints left open for inspection, if field conditions permit, as determined by Engineer.
    b. Expose joints for the acceptance test on buried pressure piping to be pneumatically tested or subjected to an initial service leak test.
    c. Conduct final hydrostatic acceptance tests after trench has been completely backfilled.
2. Exposed Piping: Conduct tests after piping has been completely installed including supports, hangers, and anchors, but prior to insulation.

D. Hydrostatic Leak Tests:

1. Equipment: Provide the following:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

2. Procedure:
    a. Use water as the hydrostatic test fluid.
    b. Provide clean test water of such quality as to minimize corrosion of the materials in the piping system.
    c. Open vents at high points of the piping system to purge air pockets while the piping system is filling.
    d. Venting during filling of system may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.
    e. Test piping systems at test pressure specified in Piping Schedule.
    f. Maintain hydrostatic test pressure continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
    g. Examine joints and connections for leakage.
    h. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.
    i. Correct visible leakage and retest to satisfaction of Engineer.
3. Buried Water Lines:
    a. A limited amount of leakage is permissible according to formula specified.
    b. Conduct hydrostatic testing as follows:
        1) Pipe with Concrete Thrust Blocking: Do not make pressure test until a minimum of 5 days after thrust blocking is installed.
        2) If high-early strength cement is used for thrust blocking, time may be reduced to 2 days.
    c. Cement-Lined Piping: Slowly fill test section with water and allow to stand for 24 hours under slight pressure to allow cement lining to absorb water.
    d. Expel air from piping system prior to testing.
    e. Apply and maintain specified test pressure with hydraulic force pump.
    f. Valve off the piping system when test pressure is reached.
    g. Conduct pressure test for 2 hours, reopening isolation valve only as necessary to restore test pressure.
    h. Accurately measure amount of water required to maintain test pressure by placing pump suction in a barrel or similar device, or by metering.
    i. The measurement represents leakage, defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period.

j. Determine maximum allowable leakage in gallons per hour from the following formula:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour
N = Number of joints in the length of pipe tested
D = Nominal diameter of pipe, in inches
P = Test pressure during the leakage test, in pounds per square inch

k. Correct leakage greater than the allowable determined under this formula, and retest to satisfaction of Engineer.

4. Test Pressure for Water: 1-1/2 times system pressure.
5. Gravity Sewers and Drains:
   a. Test by water or air exfiltration tests as prescribed by local or state plumbing codes and visually examine for leaks.
   b. Repair leaks and retest system until no further leakage is evident.

E. Pneumatic Leak Tests:

1. Perform on compressed air, natural gas, and vacuum piping.
2. Equipment: Provide the following:

Amount	Description
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105 percent of the required primary test pressure
1	Calibrated test gauge

3. Procedure:
   a. Perform pneumatic testing using accurately calibrated instruments and oil-free, dry air.
   b. Perform tests only on exposed piping, after piping has been completely installed, including supports, hangers and anchors, and inspected for proper installation.
   c. Test piping system at test pressure specified in Piping Schedule.
   d. Protect test personnel and Owner’s operating personnel from hazards associated with air testing.

e. Secure piping to be tested to prevent damage to adjacent piping and equipment in event of a joint failure.
f. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by test.
g. Apply maximum 25 psig preliminary pneumatic test to piping system prior to final leak testing, to locate major leaks.
h. Examine joints and connections for leakage with soap bubbles.
i. Correct visible leaks and retest.
j. Gradually increase pressure in system to not more than one-half of test pressure.
k. Thereafter increase pressure in steps of approximately 1/10 of maximum test pressure until required test pressure is reached.
l. Maintain pneumatic test pressure continuously for minimum 10 minutes and for such additional time as necessary to conduct a soap bubble examination for leakage.
m. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage.
n. Correct visible leakage and retest to satisfaction of Engineer.
o. Following pneumatic testing, thoroughly purge lines that are to carry flammable gases with nitrogen to assure no explosive mixtures will be present in system during filling process.

3.10 CLEANING AND DISINFECTION

A. Clean and disinfect according to Brevard County document “2022 Criteria for Water and Sanitary Sewerage Systems Within Brevard County” submit test data to Engineer for review upon completion.

3.11 CORROSION PROTECTION

A. As specified in Section 40 27 00, Process Piping—General.

3.12 PROTECTION OF INSTALLED WORK

A. Protective Covers:

1. Provide over floor and shower drains during construction, to prevent damage to drain strainers and keep foreign material from entering drainage system.
2. Cover roof drains and emergency overflow drains during roofing process so roofing material and gravel do not enter drain piping.
3. Remove at time of Substantial Completion.

3.13 FIELD FINISHING

A. In accordance with Section 40 27 00, Processing Piping—General.

3.14 PIPING IDENTIFICATION

A. Refer to Section 40 27 00, Process Piping—General, and Pipe Schedule.

3.15 SUPPLEMENTS

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

1. Plumbing Piping Data Sheets.

Section Number	Title
22 10 01.02	Polyvinyl Chloride Drain Waste and Vent (PVC-DWV) Pipe and Fittings

END OF SECTION

SECTION 22 10 01.02 POLYVINYL CHLORIDE DRAIN WASTE AND VENT (PVC-DWV) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe and Fittings	All	PVC-DWV Schedule 40 nonpressure application, Class 12454B conforming to ASTM D2665 and ANSI/NSF Standard 14 system.
Joints	All	Solvent cemented conforming to ASTM D2855 except where connection to equipment may require future removal.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.

END OF SECTION

SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

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

1. American Gas Association (AGA).
2. American Society of Heating, Refrigerating & Air-Conditioning Engineers, Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. American Society of Mechanical Engineer's (ASME).
4. American Society of Sanitary Engineering (ASSE):
   a. 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Backflow Preventers.
   b. 1015, Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Backflow Fire Protection Assemblies.
5. American Water Works Association (AWWA):
   a. C510, Double Check Valve Backflow Prevention Assembly.
   b. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   c. C550, Protective Interior Coatings for Valves and Hydrants.
6. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
7. Canadian Standards Association (CSA):
   a. B64.4, Backflow Preventers, Reduced Pressure Principle Type (RP).
   b. B64.5, Backflow Preventers, Double Check Valve Type (DCVA).
8. FM Global (FM).
9. Food and Drug Administration (FDA).
10. Foundation for Cross-Connection Control and Hydraulic Research at University of Southern California (FCCHR): Manual of Cross-Connection Control.
11. International Code Council (ICC): International Plumbing Code (IPC).
12. National Electrical Manufacturers Association, (NEMA): MG 1, Motors and Generators.

13. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
14. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. UL.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's product data.

B. Informational Submittals: Provide data in accordance with client's Section 01 78 23, Operating and Maintenance Data.

1.03 SPECIAL GUARANTEE

A. Where noted below, provide manufacturer's extended guarantee in writing with Owner named as beneficiary. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of products found defective during the stated period after date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the authority having jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 ELECTRIC WATER HEATER (COMMERCIAL):

A. Description:

1. Automatic, vertical, electric storage type.
2. Regulatory Compliance: UL listed, ASME, ASHRAE 90.1, and NSF.

3. Tank: Steel, glass-lined, 150 psig working pressure, and ASME rate with 4-inch by 6-inch handhole cleanout.
    a. Insulation: Foam or fiberglass type with minimum R value per ASHRAE 90.1.
    b. Dip Tube: Required on inlet connection down to bottom section of tank.
    c. Anode: Heavy-duty, tank-mounted, screw-in type.
    d. Pressure/Temperature Relief Valve: ASME rated.
    e. Connections: Inlet and outlet with factory-installed dielectric unions and brass drain valve with hose thread.
    f. Heating Element: Watt-density (maximum of 75 watts per square inch) incoloy sheath; immersion type.
    g. Controls: Fully automatic, house in hinged control panel, and including the following:
    h. Terminal block.
    i. Close differential immersion-type thermostat.
    j. Control transformer for 120-volt circuit and fusing.
    k. Magnetic contactors for each stage.
    l. Manual reset high-limit switch.
    m. Adjustable temperature range, 95 degrees F to 180 degrees F.
    n. Power circuit fusing as required by NEC and UL.
    o. Guarantee: 3 years.
4. Capacity: See equipment schedules on Drawings.
5. Manufacturers:
    a. AO Smith.
    b. Bradford White Corporation.
    c. Lochinvar Corporation.

2.03 DOMESTIC WATER EXPANSION TANK

A. Description:

1. Type: Prepressurized diaphragm type, horizontal or vertical per expansion tank data sheet at end of section.
2. Shell: Welded steel.
3. Diaphragm: FDA-approved, heavy-duty butyl with polypropylene liner.
4. Connection Size: Per expansion tank data sheet at end of section.
5. Maximum Operating Pressure: Per expansion tank data sheet at end of section.
6. Maximum Operating Temperature: Per expansion tank data sheet at end of section.
7. Finish: Manufacturer’s standard air-dry enamel.
8. Capacity: See equipment schedules on drawings.
9. Manufacturer: AMTROL, Inc.; Model AST.

2.04 SIMPLEX, SUBMERSIBLE SUMP PUMP:

A. Description:

1. Type: Simplex, heavy-duty, nonclog, close-coupled submersible centrifugal sewage ejector pump.
2. Volute: Stainless steel, foot mounted.
3. Impeller: Stainless steel.
4. Wear Plates: Stainless steel.
5. Motor Enclosure: Stainless steel, Buna-N O-ring seals with corrosion-resistant exterior finish.
6. Motor: Continuous-duty, built-in thermal overload protection.
7. Shaft Seals: Tandem, mechanical type.
8. Shaft: Stainless steel.
9. Bearings: Permanently lubricated, ball bearing with B-10 bearing life of 17,500 hours.
10. Electrical: Inner seal chamber with 2 moisture sensing probes and attached power and control cables, with length, voltage, and power requirements as indicated on data sheet at end of section.
11. Controls:
    a. Circuit Breakers: Motor rated.
    b. Motor Starters: Magnetic with thermal overload protection device.
    c. Level Control: Simple Single Polypropylene-encapsulated mechanical float switch.
    d. Leak Detection: Pump seal alarm circuit.
    e. Capacity: See equipment schedules on drawings.
12. Manufacturers:
    a. Grundfos.
    b. Cat Pumps.
    c. Weil Pump Company, Inc.

2.05 OIL/WATER SEPARATOR:

A. Description:

1. Separator Tank with Integral Storage: See equipment schedules on drawings.
2. FRP tank with 4-inch inlet, 4- inch outlet, and vent connections, internal fume vent, adjustable oil draw-off, removable filter screen, bottom hold down flange, and flow control fitting.
3. Cover: Nonskid diamond treadplate cover for flush-with-grade installation, rated heavy-duty traffic, stainless steel bolts, and leakproof gasket.

4. Coatings: Factory coating to resist oil, grease, and cutting oils on inside, and bituminous coating on outside.
5. Installation:
    a. Place 6-inch minimum thickness of imported crushed aggregate material on undisturbed earth or modified subgrade below oil water separator, thoroughly compact with a mechanical vibrating or power tamper. Meet requirements of Fill and Excavation specifications.
    b. Remove and keep water clear from excavation during construction.
    c. Excavation: As specified in Section 31 23 16, Excavation.
    d. Backfill: As specified in Section 31 23 23 Fill and Backfill, and Section 31 23 23.15, Trench Backfill.
    e. Setting Oil Water Separator: Finish grade of structure top shall be even with surrounding finish grade surface, unless noted otherwise on drawings.
6. Capacity: See equipment schedules on Drawings.
7. Manufacturers:
    a. Oil Water Separator Technologies.
    b. Jay R. Smith Manufacturing Company.
    c. Rockford Sanitary Systems.

2.06 BACKFLOW PREVENTERS

A. Reduced-pressure Backflow Preventers (3/4 Inch Through 2 Inches):

1. Description:
    a. Regulatory Compliance: AWWA C511, CSA B64.4, FCCHR of USC Section 10, ASSE 1013, ICC (IPC).
    b. Valve Body: Bronze.
    c. End Connections: Threaded, NPT.
    d. Maximum Working Pressure: 175 psi (350 psi test).
    e. Temperature Range: 32 degrees F to 140 degrees F.
    f. Shutoff Valve: Full port, resilient-seated, bronze ball valve with bronze ball valve test cock.
    g. Inlet Strainer: Bronze wye strainer, 40-mesh perforated, Type 304 stainless steel.
    h. Accessories: Drain line air gap fitting.
2. Sizes: See Plumbing Schedules on the Drawings.
3. Manufacturers and Products:
    a. Watts; Model LF909.
    b. Wilkins/Zurn; Model 975XL2.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, arrange, and connect equipment as shown on the Drawings and in accordance with manufacturer's recommendations.

3.02 FIELD QUALITY CONTROL

A. Pumps: Do not hydrostatic test pumps with mechanical seals.

B. Startup:

1. Piping Systems: Verify that flushing, cleaning, and testing has been completed prior to startup.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Gas Association (AGA).
2. American Society of Mechanical Engineers (ASME).
3. American Society of Sanitary Engineering (ASSE): 1010, Performance Requirements for Water Hammer Arresters.
4. Americans with Disabilities Act (ADA).
5. ASTM International (ASTM): D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
6. Food and Drug Administration (FDA).
7. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
8. Plumbing and Drainage Institute (PDI):
    a. Code Guide 302 and Glossary of Industry Terms.
    b. WH-201, Water Hammer Arrester Standard.
9. UL.

1.02 SUBMITTALS

A. Action Submittals: Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.03 REGULATORY REQUIREMENTS

A. Comply with the Americans with Disabilities Act (ADA), and local and state requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the authority having jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

B. Contractor to incorporate approved fixtures in accordance with latest JEA Facility Standards.

2.02 MANUFACTURERS

A. Drainage Products:

1. General:
   a. Smith.
   b. Wade.
   c. Zurn.

2.03 GENERAL

A. Fixture Trim: Provide plumbing fixture trim where applicable on fixtures.

B. Plumbing Fixtures: Indicated by fixture number as shown on the Drawings.

C. Drainage Products: Indicated by fixture number as shown on the Drawings.

D. Plumbing Specialties: Indicated by fixture number as shown on the Drawings.

E. Exposed fixture connections and piping shall be polished chrome-plated.

2.04 MATERIALS

A. Plumbing Fixtures:

1. SSH-1, Safety Shower/Eyewash Combination:
   a. Model: Hughes ; Model J5GS45G.
   b. Pipework and fittings: Stainless Steel.

c. Shower nozzle: Injection molded nylon 6
d. Eyewash: Acrylic capped ABS
e. Valve: Stay open.
f. Support: Freestanding, 1-1/4-inch powder coated galvanized pipe standard, stanchion, and floor flange.
g. Fully insulated with Polyurethane foam and impact resistant outer casing.

B. Drainage Products:

1. ECO-1, Cleanout:
   a. Material: Taper thread, bronze plug, heavy-duty, scoriated cast-iron top.
   b. Manufacturer and Product: Charlotte Pipe PLG 430.
2. CO-1, Cleanout:
   a. Material: Taper thread, PVC plug.
   b. Manufacturer and Product: Charlotte Pipe PVC 105X.
3. FCO-1, Floor Cleanout (Unfinished Areas):
   a. Material: Tapered thread, bronze plug with round adjustable scoriated secured cast-iron top.
   b. Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 4243S.
4. FD-1, Floor Drain (General Drainage):
   a. Materials: Cast-iron body and top.
   b. Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 2210
5. HD-1, Hub Drain:
   a. Coated cast-iron reducing hub adapter with standard cast-iron hub.
   b. Hub: Two pipe sizes larger than outlet.
6. TD-1, Trench Drain:
   a. Material: HDPE
   b. Size: 6 inches wide with galvanized iron bar grate.
   c. Manufacturer and Product: Zurn: Z886.

C. Hose Valves: Refer to Section 22 10 01, Plumbing Piping and Accessories.

D. Sealant: In accordance with Section 07 92 00, Joint Sealants.

PART 3 EXECUTION

3.01 PREPARATION

A. Drawings do not attempt to show exact details of fixtures. Changes in locations of fixtures, advisable in opinion of Contractor, shall be submitted to Engineer for review before proceeding with the Work.

3.02 INSTALLATION

A. Fixture Trim: Install fixture trim where applicable on fixtures.

B. Plumbing Fixtures, Mounting Heights:

1. Standard rough-in catalogued heights, unless shown otherwise on the Drawings.
2. Caulk fixtures in contact with finished walls with waterproof, white, nonhardening sealant which will not crack, shrink, or change color with age. See Section 07 92 00, Joint Sealants.

C. Exact fixture location and mounting arrangement shall be as indicated on toilet room elevations and details as shown on the Drawings.

D. Unless noted otherwise and as a minimum, fixtures shall be supported as indicated in PDI Code Guide 302.

E. Safety Equipment:

1. System Shutoff Valves:
   a. Shutoff valves shall give visual indication of position (open or closed).
   b. Shutoff valves shall be lockable valves and locked in open position.
2. Each safety shower, eyewash, combination safety shower/eyewash shall have red safety signoff tag. After completing requirements listed below, Contractor and Owner shall sign red safety signoff tag. Requirements are as follows:
   a. Visually check safety shower/eyewash piping for leaks.
   b. Verify that upon operation, stay-open valves remain open.
   c. Showerheads to be between 82 inches and 96 inches above standing surface.
   d. Shower spray pattern, when valve is full open, shall be a minimum 20 inches in diameter at 60 inches above standing surface.
   e. Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws Drinking Faucet Co., Model 9015.
   f. Minimum flow rates for safety showers shall be 20 gpm.
   g. Minimum flow rates for eyewashes shall be 3 gpm.
   h. Tempered water shall be temperature indicated on the Drawings.

F. Drainage Products:

1. Floor Drains: Set top flush with floor. Provide membrane clamps where required.
2. Cleanouts: Install where shown or required for purposes intended. Set cover flush with finished floor.
3. Hub Drains: Set top of hub 2 inches above finished floor.

G. Caulk penetrations of exterior walls with weatherproof sealant in accordance with Section 07 92 00, Joint Sealants.

H. Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

3.03 FIELD QUALITY CONTROL

A. Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.

B. Notify Owner and Engineer 48 hours prior to shower testing. Owner and Engineer reserve the right to witness all tempered water and safety shower testing.

C. Test safety shower and eyewash units. Water flow must be tested at both showerhead and eyewash/face ring.

1. Shower Flow:
   a. Test with tube-type water gauge (Haws Drinking Faucet Co., Model 9010) and 5-gallon container.
   b. Container shall fill in 10 seconds or less, with a minimum 20-gpm flow.
2. Eyewash Flow:
   a. Test with tube-type water gauge (Haws Drinking Faucet Co., Model 9010) and 1-gallon container.
   b. Container shall fill in 20 seconds or less.
3. Contractor shall log, date, and initial inspection upon passing flow tests.

D. Verify alarm operation both locally and systemwide. Notify security prior to test if alarm is connected system-wide.

END OF SECTION

SECTION 23 05 48
VIBRATION ISOLATION AND SEISMIC CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. A36/A36M, Specification for Carbon Structural Steel.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code—Steel.
4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): Seismic Restraint Manual: Guidelines for Mechanical Systems.
5. Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. EPDM: Ethylene-Propylene-Diene Monomer.

C. Withstand: Unit will remain in place without separation of any parts from the device when subjected to seismic forces specified and unit will be fully operational after the seismic event.

1.03 DESIGN REQUIREMENTS

A. Seismic Control:

1. Provide seismic control as required to maintain integrity of mechanical piping, ductwork, and equipment installed in this Project, so they will "withstand" seismic forces.
2. Design shall comply with requirements of this Specification, and applicable codes.
3. Design, size, and install for piping and equipment throughout facility, whether shown or not.

4. Designed by a registered professional engineer in the state where the Work is to be installed.
5. Seismic restraints shall conform to requirements of SMACNA's Seismic Restraint Manual: Guidelines for Mechanical Systems.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings, Vibration Isolators:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Product Data:
      1) Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
      2) Schedule of vibration isolator type with location and static and dynamic load on each.
      3) Vibration Isolation Base Details:
         a) Detail fabrication, including anchorages and attachments to structure and to supported equipment.
         b) Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
2. Shop Drawings, Seismic Control Components:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Signed and sealed by a registered Professional Engineer registered in the state where the Project is located.
   c. Include, as a minimum, a tabulation of design data for each snubber, including specific anchorage details.
   d. Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
   e. Product Data:
      1) Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
      2) Schedule of seismic control component type with location and static and dynamic load on each.

3) Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

f. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
2. Certifications:
   a. Manufacturer's Certificate of Compliance.
   b. Manufacturer's Certificate of Proper Installation.
   c. Welding Certificates: Welding procedures and personnel.
3. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
4. Seismic qualification certification of compliance in accordance with Section 01 45 36, Equipment Seismic Certification.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Isolation materials, flexible connectors, and seismic restraints shall be same manufacturer. Select and certify using published or factory certified data.

C. Seismic Control:

1. Designer Qualifications:
   a. Professional Engineer registered in state where Project resides.
   b. Minimum of 5 years' work experience certifying seismic snubber and anchorage details.
2. Components shall bear anchorage pre-approval "R" number, from agency acceptable to AHJ, showing maximum seismic restraint ratings.
3. Anchorage and Bracing shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the state where the Work is to be installed.

1.06 EXTRA MATERIALS

A. Furnish extra materials described below which match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Seismic Snubber Units: Furnish replacement neoprene inserts for snubbers.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION

A. General:

1. Provide for mechanical piping, ductwork, and equipment as identified by this Specification.
2. Select in accordance with equipment, pipe, or duct weight distribution to produce reasonably uniform deflections.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 30 percent and 60 percent of maximum deflection.

B. Elastomeric Pad:

1. Oil-resistant and water-resistant elastomer or natural rubber waffle pads, arranged in single or multiple layers, molded with a nonslip pattern.
2. Waffle pads bonded each side of minimum 1/4-inch thick galvanized steel separator plate.
3. Height of waffle ribs shall not exceed 0.7 times width.
4. Maximum Loading: 60 psi.
5. Minimum Single Layer Thickness: 1/4 inch.
6. Separator plate of sufficient stiffness for uniform loading over pad area.
7. Factory cut to size that matches requirements of supported equipment.
8. Waffle Pad Material: Standard neoprene.
9. Number of Layers: As required to support equipment load; refer to manufacturer’s data for load capacities.

2.02 FLEXIBLE CONNECTORS

A. Flexible Pipe Connectors:

1. Braided Nonferrous: For nonferrous piping systems, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, braze-welded to hose.
2. Braided Stainless Steel: For ferrous piping, provide stainless steel hose covered with Type 304 stainless steel wire braid with NPT steel nipples or 150-psi ANSI flanges, welded to hose.
3. Manufacturers:
    1. Mason Industries, Inc.
    2. General Rubber.
    3. Kinetics Noise Control, Inc.

B. Flexible Duct Connectors: Refer to Section 23 31 13, Metal Ducts and Accessories.

2.03 SEISMIC RESTRAINTS

A. Resilient Isolation Washers and Bushings: One-piece, molded neoprene, having a durometer 40, plus or minus 5, with a flat washer face.

B. Seismic Snubbers: Factory fabricated using welded structural steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

C. Restraining Cables: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

D. Anchor Bolts:

1. Seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

E. Manufacturers:

1. California Dynamics Corp.
2. Kinetics Noise Control, Inc.
3. Loos & Co., Inc.; Cableware Technology Division.
4. Mason Industries, Inc.
5. M.W. Sausse & Co., Inc. (VIBREX).
6. TOLCO Incorporated.

7. Unistrut Diversified Products Co.; Wayne Manufacturing Division.
8. Vibration Eliminator Co., Inc.
9. Vibration Isolation Co., Inc.
10. The VMC Group.

2.04 SHOP/FACTORY FINISHING

A. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment, before shipping.

1. Powder coating on springs and housings.
2. Electro-galvanized hardware.
3. Hot-dip galvanized metal components for exterior use.
4. Baked enamel coat metal components for interior use.

B. Color-code or otherwise mark vibration isolation and seismic control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Install products in accordance with manufacturers' written instructions.
2. Connect wiring to isolated equipment with flexible hanging loop.
3. Locate isolation hangers as near overhead support structure as possible.

B. Flexible Connectors: Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

C. Seismic Restraint Devices:

1. Notify local representative of seismic restraint materials manufacturer prior to installing seismic restraint devices.
2. No rigid connections between equipment and building structure shall be made which degrades seismic restraint system herein specified.
3. Electrical conduit to restrained equipment shall be looped to allow free motion of equipment without damage to electrical wiring.
4. Install seismic snubbers on isolated equipment.
5. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
6. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.
7. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers.
8. At trapeze anchor locations, shackle piping and equipment to trapeze.
9. Install resilient bolt isolation washers on equipment anchor bolts.
10. Upon completion of seismic restraint material installation and before startup of restrained equipment, clean debris from beneath protected equipment, leaving equipment free to contact snubbers.

3.03 FIELD QUALITY CONTROL

A. An independent testing agency will be retained by Owner to perform inspections on the installation of the anchorage and bracing of all systems.

B. Any other specified, regulatory required, or repair verification inspection and testing that are not listed in Statement of Special Inspections, are to be provided by Contractor.

C. Testing:

1. Conduct the following field quality-control testing:
   a. Isolator deflection.
   b. Isolator seismic-restraint clearance.
   c. Snubber minimum clearances.

D. Seismic Control Component Inspection:

1. Conduct periodic inspections of material installation with assistance of manufacturer's representative. Report in writing deviations from good installation practice.
2. Upon completion of seismic restraint device installation inspect completed system with assistance of manufacturer's representative. Report in writing installation errors, improperly selected snubber devices, or other fault in the system that could affect performance of the system.

3.04 ADJUSTING

A. Vibration Isolation Devices:

1. Adjust isolators after piping systems have been filled and equipment is at operating weight.
2. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height.
3. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
4. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.
5. Adjust isolators to ensure units do not exceed rated operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points.
6. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

B. Seismic Control Components:

1. Adjust snubbers according to manufacturer's written recommendations.
2. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
3. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.05 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic control devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
3. Associated Air Balance Council (AABC): National Standards for Field Management and Instrumentation Total System Balance.
4. National Environmental Balancing Bureau (NEBB):
   a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
   b. Procedural Standards for Measuring Sound and Vibration.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

1.02 SUBMITTALS

A. Informational Submittals:

1. Documentation of experience record of testing authority.
2. Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the work under this Contract.
3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
4. Written verification of calibration of testing and balancing equipment.
5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.03 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:

1. Certification by AABC of NEBB for testing, adjusting and balancing of HVAC systems.
2. Corporately and financially independent organization functioning as an unbiased testing authority.

3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.
4. Have a proven record of at least five similar projects.
5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

C. Drives for Belt-Driven Fans:

1. Furnish cast iron or flanged steel sheaves.
2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust and balance air systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.
B. Adjust and balance heating system during the coldest month and cooling systems during the hottest month respectively.

3.02 ADJUSTING AND BALANCING AIR SIDE

A. Preparation:

1. Prior to beginning the Work, perform the following activities:
   a. Review shop drawings and installed system for adequate and accessible balancing devices and test points.
   b. Recommend to Engineer dampers that need to be added or replaced in order to obtain proper air control.

c. Verify proper startup procedures have been completed on the system.
d. Verify controls installation is complete and system is in stable operation under automatic control.
e. Verify test instruments have been calibrated to a recognized standard and are within manufacturer's recommended calibration interval before beginning the Work.

B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
2. Lock and mark final positions of balancing dampers with permanent felt pen.

C. Equipment Data:

1. Collect the following data and included in final report:
   a. Type of unit.
   b. Equipment identification number.
   c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
   d. Motor data (frame, hp, volts, FLA rpm, and service factor).
   e. Sheave manufacturer, size, and bore.
   f. Belt size and number.
   g. Sheave centerline distance and adjustment limits.
   h. Starter and motor overload protection data.
   i. Include changes made during course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
   a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 5 percent minus 0 percent.
   b. After final adjustments, do not operate motor above nameplate amperage on any phase.
   c. After final adjustments, do not operate fan above maximum rated speed.

d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower. Provide written notice to air handling unit manufacturer and Engineer if drive or belt changes were made.

4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.
5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

E. Air Outlets and Inlets:

1. In each system at least one air path from fan to final branch duct termination shall have dampers fully open.
2. Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus or minus 5 percent.
3. Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.
4. After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

3.03 FIELD QUALITY CONTROL

A. Performance Testing:

1. Heating Coil:
   a. Adjust system as required to achieve full output from coil.
   b. Read and record amperages and voltages for all phases.
   c. Measure and record airflow rate, entering air temperature, leaving air temperature.
2. Heating or Sensible Cooling Coil Testing:
   a. Adjust system as required to achieve design flow conditions for air sides of coil.
   b. Measure and record airflow rate, entering air temperature, leaving air temperature.

B. Balancing Log Report Requirements:

1. Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.
2. Log and record operational information from every test for each system, as necessary to accomplish services described.
3. Include equipment data for units tested.
4. Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.
5. Indicate recorded site values, and velocity and mass correction factors used to provide equivalent standard air quantities.
6. Include separate section in log, if necessary, describing operating difficulties in air or water systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of condition and its effect on building, and describe corrective actions attempted and recommended.

C. Quality Control Verification:

1. After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:
   a. Air balancing procedures, vibration tests, and verification of test results.
   b. Perform spot tests on a maximum of 50 percent of total diffusers and grilles, on two air handling fan devices per building, with measuring equipment used in original tests, at random points selected by Engineer.
   c. Results of these spot tests shall agree with balance logs within plus or minus 5 percent. Where this accuracy cannot be verified, rebalance portions of system as requested by Engineer.
   d. At completion of rebalance procedures, perform another spot test if required to verify results.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. Association of the Nonwoven Fabric Industry (INDA). IST 80.6, Water Resistance (Hydrostatic Pressure).
3. ASTM International (ASTM):
    a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    b. C547, Standard Specification for Mineral Fiber Pipe Insulation.
    c. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    d. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
    e. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
    f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
    g. G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
    h. G22, Standard Practice for Determining Resistance of Plastics to Bacteria.
4. National Fire Protection Association (NFPA):
    a. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
    b. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
    c. 259, Standard Test Method for Potential Heat of Building Materials.
5. UL.

1.02 DEFINITIONS

A. Cold Air Ductwork: Designed to convey mechanically cooled air or return ducts in such systems.

B. Warm Air Ductwork: Designed to convey mechanically heated air or return ducts in such systems.

1.03 SUBMITTALS

A. Action Submittals: Product description, list of materials and thickness for each service or equipment scheduled, locations, and manufacturer's installation instructions.

B. Informational Submittals:

1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
2. Operation and maintenance data.

1.04 QUALITY ASSURANCE

A. Insulation installation work shall be of the highest quality consistent with the best practices of the trade including aesthetic as well as mechanical aspects of the Work. Final work shall be approved by the Owner.

B. Materials furnished under this specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

C. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.

D. UL listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Stamp or Label:

1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Project Site for use must have manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
2. Insulation Packages and Containers: Marked "asbestos-free."

PART 2 PRODUCTS

2.01 GENERAL

A. Insulation Exterior: Cleanable, grease-resistant, nonflaking, and nonpeeling.

B. Insulation: Conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.

C. Insulation for Fittings, Flanges, and Valves: Premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

D. Fire Resistance:

1. Insulation, Adhesives, Vapor Barrier Materials and Other Accessories, Except as Specified Herein: Noncombustible.
2. Do not use fugitive or corrosive treatments to impart flame resistance.
3. Flame proofing treatments subject to deterioration resulting from the effects of moisture or high humidity are not acceptable.
4. Provide materials including facings, mastics, and adhesives, with fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.

E. Materials exempt from fire-resistant rating:

1. Nylon anchors.
2. Treated wood inserts.

F. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:

1. Polyurethane insulation.
2. PVC casing.
3. Fiberglass-reinforced plastic casing.

2.02 PIPE INSULATION

A. Type P3—Elastomeric (ASTM C534, Minus 40 Degrees F to 220 Degrees F):

1. Flexible, closed cell elastomeric.
2. Nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
3. Water vapor transmission 0.1 perm-inch, or less.
4. Manufacturers and Products:
   a. Armacell; AP Armaflex.
   b. Nomaco; K-Flex LS.

2.03 DUCT INSULATION

A. Type D5—Flexible Elastomeric (ASTM 534, Type I for tubular materials and Type II for sheet materials):

1. Closed-cell, sponge- or expanded-rubber materials.
2. Manufacturers and Products:
   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

2.04 INSULATION FINISH SYSTEMS

A. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.016-inch thickness, with smooth mill finish.
2. Moisture Barrier: Provide factory applied moisture barrier, consisting of 40-pound kraft paper with 1-mil-thick low-density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturer and Product:
   a. RPR Products; INSUL-MATE.
   b. ITW, Pabco-Childers.

B. Type F2—Paint:

1. Acrylic latex paint, white.
2. Manufacturers and Products:
   a. Armstrong; WB Armaflex finish.
   b. Rubatex; 374, white finish.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor is responsible for the correct installation of the insulation specified, including aesthetic as well as mechanical aspects of the Work, shall be of the highest quality consistent with the best practices of the trade.

3.02 APPLICATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices.

B. Apply insulation over clean, finish painted, and dry surfaces.

C. Install insulation after piping system has been pressure tested and leaks corrected.

D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

F. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

G. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal all butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.

H. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units. Finish cold pipe fittings with white vapor barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

I. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

J. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.

K. Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

L. Insulate valve bodies, flanges, and pipe couplings.

M. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

N. Do not insulate flexible pipe couplings and expansion joints.

O. Do not allow insulation to cover nameplates or code inspection stamps.

P. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

Q. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

R. Placement:

1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
2. Insulate valves and fittings with sleeved or cut pieces of same material.
3. Seal and tape joints.

S. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

T. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

3.03 INSTALLATION OF DUCTWORK INSULATION

A. General: Install insulation products in accordance with the manufacturer’s written instructions and in accordance with recognized industry practices.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.

E. Seal longitudinal and circumferential joints with FSK tape, and finish with fiberglass mesh fabric embedded in vapor barrier mastic.

F. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

G. Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

3.04 INSTALLATION OF INSULATION FINISH SYSTEMS

A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

D. Do not use screws or rivets to fasten the fitting covers.

E. Install removable prefabricated aluminum covers on exterior flanges and unions.

F. Caulk and seal all exterior joints to make watertight.

3.05 PIPING INSULATION REQUIREMENTS

A. Refrigeration Suction:

1. Type P3, elastomeric.
2. 1/2-inch thickness for pipe sizes up to 1 inch.
3. 3/4-inch thickness for pipe sizes over 1 inch.

B. Condensate Drain:

1. Type P3, elastomeric.
2. 1/2-inch thickness for pipe sizes up to 2-5/8 inches ID.
3. 3/4-inch thickness for pipe sizes over 2-5/8 inches ID.

C. Pipe Hangers:

1. Type P3, Elastomeric: Rigid insulation section with 9-inch-long, 16-gauge galvanized steel saddle.

3.06 DUCTWORK INSULATION REQUIREMENTS

A. Mechanically Cooled and Heated Supply Air (Exposed to View):

1. Type D5—Flexible Elastomeric (ASTM 534, Type I for tubular materials and Type II for sheet materials).
2. 1-1/2-inch thickness.

B. Sheet Metal Plenums:

1. Type D5—Flexible Elastomeric (ASTM 534, Type I for tubular materials and Type II for sheet materials.
2. 1-1/2-inch thickness.

C. Air Distribution Devices: Refer to Section 23 37 00, Air Outlets and Inlets, for requirements.

3.07 INSULATION FINISH REQUIREMENTS

A. Ductwork Insulation (All): Type F2—Paint.

B. Piping Insulation (All): Type F3, aluminum.

C. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.08 FIELD QUALITY CONTROL

A. Insulation installation work shall be of the highest quality consistent with the best practices of the trade including aesthetic as well as mechanical aspects of the Work.

B. Test factory-applied materials assembled. Field-applied materials may be tested individually.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 760, Performance Rating of Solenoid Valves for Use with Volatile Refrigerants.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): 15, Safety Standard for Refrigeration Systems.
3. American Society of Mechanical Engineers (ASME):
   a. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   b. B31.5, Refrigeration Piping and Heat Transfer Components.
4. American Welding Society (AWS):
   a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   b. BRH, Brazing Handbook.
5. ASTM International (ASTM): B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
6. National Electrical Manufacturers Association (NEMA).
7. Underwriters Laboratories Inc. (UL).

1.02 DEFINITIONS

A. ACR: Air conditioning and refrigeration.

B. NRTL: National Recognized Testing Laboratory.

1.03 SUBMITTALS

A. Action Submittals: Manufacturer’s data on refrigerant piping, piping products, thermostatic expansion valves, solenoid valves, hot-gas bypass valves, filter dryers, strainers, pressure regulating valves and accessories.

B. Informational Submittals:

1. Welding certificates.
2. Field quality control; test report.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Safety Code Compliance: Comply with applicable portions of ASHRAE 15.

B. Brazing: Comply with applicable requirements of ASME B31.5 pertaining to brazing of refrigerant piping for shop and Project Site locations.

C. Installer: A firm with at least 5 years of successful installation experience on projects with refrigerant piping similar to that required for this Project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Refrigerant piping shall be cleaned, dehydrated, and sealed when delivered.

B. Store piping in clean and protected area with end caps in place.

PART 2 PRODUCTS

2.01 MATERIALS

A. Material and dimensional requirements for field assembled refrigerant piping, valves, fittings and accessories shall conform to ASHRAE 15 and ASME B31.5, except as hereinafter specified.

B. Piping, 3 Inches and Smaller: Copper, Type ACR tube, ASTM B280, copper No. 122, hard-drawn temper. Brazed joints required.

C. Fittings for Copper Tube: Wrought-copper/bronze solder-joint fittings in accordance with ASME B16.22.

D. Pipe Insulation: Refer to Section 23 07 00, HVAC Insulation.

2.02 MISCELLANEOUS PIPING PRODUCTS

A. Brazing Materials:

1. Except as otherwise indicated, provide 15 percent silver alloy brazing material for copper to copper and copper to brass fittings.
2. Comply with AWS A5.8M/A5.8 for brazing filler materials.

B. Refrigerant Specialties:

1. Refrigerant Suction Line Filter-Dryer:
   a. Provide steel shell, corrosion-resistant finish filter-dryer, with molded felt core with 10-micron particle retention, in size and working pressure indicated, with copper connectors, and access valve (not applicable for heat pump system).
   b. Operating Temperature Rating: 240 degrees F.
   c. Working Pressure: 500 psi.
   d. Provide size recommended by refrigeration equipment manufacturer.
2. Refrigerant Liquid Line Dryer:
   a. Provide refrigerant liquid line filter-dryer for all units.
   b. Operating Temperature Rating: 240 degrees F.
   c. Working Pressure: 500 psi.
   d. For heat pumps, provide biflow directional types (not required if included with air-conditioning equipment).
   e. Provide size recommended by refrigeration equipment manufacturer.

C. Refrigerant Valves:

1. Globe and Check Valves: Listed and labeled by an NRTL.
   a. Shutoff Valves:
      1) Forged brass, packed, back seating winged seal cap, 300 degrees F (140 degrees C) temperature rating 500 psi working pressure.
      2) Maximum Opening Pressure: 0.5 psig.
      3) Valve required only if shutoff service valves are not included with package air-conditioning equipment.
   b. Manufacturers:
      1) Henry Technologies.
      2) Parker Hannifin Corp.
2. Solenoid Valve: Listed and labeled by an NRTL.
   a. Two-Way Solenoid Valves: Forged brass, designed to conform to AHRI 760, normally closed, Teflon valve seat, NEMA 1 solenoid enclosure, 24 volts, 60-Hz, UL Listed, 1/2-inch conduit adapter, 250 degrees F (121 degrees C) temperature rating 500 psi working pressure.
   b. Provide valve only if recommended by air-conditioning equipment manufacturer.

c. Manual Operator: Provide optional manual operator to open valve.
d. Manufacturers:
1) Alco Controls Div.; Emerson Electric Co.
2) Automatic Switch Co.
3) Parker Hannifin Corp.

3. Thermostatic Expansion Valve:
a. Body Bonnet and Seal Cap: Forged brass or steel.
b. Diaphragm, Piston, Closing Spring and Seat Insert: Stainless steel.
c. Capillary and Bulb: Copper tubing filled with refrigerant.
d. Suction Temperature: 40 degrees F.
e. End Connections: Socket or flare.
f. Working Pressure: 700 psig.
g. Provide valve only if recommended by air-conditioning equipment manufacturer.
h. Manufacturers:
1) Henry Technologies.
2) Parker Hannifin Corp.
3) Danfoss Group Global.

4. Safety Relief Valve:
a. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
b. Seat Disk: Polytetrafluoroethylene.
c. Working Pressure: 500 psig.
d. Operating Temperature: 240 degrees F, maximum.
e. Provide valve only if recommended by air-conditioning equipment manufacturer.
f. Manufacturers:
1) Henry Technologies.
2) Parker Hannifin Corp.
3) Danfoss Group Global.

D. Refer to Section 40 05 15, Piping Support Systems, for piping shields and piping support requirements.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPING SYSTEM

A. Install piping products in accordance with manufacturer’s written instructions, applicable requirements of ASME B31.5, ASHRAE 15, and in accordance with recognized industry practices to ensure products serve intended function.

B. Install dryers on liquid and suction lines.

C. Refrigerant Piping:

1. Cut pipe accurately to measurements established at Site and work into place without springing or forcing.
2. Install piping with sufficient flexibility to adequately provide for expansion and contraction as a result of temperature fluctuation inherent in its operation.
3. Where pipe passes through building structure, pipe joints shall not be concealed, but located where they may be readily inspected.
4. Run pipe to be insulated as shown and as required with sufficient clearance to permit application of insulation.
5. Run piping as shown on Drawings, taking care to avoid interference with other piping, conduit or equipment. Except where specifically indicated otherwise, run piping plumb, and straight and parallel to walls and ceilings.
6. Trapping of lines shall not be permitted, except where indicated.
7. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
8. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.
11. Install refrigerant piping in protective conduit where installed belowground.
12. Install accumulator in suction line near condensing unit.
13. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
14. Slope refrigerant piping as follows:
    a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
    b. Install horizontal suction lines with a uniform slope downward to compressor.
    c. Install traps and double risers to entrain oil in vertical runs.
    d. Liquid lines may be installed level.

D. Pipe Sleeves:

1. Provide pipe sleeves of suitable size for pipe and tubing that penetrate building structure.
2. Secure sleeves in position and location before and during construction. Space between pipe and sleeves, or between insulation and pipe sleeves, shall be not less than 1/4 inch between outside of pipe or insulation, and inside wall of sleeves.

3. Sleeves for uninsulated pipes shall have ends flush with finished wall surfaces; provide pipe or tubing as above with outside perimeter of pipe caulked to sleeve.
4. Extend sleeves for insulated pipes 1/2 inch from wall faces and caulk to sleeve on both sides.
5. Seal terminal ends of pipe insulation with mastic.
6. Extend sleeves for lines passing through floors 3 inches above finished floor slab and caulk to slab.

E. Braze cap (seal) ends of piping when not connected to mechanical equipment.

3.02 SOLDER JOINTS

A. Solder joints shall not be used for joining refrigerant piping systems.

3.03 BRAZED JOINTS

A. Braze copper piping with silver solder complying with AWS A5.8M/A5.8.

B. Brazed Joints:

1. Construct joints according to AWS *Brazing Handbook* Chapter "Pipe and Tube".
2. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
3. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

C. Inside of tubing and fittings shall be free of flux.

D. Clean parts to be joined with emery cloth and keep hot until solder has penetrated full depth of fitting and extra flux has been expelled.

E. Cool joints in air and remove flame marks and traces of flux.

F. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel air.

G. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

3.04 PIPE HANGERS

A. Refer to Section 40 05 15, Piping Support Systems, for piping shields and piping support requirements.

3.05 EQUIPMENT CONNECTIONS

A. Connect refrigerant piping to mechanical equipment in the manner shown, and comply with equipment manufacturer's instructions where not otherwise indicated.

3.06 FIELD QUALITY CONTROL

A. General:

1. Notify Engineer at least 48 hours before testing is performed.
2. Furnish equipment required for tests.
3. Group as many systems together as possible when testing in order to consolidate number of test inspections.

B. Leak Test:

1. Prior to initial operation, clean and test refrigerant piping in accordance with ASME B31.5.
2. Perform initial test with dry nitrogen to 300 psig minimum using soap solution to test joints.
3. Evacuate system after initial test and charge system with refrigerant or dry nitrogen, 20 percent refrigeration mixture to 600 psig minimum.
4. Upon completion of initial system test, test factory, as well as field, refrigerant piping joints with electronic-type leak detector to acquire a leak-tight refrigerant system.
   a. If leaks are detected, remove entire refrigerant charge for the system, replace defective pipe or fitting, and retest entire system as specified above.

C. Evacuation, Dehydration, and Charging:

1. After system is found to be without leaks, evacuate system using reliable gauge and vacuum pump capable of pulling a vacuum of at least 1-mm Hg absolute (29.88-inch Hg gage).
2. Evacuate system with vacuum pump until temperature of 35 degrees F (2 degrees C) is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.

4. Maintain vacuum on system for minimum of 12 hours after closing valve between vacuum pump and system. If system holds vacuum for 12 hours it is ready for charging.
5. Break vacuum with refrigerant gas or dry nitrogen gas, allowing pressure to build up to 2 psi (15 kPa).
6. Install new filter-dryer core in charging line.
7. Repeat evacuation procedure and complete charging of system; provide full operating charge.

3.07 ADJUSTING

A. General:

1. Adjust high-pressure and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
2. Adjust setpoint temperature of air-conditioning or chilled-water controllers to system design temperature.
3. Perform following adjustments according to manufacturer's written instructions before operating refrigeration system:
   a. Open shutoff valves in condenser water circuit.
   b. Verify compressor oil level is correct.
   c. Open compressor suction and discharge valves.
   d. Open refrigerant valves, except bypass valves that are used for other purposes.
   e. Check open compressor-motor alignment and verify lubrication for motors and bearings.

B. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13
METAL DUCTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.
3. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
4. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure).
5. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
   c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
   e. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
   g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
   h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment.
   j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.

k. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
l. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.
p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

6. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.
7. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
   b. 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   c. 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
   d. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   e. 259, Standard Test Method for Potential Heat of Building Materials.
   f. 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
    a. Duct Construction Standards.
    b. Guidelines for Seismic Restraints of Mechanical Systems.
    c. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
    d. HVAC Air Duct Leakage Test Manual.
9. UL:
    a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.
    b. 214, Standard for Tests for Flame-Propagation of Fabrics and Films.
    c. 555, Standard for Safety Fire Dampers.
    d. 555S, Standard for Safety Smoke Dampers.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. CFM: cubic feet per minute.
2. FPM: feet per minute.
3. PCF: pounds per cubic foot.
4. WC: water column.

B. Sealing Requirements: For the purpose of duct systems sealing requirements specified in this section, the following definitions apply:

1. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
2. Joints, duct surface connections including:
    a. Girth joints.
    b. Branch and subbranch intersections.
    c. Duct collar tap-ins.
    d. Fitting subsections.
    e. Louver and air terminal connections to ducts.
    f. Access door, and access panel frames and jambs.
    g. Duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Rectangular, Rigid Round, and Oval Ductwork:
      1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
      2) SMACNA Figure Numbers for each shop fabricated item.
      3) Reinforcing details and spacing.
      4) Seam and joint construction details.
      5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
   b. Ductwork Accessories:
      1) Manufacturer's product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction, dimensions of individual components, and finishes, including the following items:
         a) Fittings and volume control damper installation (both manual and automatic) details.
         b) Sealing materials.
         c) Dampers; include leakage, pressure drop, and maximum back pressure data.
         d) Duct-mounted access panels and doors.
         e) Sheet metal fasteners.
   c. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Record Drawings: Include duct systems routing, fittings details, and installed accessories and devices.

1.04 QUALITY ASSURANCE

A. Industry Standards:

1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA Duct Construction Standards relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.

2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.
3. NFPA Compliance: NFPA 90A and NFPA 90B.

B. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

C. Suppliers of duct and fitting components shall provide on request the following information:

1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
2. Laboratory performance data for fittings, including zero-length dynamic losses.

D. Installer shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Project.

E. Changes or alterations to layout or configuration of duct system shall be:

1. Specifically approved in writing by Engineer.
2. Proposed layout shall provide original design results, without increasing system total pressure.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork from dirt, water, and debris. During storage on Job Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

B. If fabricated sound-lined ductwork gets wet during installation, remove and dispose of ductwork from the Site.

C. Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

D. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

PART 2 PRODUCTS

2.01 SCHEDULES

A. Ductwork Schedule: Refer to Drawings.

2.02 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

C. Ductwork thinner than 26-gauge will not be allowed.

D. Ductwork Interior Surfaces:

1. Smooth.
2. No sheet metal parts, tabs, angles, or other items may project into air ducts, unless otherwise specified.
3. Seams and joints shall be external.
4. For ductwork that is required to be reinforced, use only external reinforcing.

2.03 SHEET METAL MATERIALS

A. Construct metal duct systems from materials as indicated in Ductwork Schedule.

B. Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.

C. Aluminum Ductwork:

1. Comply with ASTM B209.
2. Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.
3. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or equivalent.

D. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.04 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

C. Solvent-Based Sealants:

1. Ultraviolet light resistant.
2. Mildew resistant.
3. Flashpoint: Greater than 70 degrees F, SETA CC.
4. Manufacturers and Products:
    a. Hardcast, Inc.; Versagrip 102.
    b. Rectorseal; AT-33.
    c. Childers CP-140.

D. Water-Based Sealants:

1. Listed by manufacturer as nonflammable in wet and dry state.
2. Manufacturers and Products:
    a. Foster; Series 32.
    b. Childers; CP-145A, 146.
    c. Rectorseal; Airlok 181.

2.05 DUCTWORK FASTENERS

A. General:

1. Rivets, bolts, or sheet metal screws.
2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:

1. Aluminum Ductwork System:
   a. Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated Type 410 stainless steel, complete with bonded metal and fiber washer for dielectric separation.
   b. Manufacturers:
      1) DB Building Fasteners Inc., Santa Fe Springs, CA.
      2) Clark Craft Fasteners, Tonawanda, NY.

2.06 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated in Ductwork Schedule.

B. Where no specific duct pressure designations are indicated in Specifications or on Drawings, 2-inch WC pressure class shall be basis of Contract.

2.07 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20-gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

2.08 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Elbows:

1. Fit square-turn elbows with vane side rails.
2. Shop fabricate double-blade turning vanes of same material as ductwork.
3. Fabricate with equal inlet and outlet.
4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.
5. Manufacturers:
   a. Elgen.
   b. Duro-Dyne.

2.09 RECTANGULAR DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections to rectangular duct mains shall be made using factory fabricated fittings with spot welded tap to main duct connections**.**

2.10 DUCTWORK HANGERS AND SUPPORTS

A. General:

1. Ductwork support system shall be designed and provided by HVAC contractor in accordance with SMACNA Manual referenced for type of duct system being installed.
2. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
3. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
4. Wire hangers are not acceptable.
5. Hanger Spacing:
   a. Ducts Up to 60 inches in Largest Dimension: 10 feet, maximum.
   b. Ducts Over 61 inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:

1. Aluminum Ductwork Indoors and Outdoors:
   a. Carbon steel, hot-dipped galvanized after fabrication.
   b. Non-metallic pad between lower attachment and ductwork, to achieve dielectric separation.

C. Building Attachments:

1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
3. Upper Attachment (Concrete):
   a. Drive pin fastener and expansion nail anchor may be used for ducts up to 18-inch maximum dimension.
   b. Threaded stud fastener may be used for ducts up to 36-inch maximum dimension.
   c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fasteners.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.11 DUCTWORK FLEXIBLE CONNECTIONS

A. General:

1. Factory fabricated metal-edged fabric flexible connectors for commercial or industrial applications.
2. Sheet metal permanently secured to fabric with double fabric fold, double metal crimp.
3. Comply with NFPA 90A and NFPA 90B requirements.
4. Airtight and waterproof.

B. Materials:

1. Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
2. Metal Edges: Construct from same material as ductwork, unless otherwise noted.
3. Fabric:
   a. Comply with NFPA 701 or UL 214 (except teflon coated).
   b. Woven polyester or nylon for most applications.
   c. Woven fiberglass for high temperature applications.
   d. Coating: Vinyl.

C. Construction:

1. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.
2. Standard Metal Edged Connectors: Strip of fabric 3 inches wide attached to two strips of 3-inch-wide sheet metal.
3. Wide Metal Edged Connectors: Strip of fabric 4 inches wide attached to two strips of 4-inch-wide sheet metal.
4. Extra Wide Metal Edged Connectors: Strip of fabric 6 inches wide attached to two strips of 6-inch-wide sheet metal.

D. Manufacturers:

1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

2.12 DUCT INSPECTION DOORS

A. General:

1. Insulated, gasketed, and at least 15 inches by 15 inches when duct dimensions are large enough.
2. On ductwork where largest side dimension is less then 16 inches, furnish inspection doors at least 8 inches by 8 inches.
3. Complete with necessary hardware and either Amerlock 10 or Ventlock No. 100 latches, and Ventlock Series No. 100 hinges.
4. Fabricated of same material as ductwork.

B. Round Spin-in Type Access Doors:

1. Size: 18-inch and 24-inch diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.
2. Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.
3. Manufacturer and Product: Flexmaster; Inspector Series.

C. Manufacturers:

1. Ventlok.
2. Duro-Dyne.
3. Flexmaster.

2.13 MANUAL DAMPERS

A. Butterfly Manual Dampers:

1. Fabricate from two gauges heavier than duct in which installed, of same material as ductwork.
2. Align operating handle with damper blade.
3. Provide 2-inch standoff bracket for insulated duct systems.
4. Damper Manufacturers:
   a. Ruskin.
   b. American Warming and Ventilating.
5. Operator Manufacturers:
   a. Accessible Ductwork: Ventlok.
   b. Accessible Insulated Ductwork: Ventlok.
   c. Concealed Ductwork: Ventlok.

B. Manual Opposed-Blade Balancing Dampers:

1. Externally operated gang airfoil, damper blades.
2. Fabricate from same material as ductwork.
3. Stainless steel or nylon sleeve bearings.
4. Construction shall have interlocking edges and maximum 10-inch blade width.
5. Manufacturers:
   a. Ruskin.
   b. American Warming and Ventilating.

2.14 BACK DRAFT DAMPERS

A. General: Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

B. Aluminum, Counterbalanced, Standard Duty:

1. Fabrication:
   a. Frame: 2 inches by minimum 0.06 inch (51 mm by minimum 1.5 mm), 6063-T5 extruded aluminum channel with front flange and rear flange and mitered corners.
   b. Blades:
      1) Style: Single piece, overlap frame.
      2) Action: Parallel.
      3) Material: Minimum 0.025-inch (0.6 mm) 6063-T5 formed aluminum.
      4) Width: Maximum 6 inches (152 mm).
   c. Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.
   d. Blade Seals: Extruded vinyl, mechanically attached to blade edge.
   e. Linkage: Concealed in frame.
   f. Axles: Corrosion-resistant, long-life, synthetic, locked to blade and formed as single piece with bearings.
   g. Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade enabling damper to operate over wide range of pressures.
   h. Mounting:
      1) Suitable for mounting in vertical, horizontal airflow up, and horizontal airflow down positions.
      2) Configured for positions as shown on Drawings.
   i. Finish: Mill aluminum.

2. Performance Data:
   a. Temperature Rating: Withstand minus 40 degrees to 200 degrees F (minus 40 degrees to 93 degrees C).
   b. Maximum Back Pressure: 2-inch WC (500 Pa).
   c. Maximum Spot Air Velocity: 1,000 fpm (5 mps).
   d. Operation of Blades:
      1) Start to Open: 0.01-inch WC (0.002 kPa).
      2) Fully Open: 0.06-inch WC (0.01 kPa).
   e. Pressure Drop: Maximum 0.04-inch WC (0.01 kPa) at 1,000 fpm (305 mpm) through 24-inch by 24-inch (610 mm by 610 mm) damper.
3. Manufacturers and Products:
   a. Ruskin; Model CBD2.
   b. Greenheck; Series 160, 360, 460.

2.15 CONTROL DAMPERS

A. General:

1. Specification applies to control dampers, except those specified to be furnished with equipment.
2. Furnish opposed-blade type for proportional action and parallel-blade type for two-position action, except where indicated otherwise.

B. Heavy Duty Control Dampers (MD):

1. Frame:
   a. 8 inches by 2 inches by minimum 14-gauge (203 mm by 51 mm by minimum 2 mm) channel.
   b. Bolt Holes: Both flanges.
   c. Material: As scheduled on Drawings.
2. Blades:
   a. Style: Airfoil-shaped, double-skin.
   b. Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.
   c. Minimum 14 gauge (2 mm) equivalent thickness.
   d. Material: As scheduled on Drawings.
   e. Width: 5 inches to 8 inches (127 mm to 203 mm) maximum.
3. Bearings: Stainless steel sleeve pressed into frame.
4. Seals:
   a. Blade Seals: As scheduled on Drawings.
   b. Jamb Seals: Compressible stainless steel located between blade edge and jamb.

5. Linkage:
    a. Side linkage out of airstream.
    b. Constructed of minimum 10-gauge (3.5-mm) galvanized steel clevis arms with minimum 3/16-inch by 3/4-inch (4.8 mm by 19 mm) plated steel tie bars pivoting on minimum 3/8-inch (9.5-mm) diameter stainless steel pivot pins with lock-type retainers.
6. Axles:
    a. Minimum 3/4 inch (19 m) diameter, hex-shaped, mechanically attached to blade.
    b. Material: As scheduled on Drawings.
7. Performance Data: As scheduled on Drawings.
8. Accessories: As scheduled on Drawings.
9. Manufacturers:
    a. Ruskin.
    b. American Warming and Ventilating.
    c. TAMCO.
    d. Greenheck.

2.16 CONTROL DAMPER OPERATORS

A. General:

1. Drawings and Control Diagrams indicate only one damper motor for each motorized damper (M).
2. Select actual quantity of motors required to operate each damper in accordance with size of damper provided.
3. Coordinate exact quantity of damper motors with electrical work to ensure that necessary wiring and conduit is provided for installation.
4. Provide operators for motorized dampers and motorized louvers.

B. Electric Damper Operators:

1. Performance: As scheduled on Drawings.
2. Mounting: External side plate.
3. Ample power to overcome friction of damper linkage and air pressure acting on damper blades.
4. Furnished with external adjustable stops to limit stroke.
5. Operators on modulating dampers that are to be sequenced with other control devices shall have full relay type pilot positioner and interconnecting linkage to provide mechanical feedback that will accurately position and control damper.

6. Intake, relief, and exhaust dampers shall close and return dampers shall open on control failure, unless indicated otherwise.
7. Operating Torque:
   a. Provide multiple independent damper sections, each with separate actuator, as needed to provide minimum of 120 percent of operating torque required by damper(s).
   b. Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 1-inch WC air pressure on damper blades:
      1) Opposed-Blade Dampers: Minimum 5 inch-pounds per square foot of damper area, unless higher values are recommended by damper manufacturer.
      2) Parallel-Blade Dampers: Minimum 7 inch-pounds per square foot of damper area, unless higher values are recommended by damper manufacturer.
8. Manufacturers:
   a. Belimo.
   b. Neptronic.
   c. Siemens Building Technologies.
   d. Johnson Controls.
   e. Honeywell.

2.17 EXTERNAL DUCT INSULATION

A. Refer to Section 23 07 00, HVAC Insulation.

2.18 MISCELLANEOUS ACCESSORIES

A. Accessories Hardware:

1. Instrument Test Holes:
   a. Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.
   b. Size to allow insertion of pitot tube and other testing instruments.
   c. Provide in length to suit duct insulation thickness.
2. Flexible Duct Clamps:
   a. Stainless steel band with cadmium-plated hex screw to tighten band with worm-gear action.
   b. Provide in sizes from 3 inches to 18 inches to suit duct size.
3. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Miscellaneous:

1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
2. Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.
3. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth.
4. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

B. Ductwork Location:

1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
2. Avoid diagonal runs wherever possible.
3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
4. In general, install as close to bottom of structure as possible.
5. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
6. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Penetrations:

1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
2. Clearances:
   a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.
   b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.
3. Closure Collars:
   a. Minimum 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed.
   b. Fit collars snugly around ducts and insulation.

c. Same gauge and material as duct.
d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
e. Use fasteners with maximum 6-inch centers on collars.

4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

D. Coordination with Other Trades:

1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
3. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

3.02 RECTANGULAR DUCTWORK

A. General:

1. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.
2. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

B. Low Pressure Taps:

1. Use bell mouth or conical fittings with integral locking quadrant damper. Spin-in fitting shall be sealed at duct tape with a gasket or sealed with sealant as specified for medium pressure ductwork.
2. Determine location of spin-in after outlet location is determined.
3. Fitting shall be securely attached to shaft to prevent damper from rotating around shaft.

C. Fittings:

1. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.
2. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.
3. Make offsets with maximum angle of 45 degrees.
4. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

D. Rectangular Ductwork Transverse Joints:

1. Install each run with a minimum of joints.
2. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
3. Mechanical Joint Option:
   a. Construct transverse joints with Ductmate 25/35 duct connector systems, Ductmate W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system. Slip-on duct flange connectors shall have integral sealant pocket with permanently flexible sealant.
   b. When using Ductmate W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the Ductmate W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.
   c. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
   d. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
   e. Conform to SMACNA Class A sealing requirements.

3.03 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

E. Support vertical ducts at maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

H. Install seismic restraints on ductwork systems and sway bracing as described in SMACNA Guidelines for Seismic Restraints of Mechanical Systems.

3.04 FLEXIBLE CONNECTIONS

A. Flexible Collars and Connections:

1. Use between fans and ducts.
2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.
3. For rectangular ducts, lock flexible connections to metal collars.

3.05 DAMPERS

A. General:

1. Inspection:
   a. Inspect areas to receive dampers.
   b. Notify Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.
   c. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Install dampers at locations indicated on Drawings and in accordance with manufacturer's installation instructions.
3. Install square and level.
4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
5. Damper blades and hardware shall operate freely without obstruction.
6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
8. Head and sill shall have stops.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

B. Manual Dampers:

1. Provide balancing dampers for grilles and diffusers as indicated on Drawings in branch duct as near main as possible.
2. Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

C. Back Draft Dampers:

1. Install dampers square and free from racking with blades running horizontally.
2. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

D. Control Dampers:

1. Install at locations indicated on Drawings and in accordance with manufacturer's instructions.
2. Install square and free from racking with blades running horizontally.
3. Operate opposed blade dampers from a power blade or drive axle.
4. Bracing:
   a. Install for multiple section assemblies to support assembly weight and to hold against system pressure.
   b. Install at every horizontal and vertical mullion.

3.06 ACCESS DOORS

A. Ductwork: Install access doors in ductwork, in accordance with manufacturer's instructions, at each:

1. Duct mounted fire damper.
2. Duct mounted smoke or ionization detector.
3. Motorized damper.
4. Turning vane.
5. Volume damper.
6. Automatic damper.
7. Temperature controller.

3.07 EXTERNAL DUCT INSULATION

A. Refer to Section 23 07 00, HVAC Insulation.

3.08 MISCELLANEOUS ACCESSORIES

A. Louver and Grille Blank-Off Sections: Attach airtight to louver or grille and install to allow for easy removal.

B. Inspection Plates and Test Holes:

1. Where required in ductwork for balance measurements.
2. Test holes shall be airtight and noncorrosive with screw cap and gasket.
3. Extend cap through insulation.

3.09 DUCT SEALING

A. Seal duct seams and joints as follows: As indicated on Ductwork Schedule.

B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

C. Seal externally insulated ducts prior to insulation installation.

D. Seal all audible leaks.

3.10 BALANCING OF AIR SYSTEMS

A. Perform air balancing in accordance with requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.11 PROTECTION OF INSTALLED WORK

A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.

B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.12 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

END OF SECTION

SECTION 23 34 00
HVAC FANS

PART 1 GENERAL

1.01 REFERENCES

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

1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.
2. Air Movement and Control Association International (AMCA):
   a. 99, Standards Handbook.
   b. 201, Fans and Systems.
   c. 203, Field Performance Measurement of Fan Systems.
   d. 204, Balance Quality and Vibration Levels for Fans.
   e. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   f. 300, Reverberant Room Method for Sound Testing of Fans.
   g. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
5. ASTM International (ASTM):
   a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   d. D3363, Standard Test Method for Film Hardness by Pencil Test.
   e. D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA): 45, Standard on Fire Protection for Laboratories Using Chemicals.
8. Occupational Safety and Health Act (OSHA).

9. Society for Protective Coatings (SSPC):
    a. SP 3, Power Tool Cleaning.
    b. SP 5, White Metal Blast Cleaning.
    c. SP 6, Commercial Blast Cleaning.
    d. SP 10, Near-White Blast Cleaning.
10. Underwriters Laboratories Inc. (UL): 507, Safety Standard for Electric Fans.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. SWSI: Single Width, Single Inlet.
9. TEFC: Totally Enclosed, Fan Cooled.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide following for specified products:
    a. Manufacturer’s name and model number.
    b. Descriptive specifications, literature, and drawings.
    c. Dimensions and weights.
    d. Fan sound power level data (reference 10 to power minus 12 watts) at design operating point.
    e. Fan Curves:
        1) Performance Curves Indicating:
            a) Relationship of flow rate to static pressure for various fan speeds.
            b) Brake horsepower curves.
            c) Acceptable selection range (surge curves, maximum revolutions per minute).
            d) Static pressure, capacity, horsepower demand and overall efficiency required at duty point, including drive losses.

f. Capacities and ratings.
g. Construction materials.
h. Fan type, size, class, drive arrangement, discharge, rotation, and bearings.
i. Wheel type, diameter, maximum revolutions per minute for fan class, operating revolutions per minute, and tip speed.
j. Power and control wiring diagrams, including terminals and numbers.

2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
3. "Or Equal" Equipment:
   a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on Drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
   b. Where submitted equipment results in change to ductwork and equipment configuration shown on Drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Recommended procedures for protection and handling of products prior to installation.
3. Manufacturer's installation instructions.
4. Manufacturer's Certificate of Compliance for the following: Motors specified to be premium efficient type.
5. Test reports.
6. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Performance Ratings: Tested in accordance with AMCA 210.

B. Sound Ratings: Tested in accordance with AMCA 300.

C. Fabrication: In accordance with AMCA 99.

1.05 EXTRA MATERIALS

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

Item	Quantity
Special tools required to maintain or dismantle	One complete set for each different size unit

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

A. Some specific equipment requirements are listed in Equipment Schedule. Refer to Drawings.

2.02 GENERAL

A. Spark Resistant Construction: Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.

B. Operating Limits: Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408.

C. Acoustical Levels: Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule.

D. Fan Drives:

1. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.
2. Sheaves: Capable of providing 150 percent of motor horsepower.
3. Drive Adjustment:
    a. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
    b. Provide trial and final sheaves, as well as drive belts, as required.
4. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.
5. Provide speed test openings at shaft locations.

6. Motors:
    a. Motors 20 hp or Smaller:
        1) Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
        2) Final operating point shall be at approximate sheave midpoint.
    b. Furnish motors for V-belt drives with adjustable rails or bases.
7. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.

E. Finishes:

1. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.
    a. Parts cleaned and chemically pretreated with phosphatizing process.
    b. Alkyd enamel primer.
    c. Air dry enamel topcoat.
2. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

2.03 ROOF FAN, CENTRIFUGAL UPBLAST (35-EF-01 & 02)

A. General:

1. Factory-assembled centrifugal upblast roof fan; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:

1. Construction: Aluminum, minimum 16-gauge marine alloy.
2. Windband: Finish with rolled bead.
3. Motor completely sealed from exhaust air stream.
4. Integral conduit chase for wiring.
5. Drain trough at lowest point of housing.

C. Wheel:

1. Aluminum construction, propeller type.
2. Machined, cast aluminum hub.
3. Matched to deep spun inlet venturi.

D. Shaft, Bearings, Drive:

1. Shaft:
   a. Turned, ground, and polished carbon steel.
   b. Keyed for sheave installation.
   c. Zinc-phosphate coated and oil emulsion-dipped.
2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style.
   b. Selected for average life (ABMA 9 L_{50}) of not less than 200,000 hours operation at maximum cataloged operating speed.
   c. Terminate with zerk fittings.
3. Drives:
   a. In accordance with Paragraph Fan Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: Direct.

E. Accessories: Provide as scheduled on Equipment Schedule.

F. Manufacturers and Products:

1. Aerovent: Model D53 (Direct Drive).
2. Cook; Model LUG (Direct Drive).
3. “Or-Equal.”

2.04 CONTROL

A. Thermostats, control stations and all required appurtenances to control the ventilation system as described in the sequence of operation shall be provided and installed by the electrical contractor. See electrical drawings for details.

2.05 MOTORS

A. General:

1. Fan motors shall comply with provisions of Section 26 20 00, Low-Voltage AC Induction Motors.
2. Provide integral self-resetting overload protection on single-phase motors.
3. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
4. Motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
3. Space Heater: No.
4. Number of Speeds: Single.
5. Number of Windings: One.
6. Motor Efficiency: Premium efficient.
7. Shaft Type: Solid, carbon steel.
8. Mounting: As required for fan arrangement.
9. Service Factor: 1.15.

2.06 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown on Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.07 SOURCE QUALITY CONTROL

A. General:

1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
3. Consider drive efficiency in motor selection according to manufacturer’s published recommendation or according to AMCA 203, Appendix L.

B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
2. Center punch fan shaft to accommodate tachometer readings.

C. Acoustical Levels:

1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
2. Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

D. Balancing: Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install fans level and plumb.

B. Secure roof-mounted fans to roof curbs with Type 316 stainless steel hardware.

C. Scroll Drains: Pipe drain connection through running trap to floor drain.

D. Labeling:

1. Label fans in accordance with Article Accessories.
2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

E. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

F. Equipment Support and Restraints:

1. Refer to Section 01 88 15, Anchorage and Bracing.
2. Install roof-mounted units on curbs designed to withstand, without damage to equipment, the seismic force required by code.
3. Secure vibration and seismic controls to curbs.
4. Seismic Restraint Snubbers: Install with sufficient clearance so unit isolators are not restricted for proper free isolation, but do limit movement in all directions.

G. Connections:

1. Refer to Section 23 31 13, Metal Ducts and Accessories.
2. Isolate duct connections to fans.
3. Install ductwork adjacent to fans to allow proper service and maintenance.

3.02 FIELD QUALITY CONTROL

A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.
2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify cleaning and adjusting are complete.
5. Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:
   a. Energize motor and adjust fan to indicated revolutions per minute.
   b. Measure and record motor voltage and amperage.
2. Operational Test:
   a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
   c. Test and adjust control safeties.
   d. Replace damaged and malfunctioning controls and equipment.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for facility startup.

B. Refer Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Balancing:

1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Replace fan and motor sheaves as required to achieve design airflow.

3.05 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

B. On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 880, Air Terminals.
2. ASTM International (ASTM): C636/C636M, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
3. UL.

1.02 DEFINITIONS

A. NC: Noise Criteria; background sound rating method for indoor sound.

B. WC: Water column.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s data and descriptive literature for products specified.
   b. Furnish the following information for each type of diffuser, register, and grille furnished.
      1) NC sound data.
      2) Static pressure loss data.
      3) Throw data.

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

A. Refer to Drawings.

2.02 SUPPLY GRILLES AND REGISTERS

A. Supply Grilles and Registers (SG1-X):

1. Construction: Refer to Equipment Schedule.
2. Adjustable front horizontal and rear vertical vanes on 3/4-inch centers.
3. Continuous sponge rubber gasket at face flange.
4. 1-inch minimum flat rectangular frame.
5. Performance: Refer to Equipment Schedule.
6. Manufacturers and Products:
   a. Krueger; 880/5880 Series.
   b. Titus; 300 Series.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to architectural reflected ceiling plans for coordination of locations of ceiling-mounted air outlets and inlets with ceiling grids and lighting. Where locations of devices shown on mechanical drawings do not agree with locations that are shown on architectural reflected ceiling plans, reflected ceiling plans shall take precedence. If air outlets or inlets are shown on mechanical drawings, but are not shown on architectural reflected ceiling plans, devices shall be located as near as possible to locations shown on mechanical drawings when coordinating with ceiling.

B. Install diffusers, grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

C. Support air inlets and outlets where installed in metal suspension systems for acoustical tile and lay-in panel ceilings as specified in ASTM C636/C636M and applicable building code.

END OF SECTION

SECTION 23 81 00
UNITARY AIR-CONDITIONING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. Air Moving and Conditioning Association (AMCA): Bulletin 300, Setup No. 1.
3. American Gas Association (AGA).
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
    a. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
    b. 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
5. American Society of Mechanical Engineers (ASME): BPVC Section IX, Welding and Brazing Qualifications.
6. ASTM International (ASTM):
    a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
    b. D2370, Standard Test Method for Tensile Properties of Organic Coatings.
    c. D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
    d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
    e. G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
7. Canadian Standards Association (CSA).
8. ETL Testing Laboratories (ETL).
9. International Organization for Standardization (ISO):
    a. 9001, Quality Management Systems - Requirements.
    b. 13256-1, Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps.

10. National Electrical Manufacturers Association (NEMA).
11. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials
12. Underwriters Laboratories Inc. (UL): 94, Safety Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Air Conditioning.
2. COP: Coefficient of Performance.
3. DX: Direct Expansion.
4. EER: Energy Efficiency Ratio.
5. HP: Heat Pump.
6. IR: Infra Red.
7. LED: Light Emitting Diode.
8. PSC: Permanent Split Capacitor.
9. SPST: Single Pole, Single Throw.
10. TXV: Thermostatic Expansion Valve.
11. UV: Ultraviolet.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing.
   b. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for all products specified.
   c. Manufacturer’s standard finish color selection for enclosure finishes.
   d. Complete performance data that will indicate full compliance with Specification:
      1) Include fan sound power level data (ref. 10 to 12 watts) at design operating point, based on AMCA Bulletin 300, Setup No. 1.
      2) Include heating and cooling performance data at design operating conditions.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, for heat pumps, air-conditioning units, and motors.
3. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.
4. Sample copy of guarantee.
5. Test reports.
6. Operation and Maintenance Data.
   a. Include wiring and control diagrams for equipment.
   b. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Heating and Cooling Equipment: Minimum operating efficiencies, defined as COP and EER, as specified in ASHRAE 90.1.

B. Unit shall be rated (when matched with appropriate outdoor unit) per AHRI 210/240.

C. Units shall be certified by UL and CSA, and shall be UL or ETL listed and labeled.

D. Cooling performance rated in accordance with AHRI testing procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

B. Protection of Equipment:

1. Box, crate, or otherwise protect from damage and moisture during shipment, handling, and storage.
2. Protect from exposure to corrosive fumes and keep thoroughly dry at all times.
3. Store motors, drives, electrical equipment, and other equipment with antifriction or sleeve bearings in weathertight and heated storage facilities prior to installation.
4. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.06 SPECIAL GUARANTEE

A. Refrigerant Compressors: Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of Owner, removal and replacement of compressors specified in this Specification found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. Specified components of this section, including insulation, facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

2.02 EQUIPMENT SCHEDULES

A. Refer to Drawings.

2.03 SPLIT SYSTEM AC INDOOR UNIT, DUCTED (OVER 5 NOMINAL TONS)

A. General:

1. Indoor-mounted, draw-through, packaged air-handling unit consisting of forward-curved belt-driven centrifugal fan(s), motor and drive assembly, prewired fan motor contactor, factory-installed refrigerant metering devices, cooling coil, disposable air filters, and condensate drain pan for vertical or horizontal configurations.
2. Suitable for use with air conditioner or heat pump outdoor unit.
3. Indoor unit shall be of the same manufacturer as the associated outdoor unit.
4. Modular design vertical upflow, field convertible for vertical downflow, or horizontal flow.

B. Unit Cabinet:

1. Heavy gauge galvanized steel sheets.
2. Phosphatized and factory finished in manufacturer's standard enamel paint.
3. Sufficient removable panels for access to all internal components.

4. Interior of casing insulated with 1-inch, 1-pound density, coated foil-faced glass fiber insulation attached with adhesive material.
5. Duct flanges for connection of supply and return ductwork, and filter racks.
6. Knockouts for unit electrical power and condensate piping connections.

C. Evaporator Fan:

1. Double-inlet, double-width, forward-curved fans mounted on rubber isolators.
2. Belt-drive.

D. DX Evaporator Coil:

1. Minimum three-row configuration, copper tube with aluminum fins and galvanized steel tube sheets.
2. Fins bonded to tubes by mechanical expansion.
3. Refrigerant piping sweat connections.
4. Condensate Drain Pan:
   a. High-impact thermoplastic, insulated, with primary and secondary brass drain fittings.
   b. Double sloped to prevent standing water from accumulating.

E. Electric Heating Coil:

1. UL listed.
2. Heavy-duty nickel-chromium elements.
3. Contactors with 24-volt coils, power wiring, 24-volt control wiring terminal blocks, and a hinged access panel.
4. Individual line-break HIGH limit control for each stage.
5. HIGH limit control operating through heating element contactors, equipped with automatic reset.
6. Internally factory-wired to provide single-point power connection with unit.

F. Controls:

1. Refrigerant Metering:
   a. Factory installed TXV for refrigerant control.
   b. TXV shall be capable of external adjustment.
   c. Heat Pump Applications: Reverse flow bypass TXV with internal check valves.
2. Magnetic contactor for fan.
3. Overload protection in each leg.

4. Control voltage transformer.
5. Terminal strip for connection of remote controls.
6. Control board fusing.

G. Air Filters:

1. Disposable 2-inch thick with pleated nonwoven fabric media.
2. Filter access from either the right or left side of the unit.

H. Accessories: Provide as scheduled in Equipment Schedule.

I. Manufacturers:

1. Carrier.
2. Trane.
3. Rheem.
4. Lennox International.
5. York International.

2.04 SPLIT SYSTEM AC OUTDOOR UNITS

A. General:

1. Factory assembled, single piece, air-cooled air conditioner outdoor unit.
2. Contained within the unit enclosure shall be factory wiring, piping, controls, compressor, and holding charge of R-410 refrigerant.
3. Outdoor unit shall be same manufacturer as associated indoor unit.

B. Unit Cabinet:

1. Constructed of galvanized steel, phosphatized and coated with a baked enamel finish. Finish shall pass the 500-hour salt spray test.
2. Removable access panels for access to internal components.
3. Outdoor Compartment: Isolated, with acoustic lining to ensure quiet operation.
4. Knockouts for unit electrical power.

C. Condenser Fans:

1. Direct-drive propeller type shall discharge air vertically and shall blow air through outdoor coil.
2. Motors:
   a. Totally enclosed, with Class B insulation and permanently lubricated bearings.
   b. Thermal overload protection.

3. Shaft of galvanized or stainless steel construction.
4. Fan blades shall be corrosion-resistant and be statically and dynamically balanced.
5. Equip openings with PVC-coated protection grille over fan and coil.

D. Compressor:

1. Fully hermetic reciprocating or scroll type.
2. Equipped with oil system, operating oil charge, and motor.
3. Internal overloads shall protect compressor from overtemperature and overcurrent.
4. Motor: NEMA rated, Class F, suitable for operation in a refrigerant atmosphere.
5. Scroll compressors shall have high discharge gas temperature protection.
6. Reciprocating compressors shall be equipped with crankcase heaters to minimize liquid refrigerant accumulation in compressor during shutdown and to prevent refrigerant dilution of oil.
7. Installed on rubber vibration isolators and shall have internal spring isolation.

E. Condenser Coil: Constructed of aluminum fins mechanically bonded to internally enhanced seamless copper tubes that are cleaned, dehydrated, and sealed.

F. Refrigeration Components:

1. Brass external liquid line service valve with service gauge port connections.
2. Suction line service valve with service gauge connection port.
3. Service gauge port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps.
4. Suction Line: Accumulator.
5. Pressure relief.

G. Controls:

1. Factory selected, assembled, and tested.
2. Refrigerant Metering:
   a. Reversing valve for heat pump units.
   b. Heating mode metering device for heat pump units.

3. Automatic restart on power failure.
4. Three-pole contactors.
5. Time delay control sequence shall be provided standard through control board on indoor units.
6. High pressure and liquid line low pressure switches.
7. Automatic outdoor fan motor protection.
8. Start capacitor and relay (single-phase units without scroll compressors).
9. Defrost board to provide defrost control.
10. Safeties:
    a. Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
    b. Safety lockout if an outdoor unit safety is open.
    c. High condensing temperature protection.
    d. System diagnostics.
    e. Compressor motor current and temperature overload protection.
    f. High pressure relief.
    g. Outdoor fan failure protection.

H. Accessories: Provide as scheduled in Equipment Schedule.

I. Manufacturers:

1. Carrier.
2. Trane.
3. Rheem.
4. Lennox International.
5. York Air Conditioning.

2.05 UNITARY EQUIPMENT CONTROL

A. 7-Day programmable Thermostat:

1. Heating and Cooling Stages:
    a. Multi stage cooling and heating electronic control.
    b. Staging delay between each cycle.
    c. Visual indication of activation of each stage.
2. Temperature Scale: Furnish 50 to 90 degrees F dial.
3. 7-Day programmable.
4. External adjustments.
5. Operator interface to consist of temperature adjustment, LCD room temperature display, and visual indication of each cooling and heating stage activation.

6. Insulating back, where exterior wall mounting is indicated.
7. Adjustable “dead band” between heating and cooling to be between 4 degrees F and 20 degrees F.
8. Power loss memory for restoration of sequence of operation in event of power loss.

2.06 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.
2. Control voltage to indoor unit fan shall be 24 volts.
3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
4. Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit, unless otherwise noted.

B. Motors:

1. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
2. Unless otherwise stated, electric motors shall comply with the following:
   a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.
   b. Enclosure: ODP, unless specified otherwise.
   c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
   d. Winding Thermal Protection: Manufacturer’s standard.
   e. Space Heater: Manufacturer’s standard.
   f. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer’s standard.
   g. Efficiency: Minimum efficiency per Section 26 20 00, Low-Voltage AC Induction Motors.

2.07 ACCESSORIES

A. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch-high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Quantity as recommended by manufacturer.

2.08 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Direct expansion coils leak tested underwater with 200-psig air. Pressure tested to 450 psig.
2. Electric heating coils tested with 2,000-volt dielectric test.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with manufacturer's recommendations, and these Specifications.
2. Set and install equipment so equipment is level and properly supported.
3. Ensure piping connections to equipment do not cause strain on equipment.
4. Ensure vibration isolation has been installed per manufacturer's instructions and isolation devices are performing satisfactorily.
5. Install safety devices as recommended by manufacturer and required by code.

B. Isolate sheet metal duct connections from portions of unit not internally spring-isolated from fans, or other vibrating or rotating equipment.

C. Inspect internal casing insulation, seal exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

D. Filters:

1. Install set of filters in each unit before operating and leave in place during startup and testing to keep equipment and ductwork clean.
2. Do not operate units until filters are installed. If operated without filters, completely clean ductwork, coils, and interior of units.

E. Lubricate unsealed bearings prior to startup.

3.02 FIELD QUALITY CONTROL

A. Initial equipment testing and startup shall be made by authorized representative of unit manufacturer.

B. Air-cooled outdoor unit shall not be started without complete prestart checkout of entire refrigerant piping system and charging of system with refrigerant as recommended by equipment manufacturer.

C. Field Testing: Manufacturer shall provide factory-trained representative employed by equipment manufacturer to perform the following services. Supervision only, of Contractor personnel, will not be acceptable.

1. Leak test.
2. Refrigerant pressure test.
3. Evacuate (if required).
4. Dehydrate (if required).
5. Charge condensing unit with refrigerant and oil (if required).

3.03 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for the following:

1. Inspect installation including external interlock, power connections; supervise initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.
2. Test Report:
   a. Submit test reports unit is in safe and proper operating condition.
   b. Contain pressure and control settings, meg readings, voltage readings per phase during START and RUN, suction temperature and pressure, liquid temperature and pressure.
   c. List minor discrepancies to be corrected which do not affect safe and reliable operation.
   d. One copy of report shall be left in unit control panel.

3. One copy of bound installation operation and maintenance service, and parts brochures, including applicable serial numbers, full unit description, parts ordering sources, shall be placed in unit control panel at time of starting.
4. Training of Owner’s personnel for specified equipment.

3.04 ADJUSTING AND CLEANING

A. Air System Balancing: As specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

B. Install set of filters at time of final cleaning as defined in Section 01 77 00, Closeout Procedures.

END OF SECTION

SECTION 23 82 00
TERMINAL HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 REFERENCES

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

1. Air Moving and Conditioning Association (AMCA): 300, Reverberant Room Method for Sound Testing of Fans.
2. American Gas Association (AGA).
3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1 IP/SI, Energy Standard for Buildings, Except Low-Rise Residential Buildings.
4. ASTM International (ASTM):
   a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   b. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
5. Electrical Test Laboratories (ETL).
6. National Electrical Manufacturer's Association (NEMA).
7. National Fire Protection Association (NFPA):
   a. 54, National Fuel Gas Code.
   b. 70, National Electrical Code (NEC).
   c. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
8. Sheet Metal and Air Conditioning Contractors' National Assoc., Inc. (SMACNA): Ducted Electric Heat Guide for Air Handling Systems.
9. UL: Product Directories.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. PSC: Permanent Split Capacitor.

9. SWSI: Single Width, Single Inlet.
10. TEFC: Totally Enclosed, Fan Cooled.
11. UV: Ultraviolet.
12. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing.
2. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.
3. Manufacturer’s standard finish color selection for cabinet finishes.
4. Performance data, including sound power level data (reference 10 to minus 12 power watts) at design operating point, shall be based on AMCA 300.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s test reports for the following: Electric space heater.
3. Recommended procedures for protection and handling of equipment and materials prior to installation.
4. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Heating Equipment: Minimum operating efficiencies, specified in Chapter 6 of ASHRAE 90.1 IP/SI and the State of Tennessee Energy Code.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Equipment Schedules: Refer to Drawings.

2.02 UNIT HEATER, ELECTRIC, SUSPENDED

A. Characteristics:

1. Factory assembled including casing, heater elements, fan wheel, drive assembly, motor, controls and accessories.
2. UL listed.
3. Meet requirements of National Electrical Code.
4. Three phase heaters shall have balanced phases.
5. Casing:
   a. Heavy gauge steel casing.
   b. Baked enamel finish.
   c. Individual adjustable discharge louvers.
   d. Protective air inlet louvers or fan guards.
6. Heating elements shall be one of the following types:
   a. Aluminum finned, copper clad, steel sheath.
   b. High mass, all steel tubular finned type, copper brazed, in fixed element banks.
   c. Nickel-chromium wire elements enclosed in powder filled aluminum coated steel tubes with permanently fused fins.
   d. Steel tubes with nickel chromium resistance wire embedded in a dielectric with steel fins crimped and brazed to the tube.
   e. Corrosion-resistant steel fins brazed to tubular heating elements.
7. Fan and Motor:
   a. Totally enclosed motor.
   b. Direct drive fan.
   c. Sealed bearings. Permanently lubricated.
8. Controls:
   a. Thermal overload protection with automatic reset.
   b. Controls, transformers, and contactors shall be factory assembled, except wall mounted thermostats when indicated.

B. Accessories and Features: Provide as scheduled in Equipment Schedule.

C. Manufacturers and Products:

1. Qmark; Type MUH.
2. Trane; Type UHEC.

3. Modine: Type HER (horizontal discharge).
4. Markel; Series 5100.
5. Chromolox; Series LUH (horizontal discharge).

2.03 HEATER CONTROL

A. Electric thermostat:

1. Modulating electric type, except where two-position action is required.
2. Temperature Scale: Furnish 50 to 90 degrees F dial.
3. External adjustments.
4. Adjustable sensitivity.
5. Insulating back where exterior wall mounting is indicated.
6. Nonlocking wire protective guard.

2.04 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.
2. Control voltage to indoor unit fan shall be 24 volts.
3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
4. Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit, unless otherwise noted.

B. Motors:

1. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
2. Unless otherwise stated, electric motors shall comply with the following:
   a. Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.
   b. Enclosure: ODP, unless specified otherwise.
   c. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
   d. Winding Thermal Protection: Manufacturer’s standard.
   e. Space Heater: Manufacturer’s standard.
   f. Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer’s standard.
   g. Efficiency: Minimum efficiency per Section 26 20 00, Low-Voltage AC Induction Motors.

2.05 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

2.06 SOURCE QUALITY CONTROL

A. Functional Test:

1. Perform manufacturer's standard factory test on equipment.
2. Test equipment furnished.
3. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
4. Equipment with Electric Resistance Heating Coils: Test with 2,000-volt dielectric test.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install in strict compliance with manufacturer's instructions. Maintain clearances around unit as listed in manufacturer's recommendations.

B. Electric Unit Heaters, All Types:

1. Bottom of unit shall be a minimum of 8 feet above finish floor, unless indicated otherwise.
2. Heater shall be permanently mounted in position indicated with a fixed power supply.
3. Install so obstructions do not block heater air inlet or outlet.

3.02 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified equipment.

END OF SECTION

SECTION 26 05 00
BASIC ELEC MATERIALS AND METHODS

PART 1 GENERAL

1.01 DESCRIPTION

A. General Conditions:

1. The accompanying General Conditions (front-end specifications) shall apply to and form a part of this section.

B. General Requirements:

1. Carefully examine General Conditions, other specification sections, and other drawings (in addition to Electrical) in order to be fully acquainted with their effect on electrical work.
2. Do all work in compliance with all applicable codes, laws, and ordinances, the National Electrical Safety Code, the National Electrical Code (hereinafter referred to as “Code”), applicable energy codes, and the regulations of the local utility companies. Obtain and pay for any and all required permits, inspections, certificates of inspections and approval, and the like.
3. Cooperate with other trades and contractors at job. Perform work in such manner and at such times as not to delay work of other trades. Complete all work as soon as the structure and installations of equipment will permit. Patch, in a satisfactory manner and by the proper craft, any work damaged by electrical workmen.
4. The Owner shall be provided access to all software to include copies of software for all systems provided under this division of the specifications. Software shall be password protected where applicable.
5. Only qualified electrical sub-contractors will be allowed to submit proposals for this project. In order to be considered qualified, contractor shall have completed a minimum of five (5) projects of similar type/scope and equal or greater magnitude and complexity within the last ten (10) years. Sub-contractors without qualifications will be rejected. If desired, potential electrical sub-contractors may submit qualification evidence for review and pre-bid approval a minimum of ten (10) days prior to bid. Previous projects used to meet this experience requirement must have included similar (or greater) scopes of work for each of the following areas:
   a. Power Systems.
   b. Control Systems.
   c. Instrumentation Systems.

6. Electrical contracting firm shall be licensed as an electrical contractor in the state where work will be performed

1.02 GENERAL SCOPE OF ELECTRICAL WORK (REFER TO DRAWINGS FOR OTHER SPECIFIC SCOPE ITEMS)

A. Furnish all labor and materials to complete electrical work as shown on drawings and/or herein specified.

B. Remove all existing electrical equipment and wiring made obsolete by this project and remove or relocate all electrical services located on or crossing through the project property, either above or below grade, which would obstruct the construction of the project or conflict in any manner with the completed project or any code pertaining thereto. Dispose of salvageable materials as directed by the Engineer. Contractor shall schedule meeting to review scope of electrical demolition and to confirm scope and phasing of proposed demolition with the owner in the presence of the prime consultant prior to start of any electrical demolition.

C. Furnish and install complete power, telephone and other electrical services as shown on drawings and/or specified herein.

D. Pay all electrical utility company service charges (if any) in connection therewith, including permanent meter deposit. Meter deposits will be refunded to Contractor at time of Owner's acceptance.

E. Furnish and install complete power distribution system as shown on drawings and/or specified herein.

F. Furnish and install a complete Power Generation and Automatic Transfer Switch System as shown on drawings and/or specified herein.

G. Furnish and install complete reduced voltage soft starters and associated devices for motors as shown on drawings and/or specified herein.

H. Furnish and install disconnect switches for motors as shown on drawings and/or specified herein.

I. Furnish and install complete electrical grounding systems as shown on drawings and/or specified herein.

J. Install and connect electrical equipment mentioned in Division 26/27/28 Specifications or noted in drawings, whether furnished by electrical contractor or by others.

1. Where shown or specified, equipment furnished by others shall be installed and connected under this Contract.
2. Where shown or specified, Contractor shall receive, unpack, check and assume custody of equipment furnished by Others. Contractor shall assume responsibility for care and safekeeping of this equipment, when delivered into his custody. He shall protect it from moisture, dust and damage during construction and until Owner acceptance of project.

K. Furnish and install complete electrical lighting systems as shown on drawings and/or specified herein.

L. Furnish and install all electrical items shown on drawings and/or herein specified, unless shown or specified otherwise.

M. Furnish and install complete controls, instrumentation & auxiliary systems as shown on drawings and/or specified herein.

N. Furnish and install a complete Surge Protection System as shown on drawings and/or specified herein.

O. Furnish and install a complete Building Lightning Protection System as shown on drawings and/or specified herein.

P. Procure and pay for permits and certificates as required by local and state ordinances and fire underwriter's certificate of inspection.

Q. Balance loads as equally as practicable on services, distribution feeders, circuits and buses. Provide typewritten directory for each panel.

R. Unless specifically indicated or required otherwise, terminate all circuitry/cabling provided within this contract at associated equipment/devices/etc. in accordance with all applicable codes, standards and supplier requirements, whether associated equipment/device/etc. is furnished within this contract or by others.

S. Complete field testing, adjustment & startup of all systems listed above as shown on drawings and/or specified herein.

PART 2 PRODUCTS

2.01 APPROVED MATERIALS AND DEVICES

A. Where not otherwise specified, provide only new, standard, first-grade materials/systems throughout, conforming to standards established by Underwriter's Laboratories, Inc., and so marked or labeled, together with

manufacturer's brand or trademark. All equipment/systems subject to approval of Engineer before installation. All like items and associated equipment/systems shall be of one manufacturer.

B. To ensure proper coordination, it is intended that all electrical equipment and materials specified in Division 26/27/28 of these specifications and shown on the electrical drawings be furnished and installed by the electrical sub-contractor. It will not be permissible for any of these items to be furnished directly by the general contractor without the electrical contractor's coordination.

C. To ensure commonality of spare parts, it is required that the electrical contractor provide the same brand for all circuit breakers, starters, power equipment, etc. provided under the following divisions of these specifications:

1. SECTION 26 05 73: POWER DISTRIBUTION SYSTEM ELECTRICAL STUDIES
2. SECTION 26 22 00: DRY TYPE TRANSFORMERS
3. SECTION 26 24 16: POWER PANELBOARDS - CIRCUIT BREAKER TYPE
4. SECTION 26 24 17: LIGHTING PANELBOARDS
5. SECTION 26 24 19: MOTOR CONTROL CENTERS
6. SECTION 26 28 16: SAFETY SWITCHES AND FUSES

2.02 SUBMITTALS

A. All submittals to the design team shall be accompanied by a letter summarizing all proposed deviations from specified products or pre-approved substitutions. The absence of such a letter shall be understood to indicate that the contractor intends to meet all contract requirements, regardless of cut-sheets/data-sheets provided within the submittal.

B. Submit to Engineer ten (10) days prior to bid date three (3) copies of any items and/or manufacturers which are proposed as substitutes for those specified.

C. Submit to Engineer promptly after award of Contract and prior to purchasing, the number of copies required by the contract. All drawings of a specific item or system shall be made in one submittal, and within thirty (30) days after award of Contract. Shop drawings of all power equipment shall contain exact details of device placement, phasing and numbering, in form of elevations, for each major piece of equipment. Shop drawings shall be submitted on the following:

1. SECTION 26 05 73: POWER DISTRIBUTION SYSTEM ELECTRICAL STUDIES
2. SECTION 26 09 44: DISTRIBUTED DIGITAL LIGHTING MANAGEMENT SYSTEM
3. SECTION 26 22 00: DRY TYPE TRANSFORMERS
4. SECTION 26 23 00: PARALLELING SWITCHGEAR
5. SECTION 26 24 16: POWER PANELBOARDS - CIRCUIT BREAKER TYPE
6. SECTION 26 24 17: LIGHTING PANELBOARDS
7. SECTION 26 24 19: MOTOR CONTROL CENTERS
8. SECTION 26 28 16: SAFETY SWITCHES AND FUSES
9. SECTION 26 29 00: MANUFACTURED CONTROL PANELS
10. SECTION 26 29 16: REDUCED VOLTAGE SOFT STARTERS, 600VAC
11. SECTION 26 32 13: GENERATOR SETS
12. SECTION 26 36 23: AUTOMATIC TRANSFER SWITCHES
13. SECTION 26 41 00: LIGHTNING PROTECTION SYSTEM
14. SECTION 26 43 00: SURGE PROTECTIVE DEVICES
15. SECTION 26 44 00: ELECTRICAL HEAT TRACING SYSTEMS
16. SECTION 26 50 00: LIGHTING MATERIALS AND METHODS ALL POWER DISTRIBUTION EQUIPMENT (i.e. SWITCHBOARDS, PANELBOARDS, DRY TYPE TRANSFORMER, ETC.)
17. ALL ELECTRICAL AND TELECOMMUNICATION EQUIPMENT LAYOUTS - Submittals shall include ¼” = 1’-0” CAD drawings (hand drawn sketches will not be accepted) of each electrical room, IT room, electrical equipment stand, generator area, or any other similar area with electrical equipment. Drawings shall indicate all panelboards, transformers, switchboards, generators, equipment racks, control panels, HVAC equipment, etc. that are located in each electrical/IT area. Layouts shall show that each piece of electrical equipment has the clearances, working space and dedicated equipment space required by applicable codes. No conduits to equipment within these areas shall be installed until submittals have been provided and returned without exception by the design team.
18. ALL CONTROL ITEMS & SYSTEMS

D. The contractor shall fully review, comment upon and correct all shop drawings as required to assure compliance with contract documents prior to submittal to Engineer. The failure of the contractor to properly review and correct shop drawings prior to submittal will result in rejection of shop drawings by the engineer. Review by the Engineer will be for general conformance with contract documents. The contractor shall be fully responsible for correctness of all submitted dimensions, details, quantities and locations.

E. None of the above items shall be installed until shop drawings or catalog data have been reviewed by Engineer without rejection or required resubmittal. Any listed item not submitted, even if specified, shall be considered not acceptable and shall be removed if directed.

F. Any required resubmittal will be reviewed by the Engineer for conformance with previously issued comments only. The contractor shall be responsible for verifying that all items not specifically requiring resubmittal have not been altered from the previously reviewed submittal.

G. Material proposed for substitution shall be of the same quality, perform the same functions, conform to such physical dimensions and appearance as are required by the Engineer. All material proposed for substitution is subject to the approval of the Engineer and his authority for approval is final. No material proposed for substitution will be considered unless all submittal data complies with the drawings and specifications of Section 16 as to time of submission, number of copies of submittal, and detail requirements.

H. Samples of material shall be furnished where required by drawings or Division 26/27/28 Specification, or as requested by the Engineer on items proposed as substitutes.

I. Submit to Engineer a certificate of final inspection from local inspection department.

PART 3 EXECUTION

3.01 SITE VISIT

A. The Contractor shall visit the site to determine existing dimensions and conditions affecting electrical work. Failure to do so in no way relieves Contractor of his responsibility under Contract.

3.02 CLEARANCE WITH UTILITIES

A. It shall be the responsibility of this Contractor, prior to bid, to reaffirm with the utility companies involved, that the locations, arrangement (and with power company voltage, phase, and metering required) and connections to utility service are in accordance with their regulations and requirements. If their requirements are at variance with these drawings and specifications, the Contract price shall include any additional cost necessary to meet those requirements without extra cost to Owner after a contract is entered into.

B. On many projects the utility company may levy charges due to locations, size or type service involved. The Contractor shall be responsible for these

charges (including permanent meter deposit), unless such charges are not available prior to bid and Contractor so documents as described below. The meter deposit will be refunded to the contractor at time of Owner's acceptance.

C. Should above cost not be available, prior to bid, Contractor must submit a letter signed by a responsible utility company person so stating with his bid and in turn must be submitted by Prime Contractor with his bid to Owner. The cost will then be deleted from the Contract and become responsibility of the Owner.

D. Arrange with utility companies for such services as shown or herein specified and installation of meter where shown. Furnish with shop drawings a signed document from utility companies describing the location and type of services to be furnished and any requirements they may have. This document shall be signed for each utility company by a person responsible for granting such service.

3.03 WORKMANSHIP

A. All work shall be in accordance with the latest editions of NFPA 70 (National Electrical Code), NFPA 101 (Life Safety Code), National Electric Safety Code, International Building Code, applicable NECA standards and the rules and regulations of State and Local Authorities Having Jurisdiction.

B. All work shall be executed in a workmanlike manner and shall present a neat and mechanical appearance upon completion.

C. All equipment, devices, etc. shall be installed in accordance with manufacturer's recommendations.

D. All items shall be installed straight and plumb in a workmanlike manner and care shall be exercised so that like items are mounted the same position, heights and general location.

E. Keep site clean of accumulation of cartons, trash and debris.

3.04 SAFETY

A. The contractor is solely responsible for all job safety. Engineer assumes no responsibility for job safety. Maximum consideration shall be given to job safety and only such methods as will reasonably ensure the safety of all persons shall be employed. The codes and regulations of OSHA shall be given strict compliance as well as such other codes, laws, and regulations as may be applicable.

3.05 CONTRACT DOCUMENTS

A. Contract documents indicate diagrammatically, extent, general character and approximate location of work. Where work is indicated but minor details omitted, furnish and install it complete so as to perform its intended functions. For details and mechanical equipment, follow drawings provided by other disciplines (Architectural, Mechanical, Structural, Civil, etc.) and fit electrical work thereto.

B. Contract documents consist only of the hardcopy documents issued by the Prime Engineer. Electronic documents issued directly by the electrical engineer to the contractor and/or its sub-contractors/vendors are issued for convenience only (electronic documents are not formal contract documents).

C. If the contractor and/or one of its suppliers require a one-time transfer of electronic files of the current electrical construction documents to prepare shop drawings (or for another similar purpose), it shall:

1. Sign a waiver prepared by the electrical engineer prior to the transmittal of these files.
2. Agree to pay the electrical engineer a fee of $50.00 per drawing, up to a maximum of $400 per transfer, payable upon receipt of the files.
3. To the fullest extent permitted by law, indemnify, hold harmless, and defend JRA from all claims, damages, losses and expenses, including attorneys' fees arising out of or resulting from the use of the CAD files.

D. Take finish dimensions at job in preference to scaled dimensions.

E. Except as above noted, make no changes in or deviations from work as shown or specified except on written order of Engineer.

3.06 UNDERGROUND UTILITY/EQUIPMENT COORDINATION

A. Prior to commencement of work, verify exact locations of all existing or proposed underground utilities and/or underground equipment and verify that proposed electrical installation does not conflict with these items. Notify Engineer immediately if any conflict is found.

3.07 EQUIPMENT STORAGE

A. Store all electrical equipment in dry, covered locations as directed by equipment manufacturers. Contractor shall be responsible for replacing or repairing improperly-stored equipment as directed by Engineer.

3.08 EXCAVATION, CUTTING AND PATCHING

A. Perform all cutting and excavating as necessary for installation of electrical systems, unless specifically covered under another section. After Engineer's observation, complete all excavation, filling and backfilling as directed under specifications for preparation of site and earthwork. Foundations for equipment shall be as specified under concrete section. Concrete pads shall be minimum of 6" thick; unless greater thickness required by equipment manufacturer. Obtain specific approval of Engineer before cutting into any structural members.

B. For all such work employ competent workmen, and finish up in neat and workmanlike manner, equal to quality and appearance to adjacent work.

3.09 PENETRATIONS

A. All penetrations in water tight barriers shall be made so that barrier rating is not compromised. Furnish roof flashing for all equipment installed under Division 26/27/28 that penetrates through the roof. Appropriate flashing is specified under roofing and sheet metal section. Supply these flashings for installation under roofing and sheet metal section.

B. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly to maintain the fire/smoke rating of the associated membrane.

C. Where penetrations are required through structural elements, verify penetration locations and sizes with structural engineer. In no case shall the structural integrity be compromised without written approval from structural engineer.

3.10 INSTALLATION OF EQUIPMENT - GENERAL

A. Care shall be exercised in exact routing and location of all items so as not to obstruct access to equipment, personnel walkways, or expose it to potential mechanical damage.

B. Items shall be securely anchored and/or fastened. Provide proper support for all equipment, devices, conduits, boxes, panels, etc. as required by code and for a workmanlike installation. Provide guy wiring for wood poles where required to prevent leaning. All construction shall meet the seismic design requirements of the building code. Items (especially transformers, light fixtures, equipment racks, freestanding gear, generators, etc.) installed in seismic zones C, D, E or F shall be supported and braced per applicable codes and standards.

C. All wall, pole or frame-mounted electrical equipment shall be mounted to metal unistrut (or similar) frames of same material as electrical equipment.

For example, pole-mounted stainless steel disconnect switches shall be mounted to stainless steel unistrut frames.

D. All electrical equipment, furnished by Contractor or by others shall be covered and protected during construction.

E. All control cabinets, panels, motor control centers and other electrical cabinets and enclosures shall have all trash removed and be vacuumed clean. All foreign paint, etc., shall be removed from exterior and all scratches in finish touched up with same color and material as original. Any rusted areas shall be sanded, primed and repainted.

F. All relays, starters, push-button and other control devices shall be cleaned and if necessary, lubricated with CRC 2-26 to assure free operation.

3.11 MOTORS, STARTERS AND CONTROLS

A. Unless otherwise specified or shown, all motors will be furnished and installed under other sections of this specification.

B. Electrical Contractor shall install all starters and all electrical power wiring and connections to motors and starters.

C. Unless otherwise specified or shown, all control items for motors shall be furnished, installed and wired in conduit by the electrician.

3.12 CIRCUITS AND BRANCH CIRCUITS

A. Outlets shall be connected to branch circuits as indicated on drawings by circuit numbers. No more outlets than are indicated shall be connected to a circuit.

B. Branch circuit homeruns shall be installed as shown on drawings. Multiple homerun conduits shall not be combined by contractor into larger, single homerun conduits unless specific permission is granted by the Engineer.

3.13 LUG/TERMINAL RATINGS

A. All lug/terminal ratings, sizes, locations, types, etc. shall be coordinated with the associated conductor sizes, types, routings, etc. by the contractor.

B. All lugs/terminals/etc. shall be rated for 75 degree C terminations (minimum, unless specified otherwise).

3.14 EQUIPMENT FAULT CURRENT RATINGS

A. All equipment and breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated distribution equipment. All interrupting ratings shall be full ratings. Where new devices or breakers are added to existing distribution equipment, the new devices/breakers shall have interrupting ratings matching or exceeding that of the existing distribution equipment.

3.15 OUTLET LOCATION

A. Symbols shown on drawings and mounting heights indicated on drawings and in specifications are approximate only. The exact locations and mounting height must be determined on the job and it shall be the Contractor's responsibility to coordinate with other trades to ensure correct installation.

3.16 IDENTIFICATION

A. Each panel shall have each circuit identified. Panels without branch circuit nameplates shall have typewritten directories.

B. Each individually mounted switch, circuit breaker, starter and/or any other control or protective device shall identify equipment fed and fuse size, if any, by engraved plastic nameplate, white with black letters, screw attached.

C. See Specification Section 26 05 53 for additional requirements.

3.17 GROUNDING

A. All equipment shall be grounded and bonded in accordance with all state/local regulations, The National Electrical Code and as specified herein.

3.18 PAINTING

A. Refer to Painting/Finishing specifications for requirements regarding field painting of exposed conduit. Any scratches, dents or rust spots in conduit electrical enclosures, panels, motor control or any other electrical items shall have the dents removed, and they, along with any rust spots or scratches, sanded and touched up with the same exact color paint as original finish.

3.19 ACCEPTANCE TESTING

A. Upon completion of work, the entire electrical system installed within this project shall be tested and shall be shown to be in perfect working condition, in accordance with the intent of the specifications and drawings. It shall be the responsibility of the Electrical Contractor to have all systems ready for operation and to have an electrician available to operate same in accordance

with and under the supervision of the observation representative(s) of the Engineer. The Electrician shall be available to assist in removal of panel fronts, etc., to permit inspection as required.

B. The electrical sub-contractor shall include in bid price start-up assistance and training from a certified representative of the manufacturer for the following systems:

1. SECTION 26 09 44: DISTRIBUTED DIGITAL LIGHTING MANAGEMENT SYSTEM
2. SECTION 26 23 00: PARALLELING SWITCHGEAR
3. SECTION 26 29 16: REDUCED VOLTAGE SOFT STARTERS, 600VAC
4. SECTION 26 32 13: GENERATOR SETS
5. SECTION 26 36 23: AUTOMATIC TRANSFER SWITCHES
6. SECTION 26 44 00: ELECTRICAL HEAT TRACING SYSTEMS

3.20 OPERATION AND MAINTENANCE DATA

A. One set of marked “AS BUILT” drawings, three (3) sets of all equipment catalog and maintenance data and three (3) sets of all final shop drawings, on all equipment requiring same shall be turned over to owner. These items shall be bound in hard back book. Contractor shall explain and demonstrate all systems to Owner’s representative.

3.21 GUARANTY-WARRANTY

A. Furnish a written Guarantee-Warranty, countersigned and guaranteed by General Contractor, stating:

1. That all work executed under this section will be free from defects of workmanship and materials for a period of one (1) year from date of final acceptance of this work.
2. Above parties further agree that they will, at their own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the term of the Guaranty-Warranty.

END OF SECTION 26 05 00

SECTION 26 05 19
POWER CONDUCTORS, 51V-600V

PART 1 GENERAL

1.01 DESCRIPTION

A. Power Wires and Cables

B. Low Voltage Wires and Cables

PART 2 PRODUCTS

2.01 POWER WIRES AND CABLES - 600 VOLT

A. General: Conductors shall have current carrying capacities as per N.E.C. and with 600 volt insulation, #12 minimum except for controls and fixture wire. Conductors shall be copper.

B. General Application (see below for exceptions):

1. At or Below Grade (including within slab-on-grade):
   a. #8 or larger conductors:
      1) XHHW or RHH/RHW/USE stranded (in conduit).
   b. #10 or smaller conductors for circuits terminating at motors:
      1) THHN/THWN or XHHW stranded (in conduit).
   c. #10 or smaller conductors (excluding circuits terminating at motors):
      1) THHN/THWN or XHHW solid (in conduit).

2. Above Grade:
   a. #8 or larger conductors:
      1) THHN/THWN, XHHW or RHH/RHW/USE stranded (in conduit).
   b. #10 or smaller conductors for circuits terminating at motors:
      1) THHN/THWN, XHHW or RHH/RHW/USE stranded (in conduit).
   c. #10 or smaller conductors (excluding circuits terminating at motors):
      1) THHN/THWN, XHHW or RHH/RHW/USE solid (in conduit).

3. Power Wire and cable shall be as manufactured by Southwire, Rome, Encore Wire, American Insulated Wire, Okonite, Phelps-Dodge, Amercable, Aetna or approved equal.

C. VFD Cabling

1. Wiring/Cabling installed between each VFD (Variable Frequency Drive) and the associated motor shall be multi-conductor shielded VFD power cable with the following characteristics:
   a. Multi-conductor cable with three (3) power conductors and three (3) ground conductors
   b. Soft annealed flexible stranded copper conductors.
   c. 1kV cross-linked polyolefin insulation (to resist the potential reflected voltages experienced in 600VAC VFD applications).
   d. Metallic shielded providing 100% shield coverage
   e. Oil, abrasion, chemical & sunlight resistant thermosetting compound outer jacket.
   f. Flexible TC-ER rated, UL listed for use in cable trays.
   g. Equal to AmerCable #37-108VFD cable.

D. Emergency Feeder Wiring

1. Where specifically required by NEC articles 700, 701, or other similar sections, feeder-circuit wiring for emergency systems and legally-required standby systems shall be a listed electrical circuit protective system consisting of 2-hour fire-rated, mineral insulated, copper-sheathed wiring cable (Pyrotenax System 1850 or equal).

E. Class 1 Control Cabling (120VAC Control Circuits, Etc.)

1. Unless specified otherwise, Class 1 control cabling shall:
   a. Be rated for exposed cable tray installation.
   b. Be plenum rated (Class 1 Control cabling and Instrumentation cabling installed in conduit or exposed in cable tray in non-plenum areas is not required to be plenum-rated).
   c. Be UL-rated for the proposed application.
   d. Be multi-conductor with overall outer sheath as required by the application. The insulation of each conductor within the overall multi-conductor cable shall be uniquely color-coded. Ground conductors (when provided) within the multi-conductor cable shall have green insulation. Conductors with green insulation shall not be used for conductors other than ground.
   e. Utilize copper conductors.
   f. Have wire gauge as required to limit voltage drop to acceptable limits determined by the system supplier and to meet all applicable code requirements.
   g. Where installed underground, within slab-on-grade or in exterior locations, be rated for wet locations.

h. Where required for specific systems, meet the specific requirements (conductor quantity, wire gauge, insulation type, shielding, etc.) of the system supplier.
i. Be rated for 600V.
j. Be industrial grade.
k. Have stranded conductors.
l. Have sunlight/oil-resistant PVC/Nylon insulation and jacket with ripcord.

2. Control cabling shall be as manufactured by Belden, AlphaWire or General Cable.

F. Fixture Wiring

1. Conductor Types:
a. Type TFFN or XFF.

2. Minimum Sizes:
a. For fixtures up to 300 watts: #16.
b. For fixtures over 300 watts up to 1500 watts: #14.
c. For fixtures over 1500 watts: as required.
d. Conductors to concrete pour fixtures: #12.

3. Fixture wire shall extend only from fixture to first junction, and not over 6 feet, except for concrete pour units.

2.02 WIRE CONNECTIONS:

A. All connector types:

1. Shall be properly rated for the proposed application by UL and per the manufacturer.

B. At Motor Connections (within motor terminal boxes):

1. On Unshielded Wire:
a. Single conductor per phase: shall be made with insulated set screw connectors or 3M 5300 Series 1kV Motor Lead Connections kits with mechanical lugs as required.
b. Multiple conductors per phase: shall be made with insulated mechanical lugs, rated for the associated motor cable types, by Polaris or Ilsco.

2. On Shielded Power Wire:

a. The braided shields and internal grounding conductors of shielded power (not instrumentation) cables shall be grounded at BOTH ends (at VFD/starter and at motor) with a termination kit provided by the cable supplier. This termination kit shall include a connection ring that makes contact around the full circumference of the braided shield, and connects all internal grounds to a common external ground point.

C. Other Dry locations:

1. On Wire larger than #10: shall be made with solderless, non-insulated compression-type connectors meeting requirements of Federal Specification WS-610e for Type II, Class 2 and shall be covered with Scotch #33 electrical tape so that insulation is equal to 150% of conductor insulation.
2. On Wire #10 and smaller: shall be made with one of the following:
   a. Ideal Wing Nuts or equal by 3M .
   b. Ideal Push-In Wire Connectors (for #12 and smaller only).

D. Other Wet/Damp locations:

1. On Wire larger than #10: shall be made with underground/direct-burial, waterproof rated EPDM or TPE-insulated connectors by Ilsco, Burndy or T&B.
2. On Wire #10 and smaller: shall be made with one of the following:
   a. Ideal Weatherproof or Underground Wire Connectors pre-filled with 100% silicone sealant as required by the application.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. All wires and cables shall be installed in conduit unless specifically noted otherwise.

B. All joints and splices on wire shall be made with solderless connectors, and covered so that insulation is equal to conductor insulation.

C. No splices shall be pulled into conduit.

D. No conductor shall be pulled until conduit is cleaned of all foreign matter.

E. Wire and cable shall be neatly formed, bundled and tied in all panelboards, wireways, disconnect switches, pullboxes, junction boxes, cabinets and other similar electrical enclosures.

F. All wires and cables installed in underground or other wet locations shall be rated by the manufacturer for wet locations.

G. Network cabling shall be continuous from endpoint to endpoint and shall not be spliced unless specifically noted otherwise.

H. All conductors/cabling (including spare conductors) shall be properly terminated unless specifically directed otherwise. See above for general termination hardware requirements.

3.02 POWER WIRE AND CABLE INSTALLATION:

A. No power conductor shall be smaller than #12 except where so designated on the drawings or hereinafter specified.

B. Multi-wire lighting branches shall be used as indicated.

C. Where more than three current-carrying conductors are installed in a single raceway or cable, conductors shall be derated as indicated in NEC Table 310.15(B)(3)(a).

D. Raceways/cables shall generally not be installed exposed to sunlight on roofs unless specifically required. Where raceways or cables are installed exposed to sunlight on roofs, conductors shall be derated with ampacities adjusted per NEC Table 310.15(B)(3)(c).

E. In installing parallel power conductors, it is mandatory that all conductors making up the feeder be exactly the same length, the same size, the same type of conductor with the same insulation. Each group of conductors making up a phase or neutral must be bonded at both ends in an approved manner.

F. In installing overhead main power services, a minimum of 5’-0” of cable per run shall be extended beyond the weatherhead(s) for connection to service drop. Confirm exact requirements with local utility company.

3.03 WIRE CONNECTIONS

A. See Part 2 above for material types.

B. Aluminum Wire Connections:

1. Where aluminum wiring is allowed, connections shall utilize compression fittings, no exceptions (Anderson Versa Crimp or equal).

C. Any stranded wire connection to wiring devices shall be made with crimp type terminals.

D. All electrical connections and terminals shall be tightened according to manufacturer's published torque-tightening values with calibrated torque wrenches as required to clearly indicate final torque value to the contractor. Where manufacturer's torque values are not provided, those specified in UL 486A & 486B shall be used.

E. All connections and connector types shall be installed in strict compliance with all requirements of the connector manufacturer.

F. Under no condition shall the specified conductors be connected to terminals rated less than 75°C. Where conductors sized #1 or smaller are shown to be terminated at equipment and the terminals of that equipment are rated for less than 75°C, contractor shall install junction box near equipment to capture the specified conductors, splice with compression connections (rated for a least 75°C) and extend conductors with ampacity rating as required by NEC (based on terminal temperature rating) to equipment terminals. The length of the conductors to be terminated shall be as directed by the AHJ but not less than 48 inches.

3.04 SHIELDED CABLE INSTALLATION

A. Shielded VFD (power) cables:

1. The braided shields and internal grounding conductors of shielded VFD (power) cables shall be grounded at BOTH ends (at VFD and at motor) with a termination kit provided by the cable supplier. This termination kit shall include a connection ring that makes contact around the full circumference of the braided shield, and connects all internal grounds to a common external ground point.
2. Contractor shall coordinate the necessary size of conduit with the outer diameter of the proposed cable type to verify that the raceway loading does not exceed NEC requirements prior to rough-in of the conduit system.

B. Shielded instrumentation (low voltage) cables:

1. The outer foil of shielded instrumentation cables shall be grounded at the PLC/control panel end only (not at the field device end) with a termination kit as directed by the PLC/control panel supplier.

3.05 LOW VOLTAGE (LESS THAN 50V) CONTROL AND NETWORK CABLE INSTALLATION:

A. All wires and cables shall be installed in conduit unless specifically noted otherwise. Low voltage control and/or network cabling located within

concealed, accessible ceiling spaces (such as above lay-in ceilings) may be run without conduit if the following requirements are met:

1. Cabling shall be plenum-rated, multi-conductor.
2. Cabling shall be supported by cable tray or with J-hook supports on intervals not to exceed 5’-0” on center. Cabling shall be supported solely from the cable tray or j-hooks supported from the building structure, without using piping, ductwork, conduit or other items as supports.
3. Cabling shall be properly bundled with plenum-rated Velcro straps on intervals not to exceed 30” on center.
4. Properly-sized conduit(s) shall be provided wherever cabling enters an inaccessible or exposed area (such as above gyp board ceilings or through walls). End bushings shall be provided on both ends of all raceway terminations. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly.

3.06 CIRCUITS AND BRANCH CIRCUITS

A. Outlets shall be connected to branch circuits as indicated on drawings by circuit number adjacent to outlet symbols, and no more outlets than are indicated shall be connected to a circuit.

3.07 LABELING AND COLOR CODING OF WIRE AND CABLE

A. Refer to Specification Section 26 05 53 for all labeling requirements.

B. A color coding system as listed below shall be followed throughout the network of branch power circuits as follows:

PHASE	120/208/240/ COLOR	120/240 HIGH LEG DELTA COLOR	277/480 VOLT COLOR
A	BLACK	BLACK	BROWN
B	RED	ORANGE (FOR HI-LEG)	ORANGE
C	BLUE	BLUE	YELLOW
NEUTRAL	WHITE	WHITE	GRAY
GROUND	GREEN	GREEN	GREEN

C. Where dedicated neutrals are installed for multi-wire branch circuits, the neutral conductors shall be color coded as follows:

PHASE	120/208/240/ COLOR	120/240 HIGH LEG DELTA COLOR	277/480 VOLT COLOR
NEUTRAL A	WHITE W/	WHITE W/ BLACK	GRAY W/

	BLACK TRACER	TRACER	BROWN TRACER
NEUTRAL B	WHITE W/ RED TRACER	WHITE W/ ORANGE TRACER (FOR HI-LEG NEUTRAL)	GRAY W/ ORANGE TRACER
NEUTRAL C	WHITE W/ BLUE TRACER	WHITE W/ BLUE TRACER	GRAY W/ YELLOW TRACER

D. Control Conductors: Shall be color coded by use of colored “tracers”. No control circuit shall contain two identical conductors. For example, a set of five (5) control conductors for a pushbutton station represents one (1) control circuit which would require five (5) uniquely-colored control conductors.

3.08 TESTING

A. The insulation resistance of all feeder conductors (feeding electrical distribution equipment such as switchboards, panelboards, transfer switches, transformers, etc.) shall be tested at the load side of the feeder breaker with a 1000-volt DC Megger Tester prior to energization or final termination. Any feeder conductor with an insulation resistance less than the recommended minimums in the latest version of NETA Acceptance Testing Specification (“ATS”) standard shall be replaced by the contractor at the contractor’s expense. All final test results shall be clearly documented (with date, time, feeder, results, test equipment, etc.), and the final test results shall be submitted to the design team for review.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING

PART 1 GENERAL

1.01 GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO GROUNDING OF THE FOLLOWING:

1. Service Equipment.
2. Transformers.
3. Non-current carrying conductive surfaces of equipment.
4. Metal Buildings.
5. Structures.
6. Other Equipment.

1.02 GENERAL REQUIREMENTS

A. All equipment, building steel, and main service shall be effectively and permanently grounded with a conductor cross section as required by the National Electrical Code and of capacity sufficient to ensure continued effectiveness of the ground connections for fault current. Ground conductors shall be as short and straight as possible, protected from mechanical injury and, if practicable, without splice or joint.

B. All grounding connections shall be installed in accordance with the National Electrical Code and all local codes and requirements. Such codes shall be considered minimum requirements and the installation of the grounding system shall ensure freedom from dangerous shock voltage exposure and provide a low impedance ground fault path to permit proper operation of overcurrent and ground fault protective devices.

PART 2 PRODUCTS

2.01 CONDUCTORS

A. All grounding conductors shall be insulated with green colored, 600 volt insulation unless noted otherwise.

B. Motors having power supplied by single conductor wire in conduit shall be grounded through the conduit system. Flexible conduit shall be “jumpered” by an appropriate bonding conductor.

C. Supplemental grounding system conductors shall be bare, softdrawn, stranded,

single conductor copper wire, and generally sized as follows (unless shown otherwise on plans):

1. Switchgear, motor control centers, and power transformer #4/0 minimum or as shown on plans.
2. Power panels, #2/0.
3. Control panels and consoles, #4.
4. Process Motors, #1/0.
5. Building Columns, #4/0.
6. Light Poles, #2.
7. Telephone Backboard & Cabinet ground busses, #2.

2.02 GROUNDING ELECTRODES

A. Grounding electrodes shall be copper-clad steel rods 3/4 inch in diameter and ten feet long. Where longer electrodes are necessary to reduce the ground resistance, Contractor shall provide sectional rods, connectors, drive heads, etc.

2.03 CONNECTIONS

A. All conductor-to-conductor, conductor-to-ground rod, conductor-to-structure, conductor-to-fence connections of #6 and larger sized conductors and underground ground connections shall be permanent exothermic welded connections (Cadweld or equal) unless otherwise noted on applicable drawings.

B. Connections to equipment shall be by bolted compression type lugs (except for motors). When the conductor is #6 and larger, the lug shall be joined to the conductor by an exothermic weld (Cadweld or equal).

C. Motors to be grounded by the grounding conductors run with the power conductors shall have a split-post grounding stud installed in the connection box.

D. Each cast pull box or junction box shall have a ground lug, connected to largest ground conductor to enter box.

E. Ground connections at conduit terminations shall be made by approved grounding bushings (see Raceways Specification Section for additional requirements).

2.04 MANUFACTURERS

A. Conduit clamps and connectors shall be manufactured by Raco, OZ., or

Ercon.

B. Lugs shall be as manufactured by Square “D”, Burndy, or T and B.

C. Exothermic weld connections shall be as manufactured by Cadweld, or approved equal.

D. Ground rods shall be as manufactured by Joslyn or McGraw Edison.

E. Split post grounding shall be as manufactured by Burndy or T and B.

PART 3 EXECUTION

3.01 MAIN SERVICE GROUND

A. The main service grounding electrode system shall consist of the following items bonded together by the grounding electrode conductor:

1. The main underground cold water pipe (metal).
2. The metal frame of the building.
3. Driven ground rods. Ground rods shall be embedded at the lowest point in the building and below the permanent moisture level. Ground rods shall be spaced a minimum of ten (10) feet apart and connected in parallel until resistance to ground does not exceed five (5) ohms.

B. The grounding electrode system shall be connected to the grounded conductor (neutral) on the supply side of the service disconnecting means by a grounding electrode conductor not smaller than that shown in Table 250.66 of the N.E.C. The main service equipment grounding conductor shall be connected to the grounding conductor on the supply side of the service disconnecting means in accordance with Table 250.122 of the N.E.C. for the ampere rating of the service entrance equipment. Where in a service entrance switchboard, the equipment grounding conductor shall not be less than 25% of the main bus rating. These connections shall be made inside the service entrance equipment enclosure.

3.02 TRANSFORMER GROUNDS

A. Dry type insulation transformers with a grounded conductor in the secondary shall be grounded in accordance with N.E.C. Section 250-30.

3.03 EXPOSED NON-CURRENT-CARRYING METAL PARTS

A. General: Ground connections to equipment or devices shall be made as close to the current carrying parts as possible, that is, to the main frame rather than supporting structures, bases or shields. Grounding connections shall be made

only to dry surfaces that are clean and dry. Steel surfaces shall be ground or filed to remove all scales, rust, grease, and dirt. Copper and galvanized steel shall be cleaned to remove oxide before making welds or connections. Code size ground conductors shall be run in all power conduits and properly terminated at each end.

B. Ground conductors shall be routed as straight as possible. Where possible, ground conductors shall be routed such as to avoid bends exceeding 90 degrees or with a radius of less than 8".

C. Motors: Exposed non-current-carrying metal parts, shall be grounded by a grounding conductor either run with power conductors, and/or separate grounding conductors. Drawings will show method(s) to be used. The ground conductors with all motor conductors shall be connected to the ground buss in the motor connection box. Jumper connections shall be installed between frames and rigid conduit for equipment having flexible conduit connections (sealtight). All AC motor grounds shall provide a low impedance path to ground. Connections from the supplemental grounding system (when specified) shall be made directly to the motor frame. Additionally, utilization equipment connected to the motor (pump, fan, mixer, etc.) shall be bonded to the motor with flexible braid-type bonding strap to ensure equalization of ground potentials.

D. Raceways & boxes: All raceways, conduits, armored or shielded cable and all exposed non-current carrying metal parts shall be grounded. Such items shall be bonded together and permanently grounded to the equipment ground buss. Metallic conduits shall be connected by grounding or clamps to ground buss. Flexible "jumpers" shall be provided around all raceway expansion joints. Bonding straps for steel conduit shall be copper. Jumper connections shall be provided to effectively ground all sections or rigid conduit connected into plastic pipe. No metallic conduit shall be left ungrounded. In conduit systems interrupted by junction or switch boxes where locknuts and bushings are used to secure the conduit in the box, the sections of conduit and box must be bonded together. If conduit, couplings or fittings have a protective coating or non-conductive material, such as enamel, such coating must be thoroughly removed from threads of both couplings and conduit and the surface of conduit or fitting where the ground clamp is secured.

E. Enclosures: Metal conduits entering free standing motor control centers, switchboards or other free standing equipment shall be grounded by bare conductors and approved clamp. Any conduits entering low voltage (480 volts or below) equipment through sheet metal enclosure and effectively grounded to enclosure by double locknut or hub need not be otherwise bonded.

F. Equipment: In addition to equipment grounding provisions mandated by code requirements, additional equipment grounding provisions (including local ground rods, connections, etc.) shall be provided by the contractor as directed by equipment suppliers.

G. Both ends of ground busses in motor control centers, switchboards, etc., shall be separately connected to the main ground buss to form two separate paths to ground.

H. Fences and Grills: Fences and metal grills around equipment carrying voltage above 500 volts between phases shall be bonded together and to ground. Fences and grill work shall be grounded at every post, column, or support, and on each side of every gate.

3.04 ACCEPTANCE DOCUMENTATION AND TESTING

A. Contractor shall take and store photographs of all underground grounding system connections prior to burial of connections, for review by Engineer.

B. Upon completion of work, the entire ground system shall be shown to be in perfect working condition, in accordance with the intent of the Specifications.

C. Contractor shall measure the resistance between the main ground bonding jumper to true earth ground using the Fall of Potential method as described by ANSI/IEEE Standard 81 (“Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of an Earth System”). If the measured value is greater than five ohms, additional grounding electrodes shall be installed as described in Part 3.1 above. The final ground resistance value shall be submitted in writing, and documented via picture of the meter reading from the Fall of Potential test, to the Engineer prior to the final observation, and shall be included in final O&M documentation.

END OF SECTION 26 05 26

SECTION 26 05 33
RACEWAYS

PART 1 GENERAL

1.01 DESCRIPTION

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:

1. Conduits
2. Conduit Fittings
3. Couplings & Connectors
4. Bushings
5. Raceway Hardware, Conduit Clamps & Supports
6. Watertight Entrance Seal Devices

PART 2 PRODUCTS

2.01 CONDUITS

A. PVC-Coated Rigid Steel:

1. The PVC coated rigid metal conduit must be UL Listed. Hazardous location fittings, prior to plastic coating must be UL listed. All conduit and fittings must be new, unused material. Applicable UL standards may include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.
2. The PVC-coated rigid metal conduit shall be ETL PVC-001 listed.
3. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.
4. Form 8 Condulets®, 3/4" through 2" diameters, shall have a tongue-in-groove “V-Seal" 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 hours shall be available.
5. A PVC sleeve extending one pipe diameter or two inches, 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.
6. 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.

7. Form 8 Condulets® shall be supplied with plastic encapsulated stainless steel cover screws.
8. 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.
9. 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 30deg.F (-1deg.C).
10. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
11. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.
12. Independent certified test results shall be available to confirm coating adhesion per ETL PVC-001 standards under the following conditions:
    a. Conduit immersed in boiling water with a minimum mean time to adhesion failure of 200 hours. ASTM D870)
    b. Conduit and condulet exposure to 150deg F (65deg C) and 95% relative humidity with a minimum mean time to failure of 30 days. (ASTM D11513.
    c. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
    d. 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).
    e. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1.
    f. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.
13. Water tight flex connectors used in areas where PVC coated metal conduit is utilized shall be PVC coated also.
14. Shall be as manufactured by Perma-Cote, Plastibond, Korkap, Ocal or Okote.

B. Rigid Galvanized Steel and I.M.C.:

1. Shall be galvanized outside and inside by hot dipping.
2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

C. E.M.T.:

1. Shall be Electro-Galvanized.
2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

D. Rigid Aluminum:

1. Shall be manufactured of 6063 Alloy, T-1 temper.
2. Shall be as manufactured by Republic, Wheatland, Triangle, Pittsburg Standard, Youngstown, Allied or equal.

E. Schedule 40 and 80 PVC:

1. Shall be composed of polyvinyl chloride and shall be U.L. rated type 40 or 80 for use with 90 degree rated conductors. Conduit shall conform to NEMA Standards and applicable sections of N.E.C.
2. The conduit manufacturer shall have had a minimum of 5 years experience in the manufacture of the products. Non-metallic raceways shall be as manufactured by Carlon, Triangle, Can-Tex, Allied or equal.

F. HDPE Innerduct

1. Shall be composed high density polyethylene and shall be orange in color, unless noted otherwise.
2. Shall be corrugated unless noted otherwise.
3. Shall be manufactured by Carlon, Ipex or equal.

G. Flexible Metallic Conduit:

1. Shall be continuous spiral wound and interlocked galvanized material, code approved for grounding.

H. Liquidtight Flexible Metallic Conduit:

1. Shall be galvanized steel-core sealtite, code approved for grounding.
2. Shall have an outer liquidtight, nonmetallic, sunlight-resistant jacket over an inner flexible metal core.
3. Shall be as manufactured by Electric-Flex, Anaconda or equal.

2.02 FITTINGS, COUPLINGS & CONNECTORS

A. Rigid Galvanized Steel and I.M.C. couplings and connectors shall be standard threaded type, galvanized outside and inside by hot dipping. Threadless and clamp type are not acceptable. Couplings/connectors shall be as manufactured by Raco, Efcor, or Appleton or equal.

B. All fittings, conduit bodies, couplings and connectors (**including, but not**

limited to, condulettes, conduit couplings, connectors, hubs, nipples, unions, expansion fittings, explosion proof seal-offs, threaded hole closures, and seal-tight connectors, etc.) used in areas where PVC-Coated Rigid conduit is used shall also be PVC-coated.

C. All fittings, conduit bodies, couplings and connectors (**including, but not limited to, condulettes, conduit couplings, connectors, hubs, nipples, unions, expansion fittings, explosion proof seal-offs, threaded hole closures, and seal-tight connectors, etc.**) installed in other wet, exterior or process areas where PVC-coated conduit systems are not required, shall be aluminum or stainless steel type. Standard steel fittings will not be acceptable.

D. All rain tight connectors shall be threaded Myers or approved equal, rated for outdoor application.

E. E.M.T. couplings and connectors shall be set screw, or steel compression type. All couplings and connectors shall be 720B, 730, 750B, or 760 series of Efcor or equal series of Raco. Pressure indented type connectors or cast metal will not be approved for any location. E.M.T. couplings and connectors shall be as manufactured by O-Z/Gedney, T&B, Efcor, Raco, Midwest or equal. E.M.T. fittings, couplings and connectors located within concrete (where allowed) shall be compression type and shall be adequately sealed with tape to ensure a concrete-tight seal.

F. Rigid Aluminum couplings and connectors shall be standard threaded type, of the same alloy as the associated conduit. Threadless and clamp type are not acceptable. Fittings shall be as manufactured by Thomas & Betts, Crouse-Hinds, Appleton, Pyle-National or equal.

G. All PVC couplings, adapters, end bells, reducers, etc., shall be of same material as conduit.

H. Liquidtight Flexible Metallic Conduit connectors shall be liquidtight with insulating throat or end bushing, designed for application with Liquidtight Flexible Metallic Conduit. Fittings shall be as manufactured by Efcor, Raco, Midwest or equal.

I. All LB unilets sizes 1 ¼" or larger shall have rollers.

J. Miscellaneous conduit fittings shall be as manufactured by Appleton, Crouse-Hinds, Pyle-National, Russell & Stoll or equal.

2.03 BUSHINGS

A. All non-grounding rigid bushings 1-1/4” and larger shall be the insulating type (O-Z/Gedney type “BB” or equal by T&B, Midwest Electric or Penn Union).

B. All non-grounding rigid bushings 1” and smaller shall be threaded malleable iron with integral noncombustible insulator rated for 150°C. Non-grounding rigid conduit bushings shall be O-Z/Gedney type “B” or equal by T&B, Midwest Electric or Penn Union.

C. All grounding rigid bushings shall be threaded malleable iron with integral noncombustible insulator rated for 150°C. All grounding rigid conduit bushings shall be O-Z/Gedney type “BLG” or equal by T&B, Midwest Electric or Penn Union.

2.04 HARDWARE, CONDUIT CLAMPS AND SUPPORTS

A. All hardware such as expansion shields, machine screws, toggle bolts, “U” or “J” bolts, machine bolts, conduit clamps and supports shall be of corrosion resistant materials (stainless steel, aluminum, galvanized or plated steel, or other approved materials).

B. Hardware in contact with aluminum handrails, plates or structural members and all hardware in exterior, wet or corrosive areas shall be type 316 stainless steel or aluminum (with bitumastic paint coating to isolate aluminum from contact with concrete where necessary) unless specifically noted otherwise.

C. Supports in exterior, process, wet or corrosive locations shall be type 316 stainless steel or aluminum (with bitumastic paint coating to isolate aluminum from contact with concrete where necessary) unless specifically noted otherwise.

D. Supports in extremely corrosive environments (such as chlorine or fluoride storage rooms) shall be PVC-Coated steel unless specifically noted otherwise.

E. Hardware and conduit clamps shall be as manufactured by Efcor, Steel City, G.A., Tinnerman or equal.

2.05 WATERTIGHT ENTRANCE SEAL DEVICES

A. For new construction, seal devices shall consist of oversized sleeve and malleable iron body with sealing rings, pressure rings, sealing grommets and pressure clamps as required (O-Z/Gedney type FSK/WSK or equal).

B. For cored-hole applications, seal devices shall consist of assembled dual pressure disks with neoprene sealing rings and membrane clamps as required (O-Z/Gedney type CSM or equal).

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

A. Minimum Diameter: 3/4-inch.

B. Raceway Type: Raceway types shall be as specified below, unless indicated otherwise on drawings:

1. Exterior, Exposed: Rigid Aluminum unless otherwise noted.
2. Exterior, Used for Instrumentation Circuits: See Below.
3. Other Exterior (Concrete-Encased or Direct Earth Buried): Schedule 40 PVC. PVC conduit shall convert to metallic conduit prior to exiting concrete-encasement or direct earth burial. See “transition” items below for additional requirements. Conduits shall be left exposed until after Engineer’s observation.
4. Interior, Exposed:
   a. Hazardous Locations: Rigid Aluminum .
   b. Wet Locations (including, but not limited to, Pump Rooms, Areas with exposed piping, Dewatering Rooms, Wet Wells, Underground Vaults, and other similar locations): Rigid Aluminum .
   c. Dry Locations: Rigid Aluminum.
   d. Extremely Corrosive Locations (Chlorine Storage Rooms, Fluoride Storage Rooms and other similar areas): Schedule 80 PVC.
5. Interior, Concealed:
   a. Embedded inside Poured Concrete Walls, Ceilings or Floors, with a minimum of 2” of concrete between finished surface and outer wall of conduit on all sides, where no anchor bolts, screws or other similar items will be installed: Schedule 40 PVC. PVC conduit shall convert to metallic conduit (exact type as specified elsewhere within this section) prior to exiting poured concrete-encasement of wall, ceiling, floor or ductbank. See “transition” items below for additional requirements.
   b. Other Raceways Embedded inside Poured Concrete Walls, Ceilings or Floors (not meeting requirements above): PVC-Coated Rigid Steel
   c. Other Raceways: E.M.T.
6. Raceways used for Instrumentation Circuits:
   a. Typical Dry or Wet Locations: Rigid Aluminum .
   b. Underground or Locations Embedded inside Poured Concrete: PVC-Coated Rigid Steel.
   c. Extremely Corrosive Locations (Chlorine Storage Rooms, Fluoride Storage Rooms and other similar areas): PVC-Coated Rigid Steel.

7. Terminations at motors, transformers and other equipment which has moving or vibrating parts:
   a. Exterior or Wet Locations (including, but not limited to, Pump Rooms, Wet Wells, Underground Vaults, and other similar locations): Liquidtight Flexible Metallic Conduit (shall generally not exceed 24 inches in length) with watertight fittings.
   b. Dry, Interior Locations: Flexible Metallic Conduit (shall generally not exceed 24 inches in length).

8. Terminations at instruments:
   a. Liquidtight Flexible Metallic Conduit (shall generally not exceed 12 inches in length) with watertight fittings.

9. Terminations at fixtures mounted in grid-type ceilings:
   a. Flexible Metallic Conduit or MC cabling (shall generally not exceed 72 inches in length and shall run from junction box to fixture, not from fixture to fixture).

10. Transition from underground or concrete-encased to exposed:
    a. Convert PVC to PVC-Coated Rigid Steel utilizing PVC-Coated Rigid Steel 90 degree bends (and vertical conduits as required by application) prior to exiting concrete/grade (except at outdoor pull boxes and under freestanding electrical equipment, where terminations shall be by PVC end bells installed flush with top of slab). Exposed portions of these coated conduits shall extend a minimum of 6” above floor level, and shall be installed at uniform heights.

3.02 RACEWAY INSTALLATION

A. General:

1. Follow methods which are appropriate and approved for the location and conditions involved. Where not otherwise shown, specified, or approved in a particular case, run all wiring concealed.
2. Where conduit crosses a structural expansion joint an approved conduit expansion fitting shall be installed.
3. Where any run of rigid aluminum conduit (including bends) exceeds 50’ in length, an approved conduit expansion fitting shall be installed (beginning at center of run) at intervals not to exceed 50’ on center.
4. A non-conductive polypropylene pull string, properly tied/secured at either end, shall be installed in all empty conduits.
5. Metal conduit field-cuts shall be cut square with a hacksaw and the ends reamed after threading.

6. PVC conduit field-cuts shall be made with hacksaw, and ends shall be deburred.
7. All PVC joints shall be made as follows:
   a. Clean the outside of the conduit to depth of the socket, and the inside of socket with an approved cleaner.
   b. Apply solvent cement as recommended by the conduit manufacturer to the interior of the socket and exterior of conduit, making sure to coat all surfaces to be joined.
   c. Insert conduit into the socket and rotate 1/4 to 1/2 turn and allow to dry.

8. All metallic conduit installed below grade or within concrete shall be coated with two (2) spiral-wrapped layers of 3M Scotchrap 50 PVC tape or two coats of asphaltum paint prior to installation.
9. Install ground wire sized per N.E.C. Table 250.122 in all conduits.
10. Use of running threads is absolutely prohibited. Conduit shall be jointed with approved threaded conduit couplings. Threadless and clamp type not acceptable.
11. Conduits shall be sized in accordance with latest National Electrical Code except when size shown on drawings.
12. Exposed, field-cut threads on all metal conduits shall be painted with zinc primer (for Galvanized Rigid or I.M.C.) or urethane paint (for PVC-Coated Rigid Steel) as recommended by conduit manufacturer .
13. Installation of PVC coated conduit systems shall be performed in strict accordance with the manufacturer's installation instructions. Damage to PVC coated conduit coating shall be touched up with patching compound as directed by manufacturer. To assure correct installation, the installer shall be certified by the manufacturer to install coated conduit.

B. Routing/Locating:

1. Exposed conduit runs shall be run level and plumb and shall, on interior of buildings, be run parallel and/or at right angles to building walls and/or partitions.
2. Conduit with an external diameter larger than 1/3 the thickness of a concrete slab shall not be placed in the slab. Conduits in slab shall not be spaced closer than 3 diameters on center.
3. Conduit run in ceiling spaces shall be run as high as possible, all at same level, and shall be supported from building structure. Do not support conduit from any other installation.
4. Conduit run within exterior CMU, concrete or other similar walls shall be run within the CMU cells / concrete structure / etc. Conduits shall not be run on the outside surface of CMU cells / concrete structure / etc.

underneath exterior veneers / etc., which could cause a thermal break in the wall insulation or a future water intrusion problem.

5. Install conduit runs to avoid proximity to steam or hot water pipes. In no place shall a conduit be run within 6" of such pipes except where crossing is unavoidable, then conduit shall be kept at least 3" from the covering of the pipe crossed.
6. Before installing raceways for motors, HVAC equipment and other fixed equipment, check location of all equipment connections/terminal boxes with equipment supplier and locate and arrange raceways appropriately.
7. No conduit for instrumentation shall be run closer than 12 inches to parallel power conduits.
8. A minimum of 12" of clearance (or more as required by associated utility companies) shall be provided between the finished lines of exterior, underground conduit runs and exterior, underground utilities (gas, water, sewer, etc.).
9. Where any portion of raceway is installed in a wet environment (such as below grade) and located at a higher elevation than the raceway termination point in a dry environment, install watertight compound inside raceway at termination around cabling to prevent transfer of water through conduit system. Watertight compound shall be rated for the potential water head pressure, based on the assumption that ground water level would be at grade level.

C. Bends:

1. Do not make bends (in any raceway, including flexible conduits) that exceed allowable conductor bending radius of cable to be installed or that significantly restrict conductor flexibility.
2. All bends within concrete-encased ductbanks installed in exterior locations shall be long radius bends (24" minimum bending radius – varies with conduit diameter).
3. All bends in raceways containing multi-conductor power cables (such as shielded VFD cables) shall be long radius bends (24" minimum bending radius – varies with conduit diameter).
4. Where numerous exposed bends or grouped together, all bends shall be parallel, with same center and shall be similar in appearance
5. All PVC elbows, bends, etc., shall be either factory bends or made with an approved heat bender.

D. Support:

1. Seismic Anchorage and Bracing:
   a. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All above-grade raceways shall be

anchored/braced in accordance with Specification Section 01 88 15 (“Anchorage and Bracing”).

2. Anchor conduit securely in place by means of approved conduit clamps, hangers, supports and fastenings. Arrangement and methods of fastening all conduits shall be subject to Engineer’s direction and approval. All conduits shall be rigidly supported (wire supports may not be used in any location). Use only approved clamps on exposed conduit.
3. Rigid Aluminum Conduits shall be supported at intervals not to exceed 5’ on center.
4. Conduit in riser shafts shall be supported at each floor level by approved clamp hangers.
5. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameters of conduits.
6. Where installed in seismic zones, suspended raceways shall be braced in two (2) directions as required to prevent swaying and excessive movement.
7. Raceways installed on top of flat roofing shall be supported a minimum of 3 ½” above roof with rubber block supports (Cooper B-Line Dura-Blok or equal). Installation shall be in strict accordance with support manufacturer’s instructions and recommendations.

E. Terminations:

1. All conduit connections to sheet metal cabinets or enclosures located in exterior or wet locations shall terminate by use of rain tight (Meyers) hubs.
2. In wet, exterior or process areas, conduits shall NOT enter tops of enclosures. All conduits shall enter enclosures from bottom, left or right sides of the enclosure (utilizing rain-tight Meyers hubs as indicated above).
3. Where rigid or I.M.C. conduits enter sheet metal boxes, they shall be secured by approved lock nuts and bushings.
4. Where metal conduits enter outdoor pull boxes, manholes, under freestanding electrical equipment or other locations where direct metal-to-metal contact does not exist between enclosure and conduit, grounding bushings shall be installed. Each grounding bushing shall be connected to the enclosure ground and all other grounding bushings with properly sized grounding conductors.
5. Where E.M.T. enters sheet metal boxes they shall be secured in place with approved insulating fittings.
6. Where PVC enters outdoor pull boxes, manholes or under freestanding electrical equipment, PVC end bells shall be installed.

7. Contractor shall be responsible for coordinating required conduit sizes with equipment hubs/conduit entry provisions (such as at motor tap boxes) prior to installation of conduit systems. Contractor shall field adjust final conduit sizes at terminations where so required (only as allowed by code) from those indicated on plans to coordinate with equipment hubs/conduit entry provisions.
8. Where conduit terminates in free air such that associated cabling/circuitry becomes exposed (such as at cable trays, etc.), conduit shall generally terminate in a horizontal orientation (to prevent dust/debris/etc. from entering conduit system). Where vertical conduit termination is necessary, the termination shall be provided with cord-grip conduit terminations to seal the conduit system.
9. Conduit ends shall be carefully plugged during construction.
10. Permanent, removable caps or plugs shall be installed on each end of all empty raceways with fittings listed to prevent water and other foreign matter from entering the conduit system.

F. Penetrations:

1. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly. Refer to drawings and other specifications for additional requirements.
2. All penetrations shall be at right angles unless shown otherwise.
3. Structural members (including footings and beams) shall not be notched or penetrated for the installation of electrical raceways unless noted otherwise without specific approval of the structural engineer.
4. Dry-packed non-shrink grout or watertight seal devices shall be used to seal openings around conduits at all penetrations through concrete walls, ceilings or aboveground floors.
5. All raceways entering structures, or where water is otherwise capable of entering equipment/devices through the raceway system, shall be sealed (at the first box or outlet) with foam duct sealant to prevent the entrance of gases or liquids from one area to another or into equipment/devices.
    a. Where the elevation of the raceway penetration (into the structure) is no more than 15’ below the other (higher) end of the same raceway, Polywater FST sealant (rated to hold back up to 22’ of continuous water head pressure), or pre-approved equal, shall be used.
    b. Where the elevation of the raceway penetration (into the structure) is between 15’ and 75’ below the other (higher) end of the same raceway, Polywater PHRD Custom Mechanical Seals (rated to hold back up to 36psi or 83’ of continuous water head pressure), or pre-approved equal, shall be used.

c. Where the elevation of the raceway penetration (into the structure) is more than 75’ below the other (higher) end of the same raceway, the contractor shall propose a custom solution designed to hold back or to drain the possible water within the associated raceway. Submittals shall be provided to the engineer for review/approval, including a summary of the anticipated elevations/PSIs, details of the proposed installation, cut-sheets of devices/materials, etc.

6. Additionally, where necessary to ensure that water does not enter equipment/devices through the raceway system (where raceways extend to equipment/devices from wet areas), junction boxes with drain assemblies in bottom shall be located at low point of raceway system near equipment/devices (to drain water out of raceway system before it enters equipment/devices). Contractors shall provide drains in raceway systems where so necessary to prevent water entry into equipment/devices. In special applications (such as to instruments, etc.,), where cabling rated for exposed application is provided, contractor may propose short air gaps (approximately 6” or less) between the end of the conduit system and the equipment/device cable entry (to be made with cable gland connectors) to prevent water in conduit system from entering equipment/devices in lieu of drained junction boxes.
7. All raceways passing through concrete roofs or membrane-waterproofed walls or floors shall be provided with watertight seals as follows:
   a. Where ducts are concrete encased on one side: Install watertight entrance seal device on the accessible side of roof/wall/floor as directed by equipment manufacturer.
   b. Where ducts are accessible on both sides: Install watertight entrance seal device on each side of roof/wall/floor as directed by equipment manufacturer.

8. All raceways passing through walls of rooms containing/storing noxious chemicals (chlorine, ammonia, etc.) or through hazardous locations shall be sealed with conduit seals (Crouse-Hinds type EYS or equal).
9. All raceways terminating into electrical enclosures/devices/panels/etc. located in hazardous locations shall be sealed with conduit seals (Crouse-Hinds type EYS, EZS or equal) within 18” of the termination.

G. Exterior Electrical Ductbanks:

1. Where exterior electrical concrete-encased ductbanks are indicated on drawings, conduit runs between buildings or structures shall be grouped in concrete-encased ductbanks as follows:

a. A minimum of 3” of concrete shall encase each side of all ductbanks.
b. A minimum of 1 ½” of separation shall be provided between each conduit within ductbanks. PVC spacers shall be installed at the necessary intervals prior to placement of concrete to maintain the required spacing and to prevent bending or displacement of the conduits.
c. Top of concrete shall be a minimum of 30” below grade. A continuous magnetic marking tape shall be buried directly above each ductbank, 12” below grade.
d. Exact routing of ductbanks shall be field verified and shall be modified as necessary to avoid obstruction or conflicts.
e. Underground electrical raceways shall be installed to meet the minimum cover requirements listed in NEC Table 300.5. Refer to drawings for more stringent requirements.

END OF SECTION 26 05 33

SECTION 26 05 34
OUTLET BOXES, JUNCTION BOXES, WIREWAYS

PART 1 GENERAL

1.01 DESCRIPTION

A. Outlet and Junction Boxes

B. Pull Boxes

C. Wireways

PART 2 PRODUCTS

2.01 OUTLET BOXES & JUNCTION BOXES (THROUGH 4-11/16")

A. Sheet Metal: Shall be standard type with knockouts made of hot dipped galvanized steel as manufactured by Steel City, Raco, Appleton, Bowers or equal.

B. Cast: Shall be type FS, FD, JB, GS, or SEH as required for application as manufactured by O-Z/Gedney, Appleton, or equal.

C. Nonmetallic: Shall be type Polycarbonate/ABS construction as required for application with non-metallic quick-release latches as manufactured by Hoffman, O-Z/Gedney, Appleton, or equal.

2.02 JUNCTION AND PULL BOXES (LARGER THAN 4-11/16")

A. Oil-Tight JIC: Shall be Hoffman Type CH box or approved equal.

B. Galvanized Cast Iron or Cast Aluminum: Shall be O-Z/Gedney or approved equal.

C. Stainless Steel: Shall be as manufactured by O-Z/Gedney, Hoffman or approved equal. Boxes shall have continuous hinges, seamless foam-in-place gaskets and screw-down clamps.

D. Nonmetallic: Shall be type Polycarbonate/ABS construction as required for application with non-metallic quick-release latches as manufactured by Hoffman, O-Z/Gedney, Appleton, or equal. Boxes shall have hinged covers and screw-down clamps.

E. Wireways: Shall be standard manufacturer's item as manufactured by Hoffman, Square "D", Burns, B & C or equal. Wireways shall have hinged

covers and screw-down clamps.

F. Pre-cast Polymer Concrete Below-Grade Hand Holes & Pull Boxes:

1. Enclosures, boxes and cover are required to be UL Listed and conform to all test provisions of ANSI/SCTE 77 “Specifications For Underground Enclosure Integrity” for Tier 15 applications (15,000lb design load and 22,500lb test load) unless noted otherwise.
2. All covers shall have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding Tier level shall be embossed on the top surface.
3. Cover shall be bolt-down include factory-labeling to read “Electric”, “Communications” or other as directed.
4. Hardware shall be stainless steel.
5. Shall be Quazite PG/LG Style or approved equal.

G. Galvanized Cast Iron Below-Grade Pull Boxes:

1. Enclosures, boxes and cover are required to conform to AASHTO H-20 requirements for deliberate vehicular traffic applications unless noted otherwise.
2. Cover shall be checkered, bolt-down include factory-labeling to read “Electric”, “Communications” or other as directed.
3. Hardware shall be stainless steel.
4. Shall be furnished with grounding kit.
5. Shall be O-Z/Gedney Type YR or approved equal.

H. Above-Grade Padmounted Low Profile Pull Boxes:

1. Construction:
    a. 12Ga. stainless steel base with 12Ga aluminum top with brushed finish, and structural bracing as required.
    b. Continuous base frame with open bottom and eight (8) ½” x 1” slots for securing box to concrete pad below and a center support member.
    c. Two (2) full-size swing-open lids with full-length, stainless steel continuous hinges, lifting handles, key-locking provisions and provisions for latching lids in open position (with stainless steel chain or approved equal).
    d. Guides on lid and base frame as required to ensure proper closing of box and to provide increased security.
    e. Aluminum or stainless steel barrier between power & instrumentation areas within box if box is used for both power and instrumentation wiring.
    f. Other stainless steel hardware as required.

2. Minimum Dimensions:
   a. Power: 40 inches square x 18 inches high.
   b. Instrumentation: 24 inches square x 18 inches high.

3. Manufacturer:
   a. Electrical Enclosure Mfg. (Pell City, AL).
   b. Ebox (Pelham, AL).
   c. Approved Equal.

I. Above-Grade Padmounted Transclosure Pull Boxes:

1. Construction:
   a. 12Ga.aluminum with brushed finish.
   b. Continuous top and bottom support frames with open bottom and slots as required for securing box to concrete pad below and a center support member.
   c. Roof with 1" crest on each unit and gutters between each unit.
   d. Vents (with screens) on top and bottom around perimeter of box.
   e. Full-size swing-out doors on two (2) opposing sides with weld-on barrel hinges (minimum of two per door) and key-locking "L"-handles with roller rods.
   f. Stainless steel barrier between power & instrumentation areas within box if box is used for both power and instrumentation wiring.
   g. Other stainless steel hardware as required.

2. Minimum Dimensions:
   a. Power: 42 inches square x 42 inches high.
   b. Instrumentation: 42 inches square x 42 inches high.

3. Manufacturer:
   a. Electrical Enclosure Mfg. (Pell City, AL).
   b. Ebox (Pelham, AL).
   c. Gilbert Electrical Systems
   d. Approved Equal.

PART 3 EXECUTION

3.01 APPLICATION

A. General

1. All boxes and wireways shall be of sufficient size to provide free space for all enclosed conductors per NEC requirements. Fill calculations shall be performed by contractor per NEC requirements.

B. Outlet Boxes & Junction Boxes (through 4-11/16”)

a. Sheet metal boxes shall be used on concealed work in ceiling or walls.

2. Cast boxes shall be used wherever Rigid or I.M.C. conduits are installed. Cast boxes shall be Cast Aluminum wherever installed in same locations as Rigid Aluminum conduit
3. All boxes installed in extremely corrosive areas (such as chlorine and fluoride storage rooms) where non-metallic raceways are used shall be non-metallic.
4. Except when located in exposed concrete block, switch and receptacle boxes shall be 4" square for single gang installation. Appropriate gang boxes shall be used for mounting ganged switches.
5. When installed in exposed concrete block, switch and receptacle boxes shall be square type designed for exposed block installation.
6. Ceiling outlet boxes shall be 4" octagon 1-1/2" deep or larger required due to number of wires.
7. Boxes installed in hazardous locations shall be explosion-proof rated for the associated application, constructed of copper-free cast aluminum.

C. Junction & Pull Boxes (larger than 4-11/16”)

1. For all below grade exterior use and elsewhere as shown:
   a. In areas subject to future vehicular traffic: shall be galvanized cast iron (rated AASHTO H-20 Loading unless noted otherwise).
   b. In areas not subject to vehicular traffic: shall be galvanized cast iron or pre-cast polymer concrete (rated for Tier 15 Loading unless noted otherwise).

2. All boxes installed exposed in exterior or wet areas shall be stainless steel (NEMA 4X).
3. All boxes installed exposed in corrosive areas shall be stainless steel (NEMA 4X).
4. All boxes installed in extremely corrosive areas (such as chlorine and fluoride storage rooms) where non-metallic raceways are used shall be non-metallic.
5. Padmounted Pull Boxes shall be installed as shown on Plans or as required by project conditions. Transclosure-style Padmounted boxes shall be installed wherever required by the quantities and sizes of conductors. Contractor shall submit all Padmounted Pull Box types prior to ordering for engineer’s review and comment.
6. Boxes installed in hazardous locations shall be explosion-proof rated for the associated application, constructed of copper-free cast aluminum.
7. All others shall be oil tight JIC box not less than 16 gauge.

3.02 INSTALLATION

A. General

1. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All boxes and wireways shall be anchored/braced in accordance with Specification Section 01 88 15 (“Anchorage and Bracing”).
2. All boxes and wireways shall be securely anchored.
3. All boxes shall be properly sealed and protected during construction and shall be cleaned of all foreign matter before conductors are installed.
4. All boxes and wireways shall be readily accessible. Contractor shall be responsible for furnishing and installing access panels per architect’s specifications. Locations shall be as directed by the architect as required to make boxes, wireways, electrical connections, etc. accessible where above gypsum board ceilings or in other similar locations.
5. All metallic boxes and wireways shall be properly grounded.
6. Refer to Specification Section 26 05 53 for identification requirements.

B. Outlet Boxes & Junction Boxes (through 4-11/16”)

1. Boxes shall be provided with approved 3/8" fixture studs were required.
2. Recessed boxes for wiring devices, surface fixtures, or connections, shall be set so that the edge of cover comes flush with finished surface.
3. There shall be no more knockouts opened in any sheet metal box than actually used.
4. Any unused opening in cast boxes shall be plugged.
5. Back to back boxes to be staggered at least 3 inches.
6. Under no circumstances shall through-the-wall boxes be used.

C. Junction & Pull Boxes (larger than 4-11/16”)

1. Pull boxes shall be installed as indicated on plans and/or as required due to number of bends, distance or pulling conditions.
2. Boxes to be imbedded in concrete shall be properly leveled and anchored in place before the concrete is poured.
3. All pull boxes and/or junction boxes installed exterior below grade, shall have their tops a minimum of 1-1/2 inches above surrounding grade and sloped so that water will not stand on lid. A positive drain shall be installed, to prevent water accumulation inside.
4. Above grade pull boxes shall be installed on concrete anchor bases as shown on Plans.

D. Wireways and/or wall-mounted equipment

1. Mount each wireway to channels of the same metal type as the wireway.
2. Conductors serving a wireway shall be extended without reduction in size, for the entire length of the wireway. Tap-offs to switches and other items served by the wireway shall be made with ILSCO type GTA with GTC cap.

END OF SECTION 26 05 34

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Wire and cable identification.

B. Pullbox & Junction Box Identification

C. Electrical distribution & utilization equipment identification.

D. Emergency and Standby Power receptacle identification.

E. Instrument and control device identification.

F. Raceway identification.

PART 2 PRODUCTS

2.01 WIRE AND CABLE IDENTIFICATION

A. Intermediate Locations:

1. Wires and cable labels shall be white, thermal transfer, halogen-free, flame-retardant marker plates (sized to accommodate three lines of text) permanently affixed to the associated cable with UV-resistant plastic wire ties. Labels shall be Panduit #M200X/300X series or equal.

B. Circuit/Cable Termination Locations:

1. Wires and cable labels shall be non-ferrous identifying tags or pressure sensitive labels unless noted otherwise.

2.02 ELECTRICAL DISTRIBUTION & UTILIZATION EQUIPMENT IDENTIFICATION

A. Labels on electrical distribution & utilization equipment shall be black-on-white engraved Bakelite nameplates permanently affixed to the equipment with rivets or silicone adhesive unless noted otherwise.

2.03 EMERGENCY AND STANDBY POWER RECEPTACLE IDENTIFICATION

A. Receptacles fed from emergency or standby power sources (such as emergency generators) shall be provided with factory-marked engraved

coverplates as follows:

1. Emergency System source: Red engraved lettering to read "EMERGENCY".
2. Legally-Required or Optional Standby Generator source:
   a. If only part of facility is fed with generator backup: Black engraved lettering to read "FED FROM GENERATOR".
   b. If entire facility is fed with generator backup: No "….GENERATOR…" label required.

2.04 INSTRUMENT AND CONTROL DEVICE IDENTIFICATION

A. Instruments and control device labels shall be black-on-white engraved Bakelite nameplates permanently affixed to the equipment or the adjacent, visible mounting surface with silicone adhesive or stainless steel wire ties.

2.05 RACEWAY IDENTIFICATION

A. Raceway labels shall be white thermal transfer marker plates permanently affixed to the associated raceway with stainless steel wire ties, with two wire ties (one on either end of marker plate to provide a flush installation) where possible. Labels shall be Panduit #M300X series or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Any proposed deviation in identification methods and materials from those described herein shall be submitted to Engineer for review and comment prior to installation.

B. Contractor shall provide all labeling or identification required by applicable local, state and national codes. These specifications do not intend to itemize all code-required labeling or identification requirements.

C. All labels/identification shall be positioned such as to be readable from the normal perspective without adjusting wiring/cables/labels. For example, labels/identification of wires/cables within cable trays shall be positioned to point towards the viewer (typically downward for overhead cable trays, or upward for cable trays within trenches).

D. All labels/identification (except for handwritten labels on concealed pullbox/junction box covers as noted below) shall be typewritten/printed/engraved in a neat, workmanlike, permanent, legible, consistent and meaningful manner. Labels shall not be handwritten unless

specific approval is granted by engineer.

3.02 WIRE AND CABLE IDENTIFICATION

A. General:

1. Where cabling is exposed (such as within cable trays), provide two wire ties per cable (one on either end of marker plate to provide a flush installation). Where cabling is concealed (such as within pullboxes/wireways), one wire tie per cable will be acceptable.

B. Intermediate Locations:

1. Thermal transfer labels shall be securely fastened to all wiring and cabling in the following locations:
   a. Wireways
   b. Pullboxes/Junction boxes larger than 4-11/16”
   c. Pullboxes/Junction boxes through 4-11/16” where wires and cables are not easily identifiable via the color coding and box labeling
   d. Vaults & Manholes
   e. Approximately every 50 feet within cable trays (especially at locations where cables exit or diverge). Labels within cable trays shall be grouped (rather than being pre-labeled on cables and pulled into cable trays).
   f. Other similar intermediate locations.

2. Labels shall be stamped or printed with the following data so that the feeder or cable can be readily identified and traced:
   a. From where the circuit originates (including panel designation and circuit number):
      1) Ex: “FROM: PP-A CIR. 3 (IN MAIN ELEC ROOM)”
   b. To where the circuit extends (using the common name of the equipment):
      1) Ex: “TO: RTU-6 (ON ROOF)”
   c. The purpose of the circuit:
      1) Ex: “POWER”
   d. The set number (If parallel power feeds are used).
      1) Ex: “SET NO. 3 OF 4”

C. Circuit/Cable Termination Locations:

1. Where multiple termination points exist within a circuit origination point (panelboard, switchboard, MCC, starter, etc.) or other similar circuit endpoint (control panel, etc.), labels shall be securely fastened to all ungrounded and neutral conductors to clearly identify the terminal

and/or circuit number associated with each conductor. For example, within lighting panels, each phase and neutral conductor shall be labeled near the terminals at a clearly visible location with the associated circuit number(s), so that if all conductors were unterminated, the labels would clearly indicate which conductor was associated with each circuit.

D. Refer to Specification Section 26 05 19 for all color-coding requirements of wires and cables.

3.03 PULLBOX & JUNCTION BOX IDENTIFICATION

A. Concealed pullboxes/junction boxes:

1. Front surface of all pullbox/junction box covers in concealed areas (such as above lay-in ceilings) or within mechanical/electrical rooms (and other similar areas where appearance of boxes is not an issue) shall be neatly marked with the ID of circuits/cables contained with permanent black marker on cover of box (Ex: “RP-1A Cir. 1, 2 & 3”). Additionally, front surface of box shall be painted red where box contains fire alarm system cabling.

B. Exposed pullboxes/junction boxes:

1. Interior surface of all pullbox/junction box covers in exposed areas shall be labeled “Power”, “Telecommunications”, “Fire Alarm” or with other similar general text neatly with permanent black marker to indicate function of box. Circuit/cable labeling within box (see above) shall identify specific cables contained. Additionally, interior surface of cover shall be painted red where box contains fire alarm system cabling.

C. Where pullboxes/junction boxes are named on contract documents (Ex:”PULLBOX #3”), an engraved nameplate shall be installed on the front surface of the box to identify the name.

3.04 ELECTRICAL DISTRIBUTION & UTILIZATION EQUIPMENT IDENTIFICATION

A. General:

1. All new and existing equipment modified by this project shall include arc-flash warning labels in accordance with NEC article 110.16.

B. All Panels, Motor Control Centers, Switchboards, Switchgear, Transformers, Etc.:

1. Engraved nameplates identifying name of equipment, nominal voltage and phase of the equipment and where the equipment is fed from shall be installed on front surface of all panels, motor control centers, switchboards, switchgear, transformers, etc.:
   a. Ex: First Line: “NAME: RP-A”, Second Line: “120/208V-3Ø-4W”, Third Line: “FED FROM: PP-A CIR. 4 (IN MAIN ELEC ROOM)”

2. Refer to Panelboard Specification Sections for additional labeling requirements (circuit directory cards, permanent circuit labels, permanent circuit numbers, etc.) required inside panelboards.

C. Safety/Disconnect Switches and Utilization Equipment (HVAC Equipment, Pumps, Powered Valves, Control Panels, Starters, Etc.)::

1. Engraved nameplates identifying equipment being fed and where the equipment is fed from shall be installed on front surface of all disconnect switches (including both visible blade type switches and toggle-type switches) and on utilization equipment (where not clearly identified by immediately adjacent local disconnect switch):
   a. Ex: First Line: “RTU-6”, Second Line: “FED FROM: PP-A CIR. 5”

2. Where safety/disconnect switches are installed on the load side of variable frequency drives, the safety/disconnect switch shall be furnished with an additional engraved nameplate to read: “WARNING: TURN OFF VFD PRIOR TO OPENING THIS SWITCH”.
3. Safety/Disconnect switches feeding equipment that is fed from multiple sources (such as motors with integral overtemperature contacts that are monitored via a control system) and Utilization Equipment fed from multiple sources shall be furnished with an additional BLACK-ON-YELLOW engraved nameplate to read: “WARNING: ASSOCIATED EQUIPMENT FED FROM MULTIPLE SOURCES – DISCONNECT ALL SOURCES PRIOR TO OPENING COVER”.

D. Emergency Systems:

1. A sign shall be placed at the service entrance equipment (and at any remote shunt trip operators, or similar, for service equipment) indicating the type and location of on-site emergency power sources (such as generators, central battery systems, etc.) per NEC requirements.
2. All boxes and enclosures (including transfer switches, generators, power panels, junction boxes, pullboxes, etc.) dedicated for emergency circuits shall be permanently marked with white-on-red engraved nameplates so

they will be readily identified as a component of an emergency circuit or system.

3. Where an Essential Electrical System (EES) is installed, all enclosures, raceways and equipment that are components of the EES shall be readily identified as such. Raceway shall be identified at intervals not exceeding 25 ft.

E. Services:

1. All Service Equipment:
   a. Engraved nameplates identifying maximum available fault current, including date the fault current calculation was performed, in accordance with NEC article 110.24.
      1) Ex: First Line: “AVAILABLE FAULT CURRENT: 16,154 AMPS”, Second Line: “DATE CALCULATED: JULY 8, 2013”
   b. All service entrance equipment shall be clearly labeled as being service entrance rated.

2. Where a building or structure is supplied by more than one service (or any combination of branch circuits, feeders and services), a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders & branch circuits supplying that building or structure and the area served by each, per NEC requirements.

F. Generators:

1. Generators shall be labeled with engraved nameplates identifying name of equipment.

3.05 EMERGENCY AND STANDBY POWER RECEPTACLE IDENTIFICATION

A. Receptacles fed from emergency or standby power sources (such as emergency generators) shall be provided with factory-marked engraved coverplates as described above.

3.06 INSTRUMENT AND CONTROL DEVICE IDENTIFICATION

A. New Instruments and control devices (whether furnished by contractor or not) shall be labeled with black-on-white engraved nameplates permanently affixed to the equipment or to the adjacent, readily-visible mounting surface with silicone adhesive or stainless steel wire ties.

1. Instruments and process control devices (float switches, etc.) shall be labeled with instrument name and, where available, instrument ID number.
2. Pushbutton stations shall be labeled with equipment being controlled. Labels shall be installed on front surface (or adjacent mounting surface) of all pushbutton stations.
3. Thermostats and other similar HVAC control devices installed in process areas shall be labeled with equipment being controlled. Labels shall be installed on front surface (or adjacent mounting surface) of all thermostats and other similar HVAC control devices.

3.07 RACEWAY IDENTIFICATION

A. Each exposed raceway shall be labeled at the point where it becomes concealed, such as where it enters a concrete floor slab, a concrete wall, the ground, etc.

B. Each raceway entering in-grade or on-grade pullboxes/junction boxes, where the conduits are only visible inside the box, shall be labeled within the box at the point where the raceway becomes concealed.

C. Raceway nameplates shall identify:

1. The location of the other end of the raceway (“TO MCC-1” or similar). If the other end of the raceway is at an intermediate, named pullbox (“INSTRUMENTATION PULLBOX #4” or similar), that pullbox name shall be labeled rather than the endpoint of the circuitry.

3.08 OTHER IDENTIFICATION

A. Factory-engraved coverplates identifying functions of light switches and other similar devices shall be installed where so required by plans/specifications.

END OF SECTION 26 05 53

SECTION 26 05 73
POWER SYSTEM ELECTRICAL STUDIES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:

1. Power Distribution System Electrical Studies.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Short Circuit Studies, Protective Devices Evaluation Studies, Protective Device Coordination Studies and Arc Flash Hazard Studies shall be performed by the same entity, which shall be a Professional Engineer registered in the state where the equipment will be installed. The studies shall be per the requirements set forth in the latest edition of NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D.

B. The studies shall be submitted to the Engineer prior to shipment of any electrical distribution equipment.

C. The studies shall include all portions of all electrical systems affected by the project (including any existing systems/equipment) from the utility service to any existing equipment at the facility (including all existing equipment fed from the same service point as any new equipment) and to all new equipment installed under this contract. All induction motors 50 HP or below and fed from the same bus may be grouped together. All induction motors greater than 50 HP shall be included individually with associated starters and feeder impedance. See individual study sections below for additional scope requirements.

D. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) or EasyPower software program.

E. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.

F. The contractor shall be responsible for collecting data on any existing or

proposed electrical equipment, devices, conductors, etc. as required to prepare the study, and shall supply pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the studies to be completed prior to shipment of equipment.

G. The Power Distribution System Electrical Studies shall be performed by Square 'D' or Cutler Hammer; or a third-party vendor if specifically approved by the engineer prior to preparation of the studies.

H. The proposed vendor shall have completed a minimum of five (5) equivalent Arc-Flash Hazard Studies in the past three (3) years.

2.02 SHORT CIRCUIT STUDY

A. The Short Circuit Study shall be performed with aid of a computer program. The study input data shall include the power company’s short circuit contribution, resistance and reactive components of the branch impedances, X/R ratios, base quantities selected, and other source impedances.

B. Short circuit momentary duty values and interrupting duty shall be calculated on each individual basis with the assumption that there is a three-phase bolted short circuit at the respective switchgear bus, switchboard, low voltage motor control center, distribution panelboard, and other significant locations throughout the system.

C. The short circuit tabulation shall include symmetrical and asymmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contributions from each connected branch, including motor back EMF current contributions shall be listed with its respective X/R ratio.

2.03 PROTECTIVE DEVICE EVALUATION STUDY

A. The Protective Device Evaluation Study shall be performed to determine the adequacy of circuit breakers, switches, transfer switches, and fuses by tabulating and comparing the short circuit rating of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied.

B. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the Engineer’s attention.

2.04 PROTECTIVE DEVICE COORDINATION STUDY

A. The Protective Device Coordination Study shall be performed to provide the

necessary calculation and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. The objective of the study is to obtain optimum protective and coordination performance from these devices.

B. The coordination study shall show the best coordination attainable for all breakers down through the largest breaker at each piece of distribution equipment. Coordination study shall demonstrate selective coordination where required by applicable codes or contract documents.

C. Phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices. Where ground fault protection is used, coordination of the ground fault protection with the first downstream overcurrent phase protection device shall be demonstrated.

D. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves be maintained.

2.05 ARC-FLASH HAZARD STUDY

A. The Arc-Flash Hazard Study shall be performed with the aid of computer software intended for this purpose in order to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

B. The Arc-Flash Hazard Study shall be performed in conjunction with a short-circuit Study and a time-current coordination Study.

C. The Arc-Flash Hazard Study shall be performed for the following equipment:

1. All Distribution Equipment – This includes but is not limited to the following:
    a. Switchgear
    b. Switchboards
    c. Motor Control Center
    d. All Lighting and Power Panelboards
    e. Fused Disconnect Switches rated greater than 100A

2. Separately enclosed devices fed from protection device rated greater than100A - This includes but is not limited to the following:
    a. Control Panels
    b. VFD’s
    c. RVSS

D. A generic Arc-Flash label shall be applied to other electrical equipment that

has not been included in the study. This includes but is not limited to the following equipment:

1. Non-fused Disconnect Switches
2. Fused Disconnect Switches rated 100A or less
3. Transformers
4. Control Panels, VFD's, RVSS, etc. rated 100A or less

E. Where a main protective device is provided, the study shall be performed on the line side and load side of the main. The worst-case result shall be used for the study result and label.

F. The Study shall be performed under worst-case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

G. Where incident energies are calculated to fall within the high marginal region of a given Hazard/Risk Category Level, the Hazard/Risk Category Level shall be increased one level.

H. The Arc-Flash Hazard Study shall be performed in compliance with the latest IEEE Standard 1584, the IEEE Guide for Performing Arc-Flash Calculations. Where IEEE 1584 does not have a method for performing the required arc-flash calculations (such as for single phase equipment), calculations shall be performed and system shall be modeled using modules/methods as recommended by the arc flash software supplier (for example, using SKM Unbalanced/Single Phase Studies module for modeling single phase systems).

I. Equipment labels to identify AFIE and appropriate Hazard/Risk Category in compliance with NFPA 70E and ANSI Z535.4 (latest version of these requirements) shall be provided to the Electrical Contractor. The Electrical Contractor shall affix the labels to the distribution equipment devices as directed by the equipment manufacturer. These labels shall, at a minimum, include the following:

1. WARNING label.
2. Hazard/Risk Category.
3. Arc Flash Boundary Distance.
4. Incident Energy (in cal/cm2) at Working Distance.
5. Shock Hazard Voltage.
6. Limited Approach Boundary Distance.
7. Restricted Approach Boundary Distance.
8. Prohibited Approach Boundary Distance.
9. Equipment Name.
10. Name of Firm who prepared the Study.

11. Project Number of the Firm who prepared the Study.
12. Date that the Study was prepared.
13. Method for calculating analysis data.
14. Statement to read: “Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidate this label” (or equivalent).

PART 3 EXECUTION

3.01 SUBMITTAL REQUIREMENTS

A. The results of the studies shall be summarized in a final report. The report shall include the following sections:

1. General:
   a. Description, purpose, basis and scope of the studies
   b. Single line diagram of the portion of the power system which is included within the scope of the work. The single line diagram shall fit on one sheet of paper (size as required) unless approved otherwise by engineer. The following information shall be shown on the single line diagram:
      1) Device Name
      2) Branch Fault Currents with directional indicators
      3) General Location (for busses only)
      4) Other basic component information such as cable type, cable length, breaker rating, buss short circuit rating, transformer voltages, transformer size, fuse size, etc..

2. Short Circuit Study:
   a. Tabulation of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding same.

3. Protective Device Evaluation/Coordination Study:
   a. Protective devices time versus current coordination curves**,** tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
   b. Fault current calculations including definitions of terms and a guide for interpretation of computer printout.
   c. Documentation from utility company on their letterhead showing their anticipated values of available short circuit currents X/R ratios and protective devices with which the power distribution system will coordinate.
   d. Time-current characteristics of the respective protective devices shall be plotted on log-log paper. Plots shall be printed in color

with a dedicated color and pattern for each curve for clear identification.

e. Plots shall include complete titles, respective single line diagrams and legends, and associated power company's relay or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breakers trip curves and fuses.

f. The coordination plots shall indicate the type of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents.

g. The coordination plots for phase and ground protective devices shall be provided on a system basis.

h. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.

4. Arc-Flash Hazard Study:

a. Tabulation of device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.

b. Recommendations for reducing AFIE levels and enhancing worker safety.

B. Furnish all labor, materials, calculations, electrical equipment, technical data and incidentals required to provide a complete short circuit study, coordination study and arc flash hazard study of protective devices, busses, etc. from the utility service to any existing equipment at the facility and all new equipment installed under this contract.

C. The study shall comply with the following applicable provisions and recommendations of the latest revisions of the following: ANSI C37.5, IEEE Standard No. 399, and IEEE Standard No. 141.

D. Submit calculations and results of the short circuit, protective device evaluation and coordination and arc flash hazard studies prior to submitting shop drawings for new equipment. Contractor shall verify that all proposed equipment is properly rated per the short circuit and protective device evaluation portions of the study prior to releasing equipment for manufacturing.

E. Submit a copy of a sample typical arc flash label layout (meeting requirements outlined above) that will be used for the project.

F. Submit final electronic copies of all SKM program files/models/input data/etc.

used to perform the study to the owner with final close-out documents. These files shall be complete as required to allow future users to recreate the study.

3.02 INSTALLATION

A. Contractor shall adjust all breaker settings as recommended by the coordination study prior to energizing equipment.

B. Contractor shall affix arc flash hazard notification labels (as determined by the results of this study) to each piece of distribution equipment prior to energization of equipment. A generic arc-flash warning label shall be affixed to any electrical equipment not included in the analysis as outlined above.

C. Where short circuit rating of equipment is dependent on setting of upstream overcurrent device, provide and install label for equipment indicating the required settings of the associated device.

END OF SECTION 26 05 73

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D877/D877M, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   b. D923, Standard Practices for Sampling Electrical Insulating Liquids.
   c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   f. D1298, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
   i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
   j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulation Resistance of Electric Machinery.
   b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.

e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
h. C2, National Electrical Safety Code.
i. C37.20.1, Standard for Metal-Enclosed Low-Voltage (1,000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
j. C37.20.2, Standard for Metal-Clad Switchgear.
k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
l. C37.23, Standard for Metal-Enclosed Bus.
m. C62.33, Standard Test Methods and Performance Values for Metal-Oxide Varistor Surge Protective Components.

3. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70B, Recommended Practice for Electrical Equipment Maintenance.
   c. 70E, Standard for Electrical Safety in the Workplace.
   d. 101, Life Safety Code.
7. National Institute for Certification in Engineering Technologies (NICET).
8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 60 days prior to performing inspections or tests:
   a. Testing firm qualifications.
   b. Schedule for performing inspection and tests.
   c. List of references to be used for each test.
   d. Sample copy of equipment and materials inspection form(s).
   e. Sample copy of individual device test form.
   f. Sample copy of individual system test form.
2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
   a. Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
   b. Staged sequence of initial energization of electrical equipment.
   c. Lock-Out-Tag-Out plan for each stage of the progressive energization.
   d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
4. Operation and Maintenance Data:
   a. In accordance with Section 01 78 23, Operation and Maintenance Data.
   b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in Operation and Maintenance Manual.
5. Programmable Settings: At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on USB drive of as-left setpoints, programs, and device configuration files for:
   a. Protective relays.
   b. Intelligent overload relays.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.

3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test Instrument Calibration: In accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

1. Scheduled with Engineer prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Notify Engineer at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Adjust mechanisms and moving parts of equipment for free mechanical movement.

E. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents and approved Submittals.

G. Realign equipment not properly aligned and correct unlevelness.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Inform Engineer of working clearances not in accordance with NFPA 70.

M. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

3.02 AC INDUCTION MOTORS

A. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate motor and check for:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
   e. Excessive vibration, in excess of values in NETA ATS, Table 100.10.
5. Check operation of space heaters.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:
      1) Motors above 200 horsepower for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
      2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 seconds and 60 seconds.
   b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer’s instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

3.03 THERMOGRAPHIC SURVEY

A. Provide thermographic survey per NETA ATS Table 100.18 of feeder conductors No. 2 and larger terminating at:

1. Motors rated 500 hp and larger.

B. Remove necessary enclosure metal panels and covers prior to performing survey.

C. Perform with equipment energized during periods of maximum possible loading per NFPA 70B, Section 20.17.

D. Do not perform survey on equipment operating at less than 40 percent of rated load.

E. Use thermographic equipment capable of:

1. Detecting emitted radiation.
2. Converting detected radiation to visual signal.
3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.

F. Temperature Gradients:

1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.
2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.
3. 16 degrees C and above indicates deficiency that is to be corrected immediately.

G. Provide written report of:

1. Areas surveyed and the resultant temperature gradients.
2. Locations of areas having temperature gradients of 3 degrees C or greater.
3. Cause of heat rise and actions taken to correct cause of heat rise.
4. Detected phase unbalance.

END OF SECTION

SECTION 26 09 44
DISTRIBUTED DIGITAL LIGHTING MANAGEMENT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Digital Occupancy and Daylighting Sensor Control
2. Emergency Lighting Control (if applicable)

B. Related Section

1. Section 26 09 43 – Lighting Control System
2. Section 26 27 26 - Wiring Devices
3. Section 27 05 00 – Auxiliary System Cables, 0-50V
4. Section 26 50 00 – Lighting Materials and Methods
5. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section
6. Electrical Sections, including wiring devices, apply to the work of this Section.

C. Control Intent – Control Intent includes, but is not limited to:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
2. Initial sensor and switching zones
3. Initial time switch settings
4. Task lighting and receptacle controls
5. Emergency Lighting control (if applicable)

1.02 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)

B. Underwriter Laboratories of Canada (ULC)

C. International Electrotechnical Commission

D. International Organization for Standardization (ISO)

E. National Electrical Manufacturers Association (NEMA)

F. WD1 (R2005) - General Color Requirements for Wiring Devices.

G. Underwriters Laboratories, Inc. (UL):

1. 916 – Energy Management Equipment.
2. 924 – Emergency Lighting
3. 2043 – Plenum Rating

1.03 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:

1. Digital Room Controllers – Self configuring, digitally addressable one, two or three relays controllers with 0-10v control for ballasts (if applicable) and single relay application specific plug load controllers.
2. Digital Occupancy Sensors connected to Digital Room Controllers – Self configuring, digitally addressable and calibrated occupancy sensors with LCD screens and two way active Infra-Red (IR) communications.
3. Digital Switches connected to Digital Room Controllers – Self configuring, digitally addressable push button switches, dimmers, and scene switches with two way active Infra-Red (IR) communications.
4. Analog and digital closed loop daylighting sensors connected to Digital Room Controllers - self-calibrating daylighting sensors that provide closed loop control to Room Controllers. Sensors and Room Controllers can provide single or multi-zone, on/off or dimming control for daylight harvesting.
5. Hand held remotes for room configuration – provides two way infrared communications to digital devices and allows complete configuration and reconfiguration of the device / room from 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send / receive / store of room variables.
6. Hand held remotes for personal control – One, two, or four (scene) button remotes provide Infrared communications to a room. Remote controls will support ON/OFF, dimming, scene control and may be configured in the field to provide specific occupant requirements without special tools.
7. Digital Lighting Management (DLM) local network – Free topology, plug in wiring system (Cat 5e) for power and data to room devices.
8. Network Bridge - provides BACnet MS/TP compliant digital networked communication between rooms, panels and the Segment Manager or BAS.

9. Segment Manager - provides web browser based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
10. Emergency Lighting Control Unit (ELCU)- allows any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.04 LIGHTING CONTROL APPLICATIONS

A. Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with manual-on functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and automatic-on occupancy sensors are more appropriate. Provide manual ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors with manual-on switches.
2. Bi-Level Lighting – Provide multi –level switched dimming controls where indicated on plans.
3. Task Lighting / Plug Loads – Provide automatic shut off of non essential plug loads and task lighting where indicated on plans. Provide automatic ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
4. Daylighted Areas. Provide daylighting controls where indicated on plans. Daytime set points for total illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
5. Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.
6. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylight system may be designed to turn off ambient lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

1.05 SUBMITTALS

A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

1. Shop Drawings: Building floorplans showing all proposed devices and composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
2. Product Data: Catalog sheets, specifications and installation instructions.

1.06 QUALITY ASSURANCE

A. Manufacturer: Minimum [10] years experience in manufacture of lighting controls.

1.07 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 0° to 40° C (32° to 104° F).
2. Relative humidity: Maximum 90 percent, non-condensing.

1.08 WARRANTY

A. Provide a five year complete manufacturer's warranty on all products to be free of manufacturers' defects.

1.09 MAINTENANCE

A. Spare Parts:

1. Provide two (2) of each product to be used for maintenance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer:

1. Watt Stopper Digital Lighting Management (DLM)
2. Equal by Acuity Lighting

B. Basis of design product: Watt Stopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:

1. Watt Stopper Digital Lighting Management (DLM)
2. Acuity
3. Substitutions:

a. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
b. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.02 SINGLE / DUAL RELAY WALL SWITCH VACANCY SENSORS

A. Type PW: Manual ON, Automatic OFF Wall switch type passive infrared occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper PW-100, PW-200 .

B. Type UW: Manual ON, Automatic OFF Wall switch type ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper UW-100, UW-200.

C. Type DW: Manual ON, Automatic OFF Wall switch type dual technology, passive Infrared and ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper DW-100, DW-200.

2.03 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Wall or ceiling mounted (to suit installation) passive infrared, ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square footage coverage requirements for each area controlled, utilizing Room Controller modules and accessories which suits the lighting and electrical system parameters.

B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation . Features include the following:

1. Digital calibration and LCD entry for the following variables:
   a. Sensitivity 0-100% in 10% increments
   b. Time Delay – Fixed (1-30 minutes in 1 minute increments), and automatic
   c. Test mode – Five second time delay
   d. PIR, Ultrasonic or Dual Technology activation and/or re-activation.
   e. Walk-through mode
   f. Load parameters including auto/manual ON, blink warning, and daylight enable/disable.

2. RJ-45 digital connections for DLM local network.
3. Two-way infrared communications port to allow remote programming through hand held commissioning tool.
4. Self contained push buttons for programming and control of room devices.
5. Device Status LED's including:
   a. PIR Detection
   b. Ultrasonic detection
   c. Configuration mode
   d. Load binding

6. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.

C. Units will provide for digital calibration and commissioning and will not have any dip switches or potentiometers for field settings

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required

E. Watt Stopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.04 DIGITAL WALL SWITCHES

A. Low voltage (RJ-45) momentary push button switches in 1,2,3,4 and 8 button configuration, decorator opening. Wall switches will include the following features:

1. Two way infrared communications port for use with personal and configuration remote controls.
2. Engraveable buttons
3. Dimming switches shall include seven LED's to indicate load levels.
4. Scene switches shall include pilot indication of scene selection.

5. Device Status LED's including:
    a. One pilot LED for each button.
    b. Power Indication
    c. One locator LED per switch
    d. Network status LED to indicate data transmission
    e. Power LED to indicate the device has power
    f. Configuration mode

B. Switches shall have two RJ-45 ports to allow connection to any other digital room device.

C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching

D. Watt Stopper product numbers: LMSW-101 / LMSW-102 / LMSW-103 / LMSW-104 / LMSW-108.

2.05 ROOM CONTROLLERS

A. Room Controllers automatically bind the room loads to the connected devices in the space without any tools or configuration requirements. Room Controllers shall be provided to match the room lighting load and control requirements and sequences. The controllers will be simple to install and will not have screw type connections, dip switches, potentiometers or require special mounting or configuration. The control units will include the following features:

1. Automatic room configuration to the most energy efficient sequence of operation based upon the devices in the room.
2. One or two relay configuration
3. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an Off-the-Shelf unit without requiring any configuration or setup.
4. Device Status LED's to indicate:
    a. Data transmission
    b. Device has power
    c. Status for each load
    d. Configuration status

5. Quick installation features including:
    a. Standard junction box mounting (inside or outside)
    b. Quick low voltage connections using standard RJ-45 patch cable

6. Plenum rated

7. Manual override and LED indication for each load
8. Universal voltage (120/230/277 VAC, 50-60 Hz)
9. Zero cross circuitry for each load.
10. Efficient 150 ma switching power supply
11. Three RJ-45 DLM local network ports
12. Watt Stopper product numbers: LMRC-101 / LMRC-102

B. 0-10 Volt enhanced Room Controllers shall include all the features of the Room Controller plus the following enhancements:

1. One, two or three relay configuration
2. Efficient 250 ma switching power supply
3. Four RJ-45 DLM local network ports.
4. One zero to 10 volt analog output per relay for control of dimmable ballasts.
5. Optional BACnet MS/TP communications port.
6. Current monitoring
7. Watt Stopper product numbers: LMRC-301 / LMRC302 / LMRC303.

C. Plug Load Room Controllers provide dedicated control of plug loads within the space. The controllers plug into the DLM local network using the RJ-45 free topology network. The room controllers include the following features

1. One relay configuration only
2. Automatic ON/OFF configuration
3. Default 30 minute (adjustable) time delay from lighting shut off to allow for electronic component use after an area is vacant
4. Watt Stopper product number: LMPL-101.

2.06 DIGITAL PHOTOSENSORS

A. Provide automatic daylight harvesting capabilities to the Room Controllers. The photo sensor / room controller configuration automatically configures the daylighting set points for ON/OFF or Dimming control. Using the automatic configuration replacing a photo sensor or room controller can be done without any special tools, programming or configuration. Photosensors include the following features:

1. The digital photosensor shall utilize an internal photodiode that measures light in a 100 degree angle cutting the unwanted light from bright sources outside of this cone
2. The digital photosensor shall be capable of turning lighting on and off or Raise / Lower depending on the type of Room Controller (on/off or dimming). Sensor range shall be from 1 - 1400fc.

3. For ON/OFF daylight harvesting the controller provides a "hold on while occupied" feature that prohibits high levels from turning OFF the controlled lights as long as the space remains occupied.
4. The sensor has a threaded nipple that mounts on a ceiling tile and for more challenging applications such as a side wall or hard rock ceiling the nipple pops off and the unit can be screwed down

B. Watt Stopper Product Numbers: LMLS-400 or equivalent.

2.07 ROOM NETWORK

A. The DLM local network is a free topology lighting control network and protocol designed to control a small area of a building. Digital room devices connect to the network using RJ-45 patch cords which provide both data and power to room devices. Features of the DLM local network include

1. Automatic configuration and binding of sensors, switches and lighting loads to the most energy efficient sequence of operation based upon the device attached.
2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
3. Push and Learn configuration that can change the automatic binding process and load parameters by using only the digital devices in the room.
4. Two way infrared communications that allow load parameters, sensor configuration and binding operations to be configured through a hand held configuration tool up to 30 feet from any device

2.08 NETWORK BRIDGE

A. Each local network shall include a network bridge component to provide a connection between the room devices and the segment network. The network bridge shall use industry standard BACnet MS/TP network communication and allow direct connection to the Segment Manager or BAS where required.

B. The network bridge may be incorporated directly into the room controller hardware or be provided as a separate module connected on the local network through an available RJ local network port

C. Provide Plug and Go operation to automatically discover all room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.

D. The network bridge shall automatically create standard BACnet objects for

selected room device parameters to allow any BACnet compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. Standard BACnet objects shall be provided .

2.09 SEGMENT MANAGER

A. The Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser. Each segment manager shall have support for one, two or three segment networks as required and allow for control of a maximum of 127 local networks (rooms) and or lighting control panels per segment network.

B. Operational features of the Segment Manager shall include the following:

1. Connection to PC or LAN via standard Ethernet TCP/IP
2. Easy to learn and use Adobe Flex based GUI compatible with Internet Explorer 8 or equal browser
3. Log in security capable of restricting some users to view-only or other limited operations
4. Automatic discovery of all DLM devices on the segment network(s). Commissioning beyond activation of the discovery function shall not be required.
5. After discovery all rooms and panels shall be presented in a standard navigation tree format
6. View and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation.
7. Set up schedules for rooms and panels. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation.
8. Group rooms and loads for common control by schedules, switches or network commands. Monitor connected load current for rooms or zones equipped with room controllers incorporating the current monitoring feature
9. Provide seamless integration with the BAS via BACnet IP

2.10 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include

1. 120 - 277 volts, 50/60 Hz., 20 amp ballast rating
2. Push to test button
3. Auxiliary contract for test / Fire Alarm system

2.11 WIRING

A. Refer to Specification Section 27 05 00 for additional requirements.

PART 3 EXECUTION

3.01 PRE-INSTALLATION COORDINATION

A. Exact occupancy sensor and daylight sensor types and locations shall be determined by the lighting control system supplier for a fully-functional system with adequate coverage throughout areas controlled by occupancy sensors. Exact locations shall be coordinated with actual HVAC register locations, furniture/casework/etc. locations, sensor coverage patterns, etc. for proper coverage in all areas. In no case may fewer devices or lower-quality devices be used in each area than indicated on contract documents.

3.02 INSTALLATION

A. When using wire other than RJ-45 connections provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements

B. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.

C. Provide all connections between system components and network connections to building LAN (via Ethernet cabling) as directed by system supplier for a fully functional networked system.

D. Calibrate all sensor time delays and sensitivity to guarantee proper coverage of occupants and energy savings.

E. Provide written or computer generated documentation on the commissioning of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities, daylighting set points.
2. Sequence of operation, manual ON, Auto OFF. Etc.
3. Load Parameters - blink warning, etc.

F. Refer to Specification Section 27 05 00 for additional installation requirements.

3.03 SUPPORT SERVICES

A. System Start Up and Commissioning

1. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.
2. Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all lighting control system components. The startup requirement is intended to verify:
   a. That all occupancy and daylighting sensors are located, installed, and adjusted as intended by the factory and the contract documents.
   b. The occupancy sensors and daylighting sensors are operating within the manufacturers specifications.
   c. The sensors and relay panels interact as a complete and operational system to meet the design intent.

3. Manufacturer to provide a written statement verifying that the system meets the above requirements.

B. Re-commissioning – After 30 days from occupancy re-calibrate all preset times, sensor time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Design Team and Owner of re-commissioning activity.

C. System Training

1. Manufacturer shall provide factory authorized technician to train owner personnel in the operation, programming and maintenance of the lighting control system including all occupancy sensors and daylighting controls.

D. System Programming

1. Manufacturer shall provide system programming including:
   a. Wiring documentation.
   b. Switch operation.
   c. Telephone overrides.
   d. Operating schedules.

END OF SECTION 26 09 44

SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies to low-voltage AC induction motors, whether or not referenced by a motor-driven equipment specification. If equipment specification section deviates from this section in requirements such as, application, horsepower, enclosure type, mounting, shaft type, or synchronous speed, then those listed requirements shall take precedence over this section.

1.02 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
3. American Petroleum Institute (API):
   a. 541, Form-Wound Squirrel-Cage Induction Motors—500 Horsepower and Larger.
   b. 670, Vibration, Axial Position, and Bearing Temperature Monitoring Systems.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C50.41, Polyphase Induction Motors for Power Generating Stations.
   c. MG 1, Motors and Generators.

5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. UL:
    a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
    b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
    c. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

E. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

F. ODP: Open drip-proof enclosure.

G. RTD: Resistance temperature detector.

H. TEFC: Totally enclosed, fan-cooled enclosure.

I. WPI: Open weather protected enclosure, Type I.

J. WPII: Open weather protected enclosure, Type II.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
    a. Service factor.
    b. Locked rotor current.

c. No load current.
d. Safe stall time for motors 100 hp and larger.
e. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
f. Guaranteed minimum full load efficiency and power factor.

4. Enclosure type and mounting (such as, horizontal, vertical).
5. Dimensions and total weight.
6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Motor terminal box, RTD box, vibration detector box dimensions, location on motor, and wiring.
8. Lateral and torsional analysis report.
9. Bearing type.
10. Bearing lubrication.
11. Bearing life.
12. Space heater voltage and watts.
13. Description, ratings, and wiring diagram of motor thermal protection.
14. For Motors 600 hp and Larger:
    a. Thermal limit curves in accordance with IEEE 620.
    b. Speed torque curve.
    c. Starting time-current curve.
    d. Thermal capability during starting.
    e. Complete lube oil system requirements.
15. Motor sound power level in accordance with NEMA MG 1.
16. Maximum brake horsepower required by the equipment driven by the motor.
17. Description and rating of submersible motor moisture sensing system.
18. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.
19. Motor terminal box, RTD box, vibration detector box, and space heater box dimensions, location on motor, and wiring.
20. Schematic wiring diagram for motor and for devices such as resistance temperature detectors, vibration sensors, leak detectors, space heaters, differential pressure switches, current transformers, as applicable.
21. Bearing Data:
    a. Identify type and manufacturer of radial journal bearings to be installed and thrust bearing to be installed.
    b. Specify proposed bearing insulation materials and methods and recommended bearing lubricant(s).

c. Bearing protection data including shaft sensing proximity vibration probes, bearing housing vibration sensors, for vertical motors, axial position probes, and resistance temperature detectors, as applicable.
d. Instrumentation, including but not limited to, vibration transducers, vibration monitoring system, RTDs, motor protection relay, leak detectors, and differential pressure switches. Provide detailed catalog information indicating complete model number derivation and wiring diagrams.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory test reports, certified.
3. Lateral and torsional analysis report
4. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.05 QUALITY ASSURANCE

A. Motors 600 horsepower and larger:

1. Production Facility: Motor manufacturer shall produce the medium voltage, induction motors at a facility manufacturer owns or operates under its own supervision.
2. Requisite Experience: Induction motor manufacturer shall be experienced in manufacture of low voltage induction motors for at least 10 years. At least 10 of manufacturer's motors of comparable capacity and complexity shall have been successfully operating in similar condition as ones specified in this section for at least 5 years in the USA.
3. Service Organizations: Motor manufacturer shall have a factory-owned or authorized service organization.

1.06 SECIAL GUARANTEE

A. Motors 600 horsepower and larger:

1. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this specification section found defective during a period of 3 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. U.S Electrical Motors
2. Siemens Energy and Automation, Inc., Motors and Drives Division.
3. Baldor.
4. Toshiba International Corp., Industrial Division.
5. WEG Electric Motors Corp.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. For motors used in hazardous (classified) locations, Class I, Division 1, Groups B, C, and D, and Class II, Division 1, Groups E, F, and G provide motors that conform to UL 674 and have an applied UL listing mark.

E. Provide motors specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

F. Lifting lugs on motors weighing 100 pounds or more.

G. Operating Conditions:

1. Maximum ambient temperature not greater than 40 degrees C.
2. Provide motors suitable for operating conditions without reduction in nameplate rated horsepower or exceeding rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

H. RTDs are to be used for monitoring temperature purposes and alarming. Thermistors are to be used for motor temperature protection based on established temperature setpoint.

I. Lateral and Torsional Analysis:

1. Driven equipment supplier with system responsibility shall perform a complete lateral and torsional analysis of each distinct equipment-coupling motor system provided on Project.
2. Identify lateral critical(s) plus torsional critical(s) speeds.
3. Produce critical speed maps; no active critical speed shall be allowed within 20 percent of operating speed range.
4. Analysis shall be performed, submitted, reviewed, and approved by Engineer prior to fabrication of machinery.
5. Mass Elastic Data: Used for independent evaluation of lateral and torsional natural frequency analysis. Encroachment by plus or minus 20 percent of any active critical speeds upon operating speed range must be eliminated to satisfaction of Engineer.

J. Motors driven by AFDs shall be rated and labeled as suitable for inverter duty, and rated for continuous operation at 40 degrees C ambient temperature running on AFD output at any frequency from 30 Hz to 60 Hz or other frequency range as may be provided by AFD manufacturer.

2.03 DESIGN REQUIREMENTS

A. Electric motors shall be in accordance with NEMA MG 1, except as indicated in equipment specifications for motors controlled for variable speed operation and other special motors, constant speed induction motors having starting torque and starting current sufficient to ramp up to speed of driven equipment. In no case shall locked rotor, pull-up or breakdown torque be less than value specified in NEMA MG 1.

B. Motors 600 horsepower and larger:

1. Torque:
   a. Motor manufacturer shall review start-up load curve for driven equipment to determine minimum motor capabilities for locked-rotor torque, pull-up torque, and breakdown torque.
   b. Motor speed-torque curve shall exceed driven equipment speed-torque curve by a minimum margin of 10 percent at all points from zero speed to pull-up speed.
   c. Motor shall also be able to start and accelerate, to rated-speed of driven equipment during a 20 percent under-voltage or reduced voltage start condition.
2. wk^2:
   a. Motors shall be capable of accelerating driven equipment without excessive temperature rises.
   b. Motor acceleration time at specified reduced voltage should not exceed locked rotor safe stall time.
3. Number of Starts: Each motor shall be capable of two successive cold starts or one hot start according to NEMA MG 1.
4. Starting: Motors shall be suitable for solid state reduced voltage (SSRV) starting.

2.04 HORSEPOWER RATING

A. As designated in motor-driven equipment specification.

B. Constant Speed Applications: Brake horsepower of driven equipment at any operation condition or at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor, Inverter Ready Motor): Driven equipment brake horsepower at any operation condition or at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

2.05 SERVICE FACTOR

A. Inverter-Duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.

B. Other Motors: 1.15 minimum at rated ambient temperature.

2.06 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specification:

Voltage Rating		
Size	**Voltage**	**Phase**
1/2 hp and smaller	115	1
3/4 hp through 700 hp	460	3

C. Suitable for full voltage starting.

D. 100 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.07 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, Paragraph 12.59.
   b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specification.
2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

2.08 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 tables.

B. Safe Stall Time: 12 seconds or greater.

2.09 INSULATION SYSTEMS

A. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class B or Class F at nameplate horsepower and designated operating conditions, except provide Class B with Class B rise insulation for EXP and DIP motors.

2.10 ENCLOSURES

A. Conform to NEMA MG 1.

B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):

1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class I, Division 1, Group C and D hazardous locations.
2. Drain holes with drain and breather fittings.
3. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
4. Terminate thermostat leads in terminal box separate from main terminal box.

D. Submersible: In accordance with Article Special Motors.

E. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article Special Motors.

2.11 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

Terminal Box Usable Values		
Voltage	**Horsepower**	**Percentage**
Below 600	15 through 125	500
Below 600	150 through 300	275
Below 600	350 through 700	225

E. Terminal for connection of equipment grounding wire in each terminal box.

F. Auxiliary Terminal Boxes (100HP and larger):

1. Provide separate boxes for termination of space heaters, stator and bearing RTD or thermocouple leads, vibration probe leads, and other factory-mounted instrumentation.
2. Space heater terminations shall be in a terminal box that is separate from control signal terminations.

G. Wire devices to auxiliary terminal boxes and terminate on suitable terminal blocks.

H. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on the Drawings.

2.12 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 hp through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. Above 400 hp: Split sleeve, oil insulated bearings**.**
4. For Direct Drive Equipment: Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.
5. For Belt Driven Equipment: Minimum 30,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Manufacturer's standard lubrication 100 hp and smaller.
   c. Oil lubricated 125 hp and larger.
   d. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
   a. Manufacturer's standard bearing type.
   b. Manufacturer's standard lubrication 200 hp and smaller.
   c. Oil lubricated 250 hp and larger.
   d. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.
2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:

1. Oil reservoirs with sight level gauge.
2. Oil fill and drain openings with opening plugs.
3. Provisions for necessary oil circulation and cooling.
4. Contain an RTD to sense oil temperature.

E. Inverter Duty Rated Motors Larger than 50 hp, Bearing Isolation: Provide electrically isolated bearings to prevent stray current damage.

2.13 NOISE

A. Measured in accordance with NEMA MG 1.

B. Maximum Sound Level for Motors Controlled by Adjustable Frequency Drive Systems: 3 dBA higher than NEMA MG 1.

2.14 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.15 EQUIPMENT FINISH

A. Protect Motor for Service Conditions:

1. ODP Enclosures: Indoor industrial atmospheres.
2. Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.

B. External Finish: Prime and finish coat manufacturer's standard.

C. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.16 VIBRATION MONITORING

A. General: Provide for each low voltage induction motor larger than 500 horsepower, for installation into the vibration and temperature monitoring rack . Configure, program, test, calibrate, and place each system into operation. System shall include the following features:

1. Microprocessor based system with programmable firmware options.
2. Programmable operating range.
3. Programmable alarm range.
4. Dual channel modules.
5. Danger voting logic for alarm/trip outputs.
6. Timed OK/channel defeat.
7. Modbus TCP Ethernet communications interface.

B. Equipment:

1. Vibration detector system for continual vibration monitoring in the X and Y directions at the top bearing of the motor for each vertical turbine pump. The system shall have the following components:
   a. Accelerometers
   b. Vibration monitoring unit.
2. Accelerometers: Two accelerometers shall be installed on the top bearing of each motor to monitor vibration in the X and Y directions for each pump.
   a. Sensitivity: 100 mV/g, plus or minus 5 percent, 25 deg. C.
   b. Acceleration range of 50 g peak.
   c. Transverse Sensitivity: Max. 5 percent of axial.
   d. Power: 18-28V dc.
   e. Grounding: Case Isolaged, internally shielded.

f. Temperature range: -54 to 121 degrees C.
g. Shock limit: 5000 g peak.
h. Case material: Stainless steel.
i. Mounting: Mounting stud.

3. Vibration Monitoring Units: The units shall monitor with adjustable setpoint and output circuitry. Monitoring units shall be provided with built-in power supply as location shown in Contract Drawings and shall contain the following items:
   a. Two-channel input plus tachometer.
   b. T form-C relay contacts.
   c. Two isolated 4-20mA Outputs.
   d. Power input 24V dc.
4. Provide terminal base with adequate space for one future vibration monitor and adequate space to allow for tow future accelerometers and associated cabling.
5. Cables requiring special calibration for optimum performance shall be calibrated by the vibration monitoring equipment manufacturer or an authorized representative thereof.
6. Configure alarm contacts to be normally closed, open in alarm condition and open on loss of power.
7. Vibration monitoring equipment to be manufactured by Bentley Nevada Corporation.
   a. Model (B/N) type 3500/05 and corresponding modules to achieve vibration monitoring requirements identified in this specification.

2.17 MOTOR TEMPERATURE DETECTION

A. Resistance Temperature Detectors (RTD)s for motors larger than 500 horsepower:

1. 100 ohm, three-wire, platinum, and prewired to terminal junction box mounted on motor base.
2. Provide two bearing RTDs (one per bearing) and six stator winding RTDs (two per phase). See Thermostats paragraph below for additional winding thermal protection requirements.
3. For motors with thrust bearings, provide two RTDs per thrust bearing.
4. For water-cooled motors, provide one air circuit RTD.

B. Winding Thermal Protection:

1. Thermostats:
   a. Motors for constant speed and adjustable speed application 10 hp through 100 hp and larger than 500 hp (in addition to winding RTDs).
   b. Bi-metal disk or rod type thermostats embedded in stator windings.
   c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)
2. Thermistors:
   a. Motors for constant speed and adjustable speed applications larger than 100 horsepower through 500 horsepower.
   b. Thermistor embedded in each stator phase winding before winding dip and bake process.
   c. In intimate contact with winding conductors.
   d. Epoxy-potted, solid-state thermistor control module mounted in NEMA 250 Type 4 box on motor, by motor manufacturer, individual thermistor circuits factory-wired to control module.
   e. Control module rated for 120V ac power supply.
   f. Control module automatically reset contact for external use rated 120V ac, 5 amps minimum, opening on abnormally high winding temperature. Provide manual reset at motor controller.

2.18 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.

B. Space Heaters:

1. On motors 25 hp and larger, unless otherwise noted on equipment data sheets, provide winding space heaters with leads wired out to separate condulet or motor terminal box.
2. Provide extra hole or hub on motor terminal box as required.
3. Unless shown otherwise, heater shall be suitable for 120V ac supply, with wattage suitable for motor frame size.

C. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

D. Anchor Bolts: Provide meeting manufacturer's recommendations and of sufficient size and number for specified seismic condition.

2.19 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Chemical Industry, Severe-Duty (CISD-TEFC):

1. In accordance with IEEE 841.
2. TEFC in accordance with NEMA MG 1.
3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.
4. Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.
5. Ventilating Fan: Corrosion-resistant, nonsparking, external.
6. Drain and Breather Fittings: Stainless steel.
7. Nameplate: Stainless steel.
8. Gaskets between terminal box halves and terminal box and motor frame.
9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
10. Double shielded bearings.
11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
12. External Finish: Double-coated epoxy enamel.
13. Coated rotor and stator air gap surfaces.
14. Insulation System, Windings, and Connections:
    a. Class F insulation, Class B rise or better at 1.0 service factor.
    b. Multiple dips and bakes of nonhygroscopic polyester varnish.
15. Service Factor:
    a. At 40 Degrees C Ambient: 1.15.
    b. At 65 Degrees C Ambient: 1.00.
16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.

C. Severe-duty Explosion-proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

D. Inverter Duty Motor:

1. Motor Supplied Power by Adjustable Voltage and Adjustable Frequency Drives: Inverter duty rated in accordance with NEMA Parts 30 and 31.
2. Provide winding insulation rated 1,600 peak volts, minimum.
3. Meet or exceed NEMA MG 1 corona inception voltage rating.
4. Provide one insulated bearing.
5. Suitable for operation over entire speed range indicated.
6. Provide forced ventilation where speed ratio is greater than published range for motor provided.
7. When installed in Division 1 hazardous (classified) location, provide motor identified by manufacturer as suitable use with a variable speed drive in a Division 1 location.
8. When installed in Division 2 hazardous (classified) locations, provide motor identified by manufacturer as suitable for use with a variable speed drive in a Division 2 location.
9. Shaft Grounding Device, Motors Larger than 20 hp: Furnish with shaft grounding brush or conductive micro fiber shaft grounding ring solidly bonded to grounded motor frame in accordance with manufacturer's recommendations.
    a. Manufacturers:
        1) Grounding Brush: Sohre Turbomachinery, Inc.
        2) Grounding Ring: EST-Aegis.

2.20 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
    a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
    b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
    c. On motors of 100 hp and smaller, furnish certified copy of motor efficiency test report on an identical motor.

4. Provide test reports for polyphase motors 100 hp and larger.
5. Temperature:
   a. Perform heat run tests on motors via embedded detector, using either of the IEEE 112 8.2.3 methods of loading.
   b. Record stator and bearing temperatures every 30 minutes until machine reaches constant temperature.
   c. Determine temperature rise for service factor loading.
6. Noise:
   a. In accordance with NEMA MG 1, Part 9.
   b. Mean A-weighted sound pressure level measured at one meter from major machine surface shall not exceed 85 dB (A) with motor operating at no-load, and rated frequency and voltage applied.
7. Vibration:
   a. Radial Shaft at Full Operating Speed: 2.0 mils peak-to-peak, maximum.
   b. Take vibration data at cold and hot operating conditions, at no-load during factory testing.
   c. Transient Shaft Vibration: 3.5 mils peak-to-peak, maximum, throughout normal startup and shutdown speed range.
   d. Values shall include shaft surface runout sensed by probes.
   e. Shaft Runout: At slow roll speeds of less than 100 rpm shall be less than 0.25 mils peak-to-peak, maximum. For areas to be observed by axial-position probes, combined total electrical and mechanical runout shall not exceed 0.5 mil.
   f. Bearing Housing Vibration:
      1) At full operating speed shall be 0.15 inches per second (RMS), maximum.
      2) Take vibration data at cold and hot conditions, at no-load.
      3) Transient Vibration: 0.5 IPS RMS, maximum, throughout normal startup and shutdown speed range.
   g. Vibration Frequency:
      1) Record during vibration testing at cold and hot conditions.
      2) Record frequencies up to seven times line frequency.
      3) When operated uncoupled at rated speed, machinery shall not exhibit unusual or abnormal frequency components on either shaft or casing vibration measurements.
      4) Normal frequency components are defined as excitations such as rotational speed, synchronous and multiples of synchronous frequency, or blade passing frequency that are inherent with mechanical construction of machinery.
      5) Unusual or abnormal frequency components are excitations that are nonsynchronous or not related to known geometry of machinery.

8. Starting Characteristics: Determine speed-torque characteristics using any of the four IEEE 112-7.3.2 recommended methods.
9. Final Factory AC High Potential Test:
    a. Perform after above tests are completed to assure no damage to insulation during setup and testing.
        1) Test according to NEMA MG 1; Part 3.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-11.
3. Efficiency and power factor by Test Method F, IEEE 112, Forms F-1, F-2, and F-3.
4. Temperature Test: IEEE 112, Form A-2.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

3.02 FIELD TESTING

A. Functional Tests: Perform the following prior to connection to driven equipment:

1. Check electrical supply at motor feeder cable terminations for any deviation from rated voltage, phase, or frequency.
2. Visually inspect motor mounting and coupling to driven equipment.
3. Visually check for proper phase and ground connections. Verify multi-voltage motors are connected for proper voltage.
4. Test insulation of all winding and bearing temperature detectors and space heaters.
5. Bump motor to test for proper rotation.
6. Test motor insulation in accordance with NEMA MG 1.
7. If the rotor is removed during shipping: Test insulation after motor has arrived at Site via an AC high potential test performed for same duration as final factory high potential test, but at 75 percent of specified voltage.

8. Take vibration data at no-load and maximum available load.
9. Test motors for proper noise, temperature, and vibratory behavior following no less than 4 hours at maximum available load and full operating speed. Noise and vibration limits used for factory testing with temporary machinery support shall also be applicable to field testing condition with proper rigid support structure below machinery.

3.03 FIELD QUALITY CONTROL

A. Refer to Section 26 08 00, Commissioning of Electrical Systems.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Certificate of Proper Installation.

END OF SECTION

SECTION 26 22 00
DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.01 GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:

1. Dry Type Transformers

1.02 GENERAL REQUIREMENTS

A. Voltage for 3 phase units shall be 480V to 120/208V, three phase, four wire unless shown otherwise. Voltage of single phase units shall be 480V to 120/240V single phase, three wire unless shown otherwise.

B. Where isolation transformer is indicated on drawings, furnish K-13 rated transformer with dual-faraday electrostatic shield.

PART 2 PRODUCTS

2.01 SEISMIC CERTIFICATION

A. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All dry type transformers shall be Seismically Certified. Supplier shall submit Seismic Certfication for this equipment in accordance with Specification Section 01 45 36 (“Equipment Seismic Certification”).

2.02 INSULATION

A. Transformers shall be ventilated with insulation to withstand a minimum of 150 degree Celsius temperature rise (Class 220 insulation) unless specifically shown otherwise on the drawings.

2.03 ENERGY EFFICIENCY

A. Transformers shall comply with the latest applicable DOE energy efficiency requirements and latest edition of NEMA standard TP-1 and shall be labeled for the EPA Energy Star Program.

2.04 SOUND RATING

A. Sound level design may not exceed the following:

	KVA	DESIGN SOUND LEVEL
1.	0-45	40 db
2.	46-112.5	44 db
3.	113-150	47 db
4.	151-300	49 db
5.	301-750	58 db

B. Sound levels shall be determined in accordance with NEMA and ASA Standards. Core and coils shall be mounted on vibration isolator pads.

2.05 ENCLOSURES

A. Transformers mounted in dry, interior locations shall be furnished with NEMA 1 enclosures unless shown otherwise.

B. Transformers mounted outdoors or in wet locations shall be furnished with NEMA 3R enclosures with drip shields unless shown otherwise.

C. Transformers installed inside motor control centers or other similarly enclosed equipment may be “open” units not requiring additional enclosures.

2.06 CLEARANCE REQUIREMENTS

A. Transformer construction/efficiency/ventilation shall allow 3” (or less) clearance from rear and sides.

2.07 TAPS

A. All units shall be equipped with a minimum of two (2) 2 ½% taps above nominal (FCAN) and a minimum of four (4) 2 ½% taps below nominal (FCBN) as required to allow adjustment of the turns ratio of the transformer to account for site voltage adjustments.

2.08 LUGS

A. Lugs shall be AL/CU compression type suitable for the quantities and sizes of conductors required.

2.09 MANUFACTURER

A. Transformers shall be Square 'D' or Cutler Hammer.

PART 3 EXECUTION

3.01 GENERAL

A. Minimum clearances shall be provided on all sides of transformers per manufacturer's and code requirements.

B. Where site voltages so require, transformer taps shall be adjusted to maintain nominal voltage on secondary side of transformer. Adjustment of dry-type transformer taps shall not be made until all upstream voltage adjustments (such as voltage tap adjustments at service transformers) are finalized.

C. Refer to Specification Section 26 05 26 for transformer grounding requirements.

D. Refer to Specification Section 26 05 53 for transformer identification requirements.

3.02 MOUNTING

A. Transformers shall be mounted as indicated on plans. No units shall be wall mounted unless shown or directed otherwise.

B. Floor mounted transformers:

1. Shall be installed on a minimum of four (4) double-deflection neoprene vibration isolators (by Amber/Booth, Korfund Dynamics or Mason Industries - size as required – with seismic restraint capability ratings as required by the associated seismic zone).
2. Shall be installed on four-inch thick concrete pads unless specifically shown otherwise. Pad shall have beveled edges.

C. Suspended transformers:

1. Shall be trapeze-mounted on unistrut frame supported by a minimum of four steel rods and shall be mounted as high as possible or at height directed (transformers shall not be mounted above lay-in ceilings or in areas with restricted ventilation). Shall be installed using a minimum of four (4) double-deflection neoprene vibration isolators (by Amber/Booth, Korfund Dynamics or Mason Industries - size as required – with seismic restraint capability ratings as required by the associated seismic zone).
2. Contractor shall supply extra supports as may be required due to size and weight.
3. Additional seismic bracing shall be provided for suspended transformers in seismic zones as required to provide a fully code-compliant installation.

END OF SECTION 26 22 00

SECTION 26 23 00
PARALLELING SWITCHGEAR

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Project drawings and contract documents requirements apply to this section.

1.02 SUMMARY

A. This section describes requirements for controls and switchgear for paralleling generator sets and distributing alternate source power. Equipment provided shall be new factory assembled paralleling equipment with dedicated purpose microprocessor-based controls designed for fast, reliable operation and including the functions described herein. Generator and Switchgear package shall be by the same Manufacturer.

B. Related sections of the project specifications include:

1. Section 26 32 13 - GENERATOR SETS

1.03 DEFINITIONS

A. ATS: Automatic Transfer Switch

B. GFP: Ground Fault Protection.

C. HMI: Human-Machine Interface

D. PLC: Programmable Logic Controller. A device with associated accessory components that is designed to accept programmable inputs and provide completely field-programmable logically controlled outputs.

E. Manufacturer: The entity that maintains engineering design control for the equipment provided, provides service and maintenance documentation, provides service direction, and provides warranty support.

F. Supplier: The entity that provides manufacturer-authorized local sales and service support for the manufacturer’s equipment.

1.04 SUBMITTALS

A. Product Data: Provide the noted technical data for the controls, switchgear, and transfer equipment described in this section. Materials required include:

B. Technical data fully describing the critical design features of the equipment proposed, and substantiating compliance to the requirements of this specification. This material shall include 3rd party certifications and listing details for all equipment provided, including seismic certifications described herein.

C. Data shall include a complete description of the features and function of the proposed equipment, described on the manufacturer's published literature or manufacturer's letterhead with a manufacturer's employee signature validating its accuracy.

D. Include Seismic Certification.

E. Include a listing of all setting ranges and factory default settings.

F. Include a detailed sequence of operation for the specific equipment provided.

G. Shop Drawings: For each control enclosure, switchgear section, or independent piece of equipment provide:

H. Elevation and other Drawings: Describing physical dimensions, weights, mounting provisions and requirements, mechanical and wiring access points.

I. Wiring Diagrams: Interconnecting wiring details including recommended control conduit configurations.

J. Submit names, qualifications, and locations of individuals who will service and support the equipment.

K. Source Quality Control Test Reports: Provide sample factory test report plan for integrated generator controls and paralleling system.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications

B. The paralleling equipment manufacturer shall be certified to ISO 9001 International Quality Standard

C. Source Limitations: The paralleling switchgear shall be designed, manufactured, and warranted by the generator set manufacturer to provide a single source of responsibility for all the products provided. Warranty documents shall be provided verifying compliance to this requirement. Supplier shall directly employ service technicians specifically trained and qualified on the diagnosis and repair of engines, alternators, power transfer equipment, and paralleling equipment. The technicians shall be trained in the

installation and commissioning of complex generator systems, including line voltage generator paralleling equipment. Switchgear manufacturer shall have more than (15) years experience to ensure quality. Documentation for similar projects shall be provided upon request.

D. The paralleling system, including generator sets and paralleling equipment, shall be serviced by a single local service organization that is trained and factory certified in both generator set and paralleling equipment service. The technicians serving the site shall be specifically trained and certified by the manufacturer in the diagnosis and repair of the synchronizing, paralleling, and load sharing equipment provided. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

E. The manufacturer shall maintain model and serial number records for the paralleling equipment for at least 20 years.

F. Equipment provided shall conform to the requirements of the following codes and standards to the extent that they are applicable:

G. UL891 – Switchboards and Controls. Control equipment provided in switchboard enclosures shall be listed and labeled under this standard.

H. UL 489 – Molded Case Circuit Breakers

I. EN55011, Class B Radiated Emissions

J. EN55011, Class B Conducted Emissions

K. EN60947-6-1 Standard for Low-voltage switchgear IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991

L. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity

M. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity

N. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity

O. IEC 1000-4-6 Conducted Field Immunity

P. IEC 1000-4-11 Voltage Dip Immunity

Q. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.

R. NFPA110 – Emergency and Standby Power Systems. All equipment provided shall meet all requirements for Level 1 systems.

S. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver paralleling system equipment in section sizes that can be moved past all obstructions in the physical site.

B. All paralleling equipment shall be stored indoors in a temperature controlled environment, in accordance with manufacturers temporary storage instructions. At a minimum, equipment shall be protected from moisture, dirt, and physical damage.

C. With written approval of the equipment manufacturer, equipment may be stored outdoors, as long as it is protected according to the manufacturer's instructions, including protection from condensation, rain, dust/dirt, and physical damage.

1.07 EXTRA MATERIALS.

A. Provide additional items to support the paralleling system equipment, completely programmed and tested, packaged and labeled consistently with designations in system drawings.

B. One set of fuses of each type used in the system

C. Submit one racking handle(s) with equipment. A charging handle shall be furnished on each breaker mechanism.

D. For all switchgear with circuit breakers in upper compartments, provide [one] circuit breaker lifting device - portable, floor-supported with a roller base.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: The paralleling switchgear shall be provided by the generator supplier. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on microprocessor-based paralleling equipment manufactured by Cummins Power Generation. Digital Paralleling Equipment by other suppliers that meets the requirements of this specification is acceptable, if approved not less than 2 weeks before scheduled bid date. Proposals must

include a line by line compliance statement based on this specification.

2.02 GENERATOR PARALLELING MONITOR AND CONTROL SYSTEM

A. Acceptable Manufacturers

1. Cummins Power Generation (Equipment specifications for this project are based on microprocessor-based paralleling equipment manufactured by Cummins Power Generation).
2. Caterpillar

B. Individual Generator Monitoring and Control Panel: Provide a paralleling control panel for each generator set in the emergency/standby power system. The paralleling control functions shall be integrated with the generator set control functions, and provided in a single, dedicated purpose microprocessor-based control designed and manufactured by the generator set manufacturer. Each paralleling control panel shall contain the functions as described in this section. No PLC-based control shall be used to provide these functions. Each paralleling control shall be independent and autonomous, requiring no interaction with other controls for proper operation, except load sharing and paralleling breaker status functions. Failure of the system master control shall have no impact on the functions described in this section for the generator sets.

C. Operator Panel. Each paralleling control shall be provided with an operator panel to allow the operator to view the status and control operation of the specific generator set being paralleled. The operator panel shall be provided with the following features and capabilities.

1. 1% or better accuracy generator set AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter, or other means shall be provided to allow viewing of voltage and amperes for each phase shall be provided. For 3-phase/4-wire systems the voltmeter shall indicate line to line and line to neutral conditions. Voltmeter, ammeter, frequency meter, kW meter and power factor meter shall have both analog and digital displays. Switches and/or other provisions shall be included to allow reading of bus voltage and frequency from this metering set.
2. Synchronizer shall be an integral part of the multi-function digital generator set control. Independent synchronization swing panels are prohibited.
3. Running Time Meter, Start Counter
4. Generator Set Operator Panel: Panel shall provide manual and automatic functions for control of the generator set. Press the manual mode button to put the unit in manual mode if the operator does not press the Start

button in 10 seconds, the control is put in the Off mode. Both manual and off modes prevent generator set from starting remotely or immediately shuts down the generator set if it is running. Press the auto mode button to put the unit in auto mode. The auto mode allows remote start, stop, breaker open, and breaker closed commands to be active. Generator controller must withstand voltage drops down to 8V DC upon engine starting.

5. Breaker trip/close switch with breaker status indicating lamps. The switch shall be interlocked with the control system such that breaker closure is not possible unless the mode select switch is in the run position and the generator set is synchronized with the system bus.
6. Control Reset push button switch with indicating lamp. Lamp shall flash to indicate that generator set is locked out due to a fault condition.
7. Lamp test push button switch. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.
8. The control panel shall be provided with a set of DC-powered lamps with a switch to allow viewing of all functions on the front panel when normal lighting systems are not available.
9. Precision voltage and frequency raise lower function. The generator set frequency and voltage may be adjusted plus or minus 5% when the generator set is operating independently of the system bus. Voltage and frequency adjustments are integral to the generator set control, along with bus metering, breaker control switches, and manual paralleling controls for ease of use by the operator. The ability to make frequency and voltage adjustments shall be disabled when the paralleling breaker is closed. Voltage and frequency adjustments while the paralleling breaker is open shall not impact on the load sharing when the paralleling breaker is closed.
10. Alarm and status indicating panel to indicate the following conditions (alarm horn shall be located on master control)

D. Internal Controls. The following internal control functions shall be provided for each generator set in the system.

1. Electronic isochronous kW load sharing control to operate the engine governors during synchronizing and to provide isochronous load sharing when paralleled. The control system shall allow sharing of real kW load between all generator sets in the system to within 1% of equal levels, without introduction of frequency droop into the system. The control system shall include all equipment required for kW load sharing with an infinite bus. The infinite bus governing controls shall allow the generator set to synchronize to an infinite bus, parallel, and ramp up to a preset load level on the generator set. Additional controls shall be provided to cause the generator set to ramp up to a kW load level

signaled by the system master control. The isochronous load sharing module and engine governor shall be a coordinated system of a single manufacturer.

2. Load demand governing controls shall be provided to cause the generator set to ramp down to zero load when signaled to shut down in a load demand mode. On a signal to re-start, the load demand governing controls shall cause the generator set to synchronize to the system bus, close, and ramp up to it's proportional share of the total bus load. The ramp rate of the generator set shall be operator-adjustable.
3. Electronic kVAR load sharing control to operate the alternator excitation system while the generator set is paralleled. The control system shall allow sharing of reactive load between all generator sets in the system to within 1% of equal levels, without introduction of voltage droop into the system. The control system shall include all equipment required for VAR load sharing with an infinite bus in either a constant VAR or constant power factor mode for future application flexibility. (Mode and adjustments selectable by the operator)
4. Equipment shall be provided to monitor the generator set as it is starting, and verify that it has reached at least 90% of nominal voltage and frequency before closing to the bus. The equipment provided shall positively prevent out of phase paralleling if two or more engine generator sets reach operating conditions simultaneously by providing a lockout signal to disable breaker closure for generator set(s) in the system which have not been selected to be the first units to close to the bus. Controls to recognize the failure of the first breaker signaled to close, and allow system operation to proceed in spite of this failure shall also be provided (breaker failure alarm). Systems using dead bus relay schemes without a disable signal to positively prevent out of phase paralleling shall not be acceptable under this specification. System shall include an independent backup to automatically operate in the event that the primary system fails.
5. Synchronizer to electronically adjust the engine governor to match the voltage, frequency and phase angle of the bus. Synchronizer shall maintain the engine generator voltage within 1% of bus voltage and phase angle within 15 electrical degrees of the bus for 0.5 seconds before circuit breaker closing. Each unit shall have its own synchronizer; systems using a switching scheme to utilize a single system synchronizer will not be approved. Synchronizers and systems which utilize a motor driven pot for control of AC voltage during the synchronizing process will not be accepted. The system shall be provided with a fail to synchronize time delay that is adjustable from 10-120 seconds. Control logic for fail to synchronize function shall allow field adjustment of function for either alarm or shutdown of the generator set on failure condition.

6. Controls shall include a permissive relay function to assure that the generator set does not attempt to close out of phase with the bus, due to errant operation of the synchronizer.
7. Controls shall include a permissive (sync check) function, to be used with “generator synchronized” indicator during manual paralleling, to prevent accidental closure of the breaker with the generator set out of phase with the bus. Provisions to allow manual closure of the first generator set to a de-energized bus shall be included.
8. Controls shall be provided to verify generator set and bus phase rotation match prior to closing the paralleling breaker.
9. Electronic alternator overcurrent alarm and shutdown protection. This protection is required in addition to the overcurrent trip on the paralleling breaker, and shall sense current flow at the generator set output terminals. The overcurrent alarm shall be indicated when the load current on the generator set is more than 110% of rated current for more than 60 seconds. The overcurrent shutdown shall be matched to the thermal damage curve of the generator set, and shall not have an instantaneous function.
10. Electronic alternator short circuit protection. This protection is in addition to the overcurrent trip on the paralleling breaker. The short circuit shall occur when the load current on the generator set is more than 175% of rated current and an aggregate time/current calculation indicates that the system is approaching the thermal damage point of the alternator. The equipment used shall not have an instantaneous function and shall be selectively coordinated with the feeder circuit breakers. This protective function shall be provided by equipment that is UL-listed as a utility grade protective relay.
11. Provide overcurrent and short circuit protection for the conductors connecting the generator set to the paralleling switchgear. This protection may be integrated with alternator protection but must be positively coordinated to prevent tripping of the paralleling breaker prior to the operation of the alternator protective equipment.
12. Controls shall be provided to sense reverse VAR conditions on the alternator while paralleled to the system bus. Reverse VAR protection shall be set to operate as directed by the power company in coordination with the generator supplier’s requirements. A reactive capability curve shall be provided to allow proper setting of this protection. Reverse power, etc. protective relaying, etc. shall be provided / integrated into the paralleling switchgear as required to satisfy all requirements of the associated power company.
13. Generator set start contacts rated 10 amps at 32 VDC. A redundant network-based starting system shall also be provided.

14. Cooldown time delay, adjustable: 0-600 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for shutdown.
15. Start time delay, adjustable: 0-300 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for start.
16. Controls shall be provided to shut down generator set and initiate alarm when the generator set is at less than 85% of nominal voltage for more than 10 seconds, more than 110% of nominal voltage for more than 10 seconds. When the control is set to operate as Inverse time, the unit will be more sensitive to voltage spikes and trip more rapidly.
17. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for reliable system operation, as described herein under “SYSTEM OPERATION".

E. Master Control System and Monitoring Equipment: Provide an independent system master control (located within the paralleling switchgear gear/lineup) to monitor and control the operation of the entire paralleling system.

F. Operator Panel. The master control panel shall be provided with at least a 15 Inch full color high resolution resistive touch Advantech HMI operator interface panel to allow the operator to view the status and control operation of system. The operator panel shall be provided with the following features and capabilities.

1. Main One Line Screen shall give a graphical display of the power system components directly controlled by the paralleling system. System status displays a combination of multi-color animation, messages and pop-up indicators.
2. System Control Screen shall provide the operator with the ability to:
3. Enable or disable load demand operation;
4. Initiate test (with or without load);
5. Control the shutdown sequence for the generator sets in the load demand mode;
6. Set the load demand time delays;
7. Set the load demand operation set points;
8. Display and modify the automatic load add and shed sequence.
9. Add in project specific features if required (customer specific modes of operation)
10. Load Control Screen shall allow the operator to monitor genset capacity, levels of load that have been added or shed.
11. Allow the operator to manually shed or add loads levels.
12. Display the name, status and priority of each load block (whether on or off).

13. Display total load, as a percentage of online generation capacity, displays on a bar graph in kW and amps.
14. Display actual system load.
15. Bus metering display shall include the following parameters for each bus segment:
16. Bus Line to Line voltage (all three phases simultaneously),
17. Bus Line to Neutral voltage (all three phases simultaneously),
18. Bus output current (all three phases simultaneously),
19. KW output of bus and as a percentage of rated KW,
20. KVA,
21. KVAR,
22. KW hours
23. KVAR hours
24. Bus line to line voltage (all three phases simultaneously) (graphical format),
25. Power Factor (graphical format), F
26. Bus output current (all three phases simultaneously) (graphical format),
27. KW output of bus, (graphical format) Frequency (graphical format).
28. Selector buttons shall be provided to allow the user to choose which bus to monitor.
29. Active Alarm Screen shall display the date, time, alarm description and acknowledged date and time for genset and system alarms (alarm horn shall be located on master control).
30. Historical Alarm Log Screen shall display the date, time, alarm description and acknowledged date and time for genset and system alarms (alarm horn shall be located on master control). These alarms should be stored and displayed in the master control for x days or x alarms.
31. Real Time Trending Screen should monitor and display four pens simultaneously. Display parameters should include voltage, current, power, and frequency for each bus. Selector buttons shall be provided to allow the user to choose which bus to monitor.
32. Historical Trending Screen The system shall include historical trending which collects, displays, and stores data. The historical data base shall be a FIFO file with storage capacity up to 26 days, or saved to a USB flash drive. Data will be saved in ".csv" file format. Each trend pen will have stop/pause/zoom features to allow the operator to magnify the trend, and also scroll back in time to view history. Historical Trend properties shall include: Refresh rate = on data change or every 2 seconds Buffering for extra data = 360 data points Continuous scrolling with pause and sliding time Time span on display = 8 hours (normal view) Time span on display = 2 hours (zoon view) USB data storage = 1 Year (with Minimum 1 Gig) Maximum and Minimum scale values = selectable by operator via touch screen Print screen function

Required Trend pens required: Total KW Total KVAR Average Amps Average L-L Voltage

33. User Login Security shall consist of 3 levels of security: Guest, Operator, and Technician. Automatic logout feature will reset access to "Guest" after defined period of time
34. Event Log Screen shall be capable of logging all breaker operations, security level changes, and system status changes with a time and date stamp.
35. The plant test report function shall provide a record that System generator sets have been operated above 30% load for a particular duration. The report shall be enabled individually for each generator set in the system. The report duration shall be adjustable between 5 – 240 minutes. The control will store at least 12 reports per generator. The operator may select, view, and print any and all of the 12 available reports per generator set. Reports shall be available via the remote web interface or FTP site. Each report shall contain the following information: Generator Set Name, Generator Set Model, 3 Phase L-L Voltage, 3 Phase Amps, Frequency, Power Factor, % KW, KW, KVAR, KVA, Oil Pressure, Coolant Temperature, Battery Voltage, Engine Hours
36. All screens shall have detailed help content
37. Diagnostic screens shall display: Operator panel diagnostics, Communications processor diagnostics and Primary controller diagnostics
38. Modbus TCP/IP over Ethernet for SCADA Interface. Refer to Specification Section 26 29 00 ("Manufactured Control Panels") for SCADA network connection requirements.

G. Internal Controls. The following internal control components or functions shall be provided for the master control:

1. Provide load demand control signals for each generator set provided, which operate when enabled to minimize fuel consumption during extended outages. The load demand can be enabled or disabled.
2. Load add and shed output contacts, rated 10 A at 250VAC/VDC. The priority level for each load shed contact set shall be field configurable through the master control operator panel.
3. The master functions shall include:
4. Automatic and manual start/stop commands for generator sets as well as paralleling breaker control.
5. System test with and without load initiated locally or remotely
6. Extended paralleling function includes peak shave and base load and may be initiated locally or remotely
7. Bus Overload function used to initiate load shed.

H. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for proper and reliable system operation.

I. Master control equipment shall contain a system of diagnostic LED's to assist in analyzing proper system function.

J. Construction

K. Manufacturer shall supply drawings that note dimensions, access requirements, and conduit entry details.

L. The master control system shall be listed and labeled under the requirements of UL891 including all covers, barriers, and supports. Individual control sections shall be isolated from each other by metal or insulating barriers.

M. All wiring shall be IEC UL891 listed 105 deg C, 600 volt rated and sized as required. Each wire, device or function shall be suitably identified by silk screen or similar permanent identification.

N. The framework and all other sheet metal components of the system shall be primed with a rust inhibiting primer, and finished with two coats of satin finish ANSI 61 gray enamel and must meet corrosion requirements of IEC 61439

O. All door mounted control components shall be industrial type oil tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.

P. AC control circuits in the switchboard shall be protected with properly sized fuses or circuit breakers,. Potential transformers shall be protected on line and load side.

Q. All CT installations shall include 6 place shorting type terminal blocks using 12 gauge wire with ring terminal connectors.

R. All field control interconnect wiring shall be sized as specified by system manufacturer (wiring not designated by the system manufacturer shall be minimum 14 AWG copper). All control interconnect wiring shall be stranded.

S. All active control system components in the system shall be suitable for operation in ambient temperatures ranging from 0 to +50 degrees C. The

controls shall be suitable for operation in an ambient ranging from 5-95% relative humidity, and shall be protected from the effects of equipment vibration.

T. The Touchscreen and other non-LED displays specified shall be suitable for operation from 0-50 degrees C. The controls shall be suitable for operation in an ambient ranging from 5-95% relative humidity.

U. System Control Power

V. Control power for the paralleling system controls shall be derived from the generator 24VDC starting batteries AND a dedicated set of 24VDC station batteries, located within the same room as the paralleling switchgear, sized as recommended by the switchgear supplier, and furnished complete with 120V battery charger, battery rack(s), and all interconnections as required for a complete system. A solid state, no break "best battery" selector system shall be provided so that control voltage is available as long as any battery bank in the system is available, and that all battery banks are isolated to prevent the failure of one battery from disabling the entire system. The power transfer control shall be supplied with redundant DC control power from two independent sources.

W. The generator set governing, voltage regulation, load sharing, synchronizing, and protection, shall be capable of proper operation with battery voltage levels down to 8vdc without external battery support. The master control shall be supplied with a station battery system rated to 10 amp minimum. The control power for the system master controls shall be derived from at least two different sets of generator set battery banks.

X. Paralleling breaker control power for each paralleling breaker shall be derived from the generator set and the station batteries for opening, and closing the breakers.

2.03 SEQUENCE OF OPERATION

A. Normal Standby Conditions Genset Breakers are open and the Gensets are not running. System loads are supplied by the normal source and may be controlled manually or by a building management system.

B. Loss of Normal Power The DMC and Gensets receive a start signal from an externally supplied utility monitoring device. The Gensets start automatically and independently and accelerate to rated voltage and frequency. The first Genset closes to the bus as dictated by the First Start System. The remaining Gensets synchronize to the Load Bus and close their respective Genset breakers. The Gensets proportionally share load on the Load Bus. The Load

Demand feature will operate if it is enabled.

C. Return of Normal Power The externally supplied utility monitoring device removes the start signal from the DMC and Gensets. The Genset Breakers open. The Gensets run in cool down mode and then shutdown. The system returns to a Standby mode of operation.

D. Test Without Load The operator initiates this sequence by selecting the Test Without Load checkbox on the System Control screen. The Gensets start automatically, independently and accelerate to rated voltage and frequency. The first Genset closes to the bus as dictated by the First Start System. The remaining Gensets synchronize to the Load Bus and close their respective Genset Breakers. The Load Demand feature will operate if it is enabled. The operator returns the system to Standby mode from Test Without Load by selecting the Off checkbox on the System Control Screen. The Genset Breakers open. The Gensets run in cool down mode and then shutdown. The system returns to Standby mode of operation.

E. Genset Bus Overload The Genset bus overload condition occurs when an operational Genset is either at or below 57 Hz for three seconds or at 105% of load for 60 seconds. If Genset bus overload condition occurs, a bus overload alarm initiates on the DMC. A Genset shuts down on overload based on the overload protection settings in the Power Command Control.

F. Failure Modes

1. Fail to Start If a unit fails to start after the overcrank time delay (time set in the genset control) expires, the unit shuts down and an alarm sounds on the DMC. The operator needs to check and rectify the problem on the Genset at this stage.
2. Fail to Synchronize If a unit fails to synchronize after a preset time delay, an alarm sounds and the unit continues attempting to synchronize until signaled to stop by an operator either on the PCC or on the Genset Control Screen of the HMI on the Digital Master Control.

G. Run Hours Based Sequence Method In this mode, the control automatically select the shut down sequence for the generator sets based on the engine run hours of the Genset, and restarts generators sets in the opposite order. Again, the generator set as the lead or preferred unit never shuts down. The control balances the run hour of the generator sets by creating a sequence based on the current run hours of the generator sets. The generator set with the fewest run hours is set as the lead generator set. The control never shuts down the lead generator set. The generator set with most run hours is the first generator set that will be shut down. The control changes the generator shut down sequence to balance the run hours, based on a threshold set by the operator at

the HMI Touch Screen. When the difference in run hours between two generator sets is greater than the threshold, the control switches the two generator sets in the sequence. To initiate the run hour based load demand sequence, the operator must navigate to the system control screen and check the load demand 'ON ENGINE HOURS' check box. The engine run hours can be monitored from the Genset Summary Screen. Upon detection of the lead or preferred Genset failure, the alternative Genset will immediately start and transfer to the bus, releasing the other Genset for maintenance There are two time delays associated with the Load Demand feature. • The Initial time delay is the time delay the DMC waits for the system loads to stabilize before monitoring the load to see if Gensets can be shut down. • The Shutdown time delay is the time delay the DMC waits before issuing a Load Demand Stop to a generator while load conditions are such that the next Genset in the Load Demand sequence should be shutdown. The system returns to the normal load demand sequence described above.

H. Priority Based Load Control

1. Load Add Sequence The Load Add feature allows the system to have each distribution device assigned to a Load Add Level in the range from 1-8. The amount of load assigned to each load level should be less than the capacity of the smallest sized Genset in the system. More than one distribution device can be assigned to a load add level. When the first Genset Connects to the Load Bus, all distribution devices assigned to load add level 1 will be commanded to add. When the second Genset Connects to the Load Bus, all distribution devices assigned to load add level 2 will be commanded to add. This sequence continues until all Gensets have been added to the Load Bus. If there are more load add levels than Gensets in the system, the DMC will continue to add load levels on a time delay basis until all load add levels in use in the system are added. In the event that not all existing Gensets connect to the Load Bus, the DMC will only add load levels equal to the number of Gensets online. Any further load add levels will need to be added using the manual commands from the Load Control screen. If during the manual adding of load levels, an overload condition occurs, the system will start the Load Shed sequence.
2. Load Shed Sequence The Load Shed feature allows the system to have each distribution device in the system to be assigned a load shed level in the range from 0-7. Load Shed level assignment can be automatically done by the DMC based upon the load add level assignments, or can be user defined. Load Shed level 0 will never shed and should be used for critical loads. Load Shed level 1 is the first load to shed when an overload condition has been detected. The load shed feature is activated when the generator detects an overload condition. An overload

condition occurs when a PCC of an operational genset senses a frequency at or below 57 Hz for three seconds or at 105% of load for 60 seconds. Upon receiving an overload condition from one or more Gensets, the DMC starts an overload timer. When this timer expires, all distribution devices assigned to Load Shed level 1 open. If the system is still in an overload condition, the DMC waits a time delay (2 Sec) and all Feeder Breakers assigned to Load Shed level 2 open. This sequence continues until the overload condition clears. Once the overload condition is reset, Load Levels may be restored manually using the Restore pushbuttons on the Load Control screen. If during the manual restore of load levels, an overload condition occurs, the system will again start the Load Shed sequence.

2.04 MANUFACTURED UNITS

A. The paralleling/distribution power equipment shall be configured as shown on the contract drawings, and rated for operation at voltage and current levels as shown on the contract drawings. It shall contain devices and equipment as shown on the drawings, in addition to meeting the requirements of this section.

B. Seismic Certification

1. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All paralleling switchgear equipment shall be Seismically Certified. Supplier shall submit Seismic Certfication for this equipment in accordance with Specification Section 01 45 36 (“Equipment Seismic Certification”).

C. Ratings

1. The low voltage switchgear shall consist of an indoor enclosure containing circuit breakers and the necessary accessory components all factory assembled (except for necessary shipping splits) and operationally checked.
2. The assembly shall be a self-supporting and floor mounted on a level concrete pad.
3. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.
4. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum AC service. System voltage will be 277/480 Series Wye volt 3 phase 4 wire with ground.
5. The ampacity of the Low Voltage Switchgear shall be determined by the loading of the feeder circuits.

6. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current as indicated on plans/schedules.
7. All circuit interruption shall be accomplished by the circuit breaker and without the aid of limiter fuses. The circuit breaker short-time ratings shall as specified on the drawings. **
8. The assembly is designed for use on 60Hz electrical systems up to 600 Vac. The assembly shall be properly braced to the ratings of the circuit breaker installed within the assembly.
9. Any items not specifically mentioned but which are obviously necessary for proper operation are implied in this specification.

D. General

1. All switchgear/breakers/etc. shall be manufactured by Schneider/Square D or by Eaton/Cutler Hammer.
2. Each steel section shall contain one or more individual circuit breakers, or instrumentation compartments, and a rear compartment for the buses and outgoing cable connections.
3. Rigid removable steel base channel shall be provided at the front and rear of each section.
4. The finish shall be medium gray ANSI #61.

E. Dimensions

1. Section widths should be 22, 30, or 36” wide dependent on the size of the circuit breakers being installed.
2. The lineup shall provide adequate wire bending space for mains and feeders breakers using up to 750 kcmil wires.
3. Section depth shall be 54” minimum when using 800A feeders. Additional depth to the lineup shall be for the sole purpose of additional wire bending and conduit space.
4. Adequate conduit space shall be provided to allow all conductors to exit the structure at the same end.

F. Moving and Handling

1. The Lineup shall be divided into shipping splits not to exceed 88” wide and shall be capable of being lifted overhead or by a forklift.
2. Each shipping split shall be provided with removable lifting straps.
3. Removable Base Channels shall be provided with prying slots for ease of final positioning at the job-site.
4. For circuit breakers, an overhead or floor mounted lifter shall be provided to ease the installation or removal of circuit breakers in excess of 75 pounds.

G. Circuit Breakers

1. Each circuit breaker shall be mounted in its own barriered compartment.
2. Feeder circuit breakers rated 2000A or less shall be capable of being mounted in the uppermost compartment without de-rating.
3. The front of the circuit breaker shall protrude through the door of the switchboard allowing access to the operational buttons, the toggle mechanism, the trip unit and the display.
4. All mains and feeders shall be two-step stored energy circuit breakers and shall allow for closed door racking.
5. All circuit breakers shall be drawout-style construction.
6. Circuit breakers of like frame sizes shall be interchangeable as standard.
7. All prepared spaces shall be fully equipped for future devices, including the racking mechanism, bussing, and secondary contacts.

H. Secondary Connections

1. All customer secondary control and communications connections shall be made from the front of the switchgear lineup.
2. A dedicated wiring area accessible from the front shall allow easy access to all control or communications terminations.
3. Control Connections shall be cage clamp terminals. All control wire shall be 14 gage SIS.
4. Dedicated conduit entry for control wires shall be provided at the top and bottom of each section, capable of landing up to 3 each 1 ½" conduits and accessible from the front.
5. All interconnections between sections at shipping splits shall use locking-pull apart terminal blocks.

I. Instrumentation

1. Where additional space is required for instrumentation, CPT's, metering, etc., a barriered instrumentation compartment shall be used.
2. The instrumentation compartment shall not inhibit the routing of control or communication wires.
3. Individual component mounting surfaces and pans in the instrument compartments shall be painted white as standard.

J. Busing

1. All vertical and horizontal distribution bussing shall be rated for the full ampacity of the lineup.
2. All bus joints shall consist of Grade 5 hardware and conical spring (e.g. Belleville) washers to withstand mechanical forces exerted during short circuits. All joints shall consist of a minimum of 2 bolts.

3. All bus bars shall be silver-plated copper.
4. All runbacks from the circuit breaker compartment to the cable compartment shall be insulated.

K. Cable Compartment

1. All incoming or outgoing power conductors shall be routed through this area.
2. Feeder Breakers shall have adequate wire bending space regardless of the interrupting rating.
3. Conduit area for each section shall be a minimum of 17” wide and provide adequate depth for all section conduits.

L. Circuit Breakers and Trip Units

1. Circuit Breakers
   a. The circuit breaker shall be listed to UL 489
   b. Circuit breakers shall be suitable for the required instantaneous rating without the use of current limiting fuses.
   c. All circuit breakers shall have field interchangeable electrical accessories including shunt trip, spring release, electrical operator, auxiliary contacts, and Trip Unit.
   d. All secondary connections shall be made directly to the front of the circuit breaker cradle.
   e. Each Circuit breaker shall have built in contact temperature and contact wear sensors.
   f. Circuit breaker must be equipped with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell. Circuit breaker must provide a positive ground contact check between the circuit breaker and cell when the accessory cover is removed while the circuit breaker is in the connected, test or disconnected positions.

2. Trip Units
   a. All trip units shall be removable to allow for field upgrades.
   b. Trip Units shall incorporate “True RMS Sensing”, and have LED long-time pickup indications.
   c. All trip units shall have the option of turning instantaneously to the off position.
   d. Electronic trip unit functions shall consist of adjustable long-time pickup and delay, and instantaneous.
   e. Adjustable long-time pickup (Ir) and delay shall be available in an adjustable rating plug that is UL Listed as field-replaceable. Adjustable rating plug shall allow for nine long-time pickup

settings from 0.4 to 1 times the sensor plug (In). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be in nine bands from 0.5–24 seconds at six times Ir.

f. Short-time pickup shall allow for nine settings from 1.5 to 10 times Ir. Short-time delay shall be in nine bands from 0.1–0.4 I2 t ON and 0–0.4 I2 t OFF.
g. Instantaneous settings on the trip units with LSI protection shall be available in nine bands from 2 to 15.
h. All trip units shall have the capability for the adjustments to be set and read locally by rotating a switch.
i. Trip unit shall provide local trip indication
j. Ground-fault protection shall be provided for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of the following types of ground-fault protection: residual, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
k. Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times In. The ground-fault settings for circuit breakers above 1200 A shall be nine bands from 500 to 1200 A.
l. Neutral current transformers shall be provided for four-wire systems.
m. Trip units shall be capable of communicating on MODBUS ® networks.
n. Trip units shall provide additional protection by offering adjustable inverse definite minimum time lag (IDMTL). IDMTL provides optimized coordination by the adjustment of the slope of the long-time delay protection.
o. Trip units shall provide real time metering. Metering functions include current, voltage, power and frequency.

M. Optional Accessories

1. Provide a circuit breaker lifter that is rail-mounted on top of switchgear.
2. A test set shall be available to provide automatic function testing of the circuit breaker. No disassembly of circuit breaker shall be required.
3. Provide phenolic graphics on the front of the entire switchgear lineup to visually represent the flow of power into/through/out of the gear. These phenolic graphics shall include arrows to show the typical direction of power flow (at main breakers, generator breakers and feeder breakers), and shall include symbols for all breakers.

PART 3 EXECUTION

3.01 POWER COMPANY APPROVAL

A. The paralleling switchgear shall be designed and built to meet all applicable power company requirements for connection to the power company's system, complete with all required relaying/protections to properly protect the power company's systems for reverse power, etc.. Contractor shall ensure that gear is specifically approved by power company for connection to their system prior to proceeding with shop drawings for the proposed switchgear.

3.02 EXAMINATION

A. The installer shall be responsible for inspection of the site and verification that the equipment can be installed and operated as required by the manufacturer.

3.03 INSTALLATION

A. The equipment shall be installed as recommended by the equipment manufacturer.

B. Remove temporary lifting provisions prior to commissioning.

3.04 IDENTIFICATION

A. Mount permanent operating instructions at each transfer point, and at the system master control. Instructions shall include a one-line system drawing, description of the operating sequences of the system and the manual operation instructions for the panel where they are installed.

B. A notice indicating location of the operation and maintenance manual shall be provided.

C. A notice indicating service support information including supplier name, telephone numbers, and manufacturer's contact information shall be provided on each major piece of equipment.

3.05 CONNECTIONS

A. Ground each piece of equipment according to the requirements elsewhere in Division 26 "Grounding and Bonding for Electrical Systems", and in compliance with instructions in the drawings.

B. Connect power conductors in compliance to appropriate instructions based on voltage class, elsewhere in Division 26.

C. Provide control interconnection wiring and connect all control interconnections in strict compliance to the equipment manufacturers'

instructions.

3.06 FIELD QUALITY CONTROL

A. Prior to acceptance testing, test insulation resistance of each switchgear bus, component, connecting supply, feeder, and control circuit (in compliance with equipment manufacturer(s).) Test continuity of each circuit. Retain permanent records of this testing.

B. A factory-authorized and certified service technician shall inspect all control wiring for type of wiring material and installation practice, verify that the wiring is properly installed by point to point testing, and complete installation and startup checks as required by the equipment manufacturer.

3.07 ADJUSTING

A. Set all protective relaying according to the results as required by a coordination study. Set all other settings as recommended by the equipment manufacturer.

B. Record all settings and provide in system operation and maintenance manuals.

3.08 CLEANING

A. All equipment is to be thoroughly cleaned, with any shipping or installation damage repaired, prior to equipment commissioning and final test.

3.09 PROTECTION

A. Equipment shall be protected from the environment in compliance to manufacturer’s recommendations. As a minimum, equipment shall be protected from moisture, dirt, and condensation.

3.10 TRAINING

A. Provide a minimum of eight hours of classroom and field training to owner’s personnel on the proper use and maintenance of the paralleling switchgear, drawout breakers and generator system(s). Owner shall have the authority to video tape the training for future use/reference.

3.11 DEMONSTRATION.

A. Factory Testing. Before shipment of the equipment to the jobsite, the entire control system (including generator set controls) and all the new switchgear directly controlled by the control system shall have sequence of operation tested at the manufacturer's facility to demonstrate that it is fully functional

prior to shipment to the jobsite. No exceptions to the requirements of this paragraph will be accepted.

B. Factory acceptance testing shall be executed successfully prior to shipment from factory.

C. The supplier of the paralleling system shall provide a manufacturer-certified representative to train the owners personnel in the proper operation and maintenance of the paralleling system.

END OF SECTION 26 23 00

SECTION 26 24 16
POWER PANELBOARDS

PART 1 GENERAL

1.01 GENERAL

A. The work under this section includes but is not limited to the following:

1. Power Panelboards
2. Power Circuit Breakers

PART 2 PRODUCTS

2.01 SEISMIC CERTIFICATION

A. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All panelboards shall be Seismically Certified. Supplier shall submit Seismic Certfication for this equipment in accordance with Specification Section 01 45 36 (“Equipment Seismic Certification”).

2.02 PANELBOARDS - GENERAL

A. Panelboards shall be dead front type, having lugs only or circuit breaker in mains as shown in panelboard schedule with circuit breaker branches.

B. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on plans. Such rating shall be established by heat rise test with Maximum hot spot temperature on any connector or bus bar not to exceed 50 degrees C rise above ambient at full rated load. Heat rise test shall be conducted in accordance with UL Standard UL67. Bus structure shall be tin-plated copper. All neutral busses shall be full size. All panelboards shall contain ground buss.

C. Entire panelboard assembly, including all bussing, shall have SCCR ratings meeting or exceeding the minimum AIC ratings listed on the plans for the panel. All ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.

D. Panelboards shall be listed by Underwriters Laboratories and shall bear the UL label. Panelboards shall be suitable for use as service equipment when required.

E. Main and sub-feed lugs shall be provided with AL/CU compression lugs suitable for the quantities and sizes of conductors required.

F. Top/bottom feed arrangement and lug sizes/quantities shall be coordinated by the contractor.

G. Service entrance panelboards shall be provided with barrier such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations**.**

2.03 CIRCUIT BREAKERS

A. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.

B. Circuit breakers shall be quick-make and quick-break, whether actuated automatically or manually. Circuit breakers shall have inverse time tripping characteristics with automatic release which shall trip free of the handle. Circuit breaker handles shall be three distinct positions—"OFF", "ON", and "TRIPPED". When a circuit breaker opens on overload or short circuit, the operating handle shall automatically assume the "TRIPPED" position.

C. Multipole breakers shall be internal common trip with single operating handle. External handle ties are not acceptable, unless specifically noted otherwise (such as for multi-wire branch circuits described below).

D. Circuit breakers feeding multiwire branch circuits (as defined by NEC) consisting of separate single phase loads sharing a common neutral shall be provided with handle ties to simultaneously disconnect all ungrounded conductors per NEC Article 210.4(B). The necessary locations of these handle ties shall be coordinated by the contractor. Where necessary, the contractor may rearrange circuit breakers (as minimally as possible) as required to meet this requirement.

E. Circuit breakers shall be of the bolt-on type.

F. Circuit breakers shall be "FA" frame and larger.

G. All breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated panel. All interrupting ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.

H. The front face of all circuit breakers shall be flush with each other. Breaker

numbers shall be permanently attached to trim.

I. All branch circuit breakers shall be listed to UL489 or shall be specially-tested to be HACR listed.

2.04 CABINETS, TRIM AND WIREWAY SPACE

A. Clear space from bottom of lugs to bottom of wireway shall be not less than 6 inches for 400 amps and below, 10 inches for 600 amps, 12 inches for 800 amps and above.

B. Panelboard interiors shall be fastened to cabinets by adjustable aligning supports.

C. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets.

D. Fronts of cabinets shall be made from a single sheet of full finished steel having the door cut out. Doors shall have flush hinges, and lock utilizing all metal construction (with all locks keyed alike). Front shall be attached to cabinets with hinged trim with piano-hinge down full length of one side to allow access to wiring without complete removal of outer trim. Front shall be provided with a metal directory and holder with clear plastic covering welded to the inside of the door. Fronts shall be code gauge full-finished steel with rust inhibiting primer and baked enamel finished in ASA #49 gray. Panelboards installed in corrosive, exterior or wet locations shall have NEMA 4 stainless steel enclosures.

E. Each section of multi-section panelboards shall be of matching heights and depths.

F. Panelboard enclosures shall be furnished as shown on panel schedule on plans for surface, flush or motor control center mounting.

2.05 MANUFACTURER

A. Panelboards shall be as manufactured by Square 'D' or Cutler Hammer.

PART 3 EXECUTION

3.01 INSTALLATION

A. All panelboard dimensions and clearances shall be carefully checked and coordinated with the proper trades to ensure proper mounting space and support prior to roughing in equipment. In no case shall any circuit breaker be located above 6’-7” A.F.F..

B. Wiring in panelboard gutters shall be done in a neat and workmanlike manner. Wiring shall be grouped into neat bundles and secured with approved tie wraps.

3.02 PERFORMANCE TESTING

A. The ground-fault protection system when provided shall be performance tested after installation by a qualified person(s) using primary current injection in accordance with the instructions provided with the equipment and NEC requirements. A written record of the testing shall be provided.

B. The arc energy reduction protection system when provided shall be performance tested after installation by a qualified person(s) using primary current injection in accordance with the instructions provided with the equipment and NEC requirements. A written record of the testing shall be provided.

3.03 PANEL IDENTIFICATION

A. Refer to Specification Section 26 05 53.

END OF SECTION 26 24 16

SECTION 26 24 17
LIGHTING PANELBOARDS

PART 1 GENERAL

1.01 GENERAL

A. The work under this section includes but is not limited to the following:

1. Lighting Panelboards
2. Circuit Breakers

PART 2 PRODUCT

2.01 SEISMIC CERTIFICATION

A. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All panelboards shall be Seismically Certified. Supplier shall submit Seismic Certfication for this equipment in accordance with Specification Section 01 45 36 (“Equipment Seismic Certification”).

2.02 PANELBOARDS

A. Enclosure:

1. Panelboards shall be dead front type and shall be in accordance with Underwriter’s Laboratories, Inc., standard of panelboards and enclosing cabinets and so labeled.
2. Panelboards installed in dry locations shall have enclosures fabricated from sheet steel and shall be finished in ASA #49. Panelboards installed in corrosive, exterior or wet locations shall have NEMA 4 stainless steel enclosures.
3. The door shall have a cylinder type lock. Lock shall be held in place by concealed screw to a captive nut, welded to inside of door. All locks shall be keyed alike.
4. A metal framed circuit directory card holder with clear plastic covering shall be factory-mounted on the inside of door.
5. Panels for 20 or more circuits, including spares and spaces, shall be 20 inches wide.
6. Panelboards enclosures shall be as shown on panel schedule on plans for surface, flush or motor control center mounting.
7. Provide hinged trim with piano-hinge down full length of one side to allow access to wiring without complete removal of outer trim.
8. Each section of multi-section panelboards shall be of matching heights and depths.

B. Bussing/Lugs:

1. Ampacity and service voltage of main buss, lugs or main breakers and branch circuit breakers shall be as shown on drawings.
2. All bussing and associated connectors shall be tin-plated copper.
3. All panelboards shall contain ground buss.
4. Entire panelboard shall be capable of withstanding a short circuit not less than the interrupting capacity of any breaker in the panel. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. Interrupting ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.
5. Buss connectors shall be for distributed phase arrangement.
6. Main and sub-feed lugs shall be provided with AL/CU compression lugs suitable for the quantities and sizes of conductors required.
7. Top/bottom feed arrangement and lug sizes/quantities shall be coordinated by the contractor.
8. Entire panelboard assembly, including all bussing, shall have SCCR ratings meeting or exceeding the minimum AIC ratings listed on the plans for the panel. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. All ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.
9. Service entrance panelboards shall be provided with barrier such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

C. Breaker arrangement and numbering:

1. Panelboards shall be factory assembled with branch breakers arranged exactly as indicated on plans.
2. Breakers shall be numbered vertically beginning top left. Multi-section panelboards shall be numbered consecutively through all sections.
3. Breaker numbers shall be permanently attached to trim.
4. Main breakers shall be vertically-mounted (branch-mounted or back-fed main breakers will not be acceptable unless specifically so shown on plans).

2.03 CIRCUIT BREAKERS

A. Circuit breakers shall be quick break, quick make, thermal magnetic type, for alternating current. Breakers shall trip free for the handle and tripping shall be indicated by the handle assuming a position between OFF and ON.

B. Circuit breakers shall be of the bolt-on type.

C. Multi-pole breakers shall be internal common trip with single operating handle; external handle ties are not acceptable, unless specifically noted otherwise (such as for multi-wire branch circuits described below).

D. Circuit breakers feeding multiwire branch circuits (as defined by NEC) consisting of separate single phase loads sharing a common neutral shall be provided with multi-pole breakers or handle ties to simultaneously disconnect all ungrounded conductors per NEC Article 210.4(B). The necessary locations of these multi-pole breakers or handle ties shall be coordinated by the contractor. Where necessary, the contractor may rearrange circuit breakers (as minimally as possible) as required to meet this requirement.

E. All breakers shall meet the minimum RMS symmetrical interrupting capacity ratings shown on plans for the associated panel. All interrupting ratings shall be full ratings. Series ratings will not be allowed unless shown otherwise on drawings.

F. All branch circuit breakers shall be listed to UL489 or shall be specially-tested to be HACR listed.

2.04 SPECIAL REQUIREMENTS

A. Any special requirements on the drawings, such as for increased interrupting rating, ground fault protection, etc., shall supersede these specifications, but only insofar as that particular requirement is concerned.

B. Lighting panels larger than 400A shall conform to the requirements for power panels.

2.05 MANUFACTURER

A. Panelboards shall be as manufactured by Square 'D' or Cutler Hammer.

PART 3 EXECUTION

3.01 INSTALLATION

A. All panelboard dimensions and clearances shall be carefully checked and coordinated with the proper trades to ensure proper mounting space and support prior to roughing in equipment. In no case shall any circuit breaker be

located above 6’-7” A.F.F..

B. Wiring in panelboard wireways shall be done in a neat and workmanlike manner. Wiring shall be grouped into neat bundles and secured with approved tie wraps.

C. For all flush-mounted panelboards, a minimum of three (3) one-inch empty conduits shall be stubbed out above the nearest accessible ceiling space for future use.

3.02 PANEL IDENTIFICATION

A. Refer to Specification Section 26 05 53.

END OF SECTION 26 24 17

SECTION 26 24 19
MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section includes requirements for motor control centers (MCC's) and all required control devices as shown on the drawing and specified to be part of the MCC equipment. The MCC shall be 277/480 V, 3-Phase, 4-Wire, 60 Hz unless otherwise indicated.

1.02 SUBMITTALS

A. Submittals shall be furnished in accordance with Specification Section 26 05 00.

B. Submittals shall show separate views of the elevation, profile and conduit openings. The elevation shall show the section identification and the unit identification. The drawings shall give dimensions of size and location of the following:

1. Vertical section height, width and depth
2. Mounting channels
3. Conduit openings top and bottom
4. Wireway openings in sides
5. Horizontal buss
6. Ground buss

C. The submittals shall contain a summary of the design specification containing but not limited to the following:

1. NEMA type enclosure and class of wiring
2. Rated buss voltage
3. Current ratings for horizontal buss, vertical busses and ground buss
4. Buss material and plating

D. Buss bracing and sheet circuit rating

E. Seismic Certification

F. The submittals shall contain a listing of all modifications, options and special equipment.

G. The submittals shall contain a listing of each unit containing but not limited to

the following:

1. Unit Location
2. Nameplate
3. Major contents of unit (fuse starter, CB switch, M.C.P., etc.) complete with NEMA size and heater rating or current rating.
4. Size of load served (H.P. KVA, KW, etc.).

H. Provide the following for each starter/controls unit:

1. A job-specific, custom wiring diagram
   a. The wiring diagram shall clearly show all control components (whether the components are mounted internal or external to the MCC enclosure).
   b. All wires and terminal blocks shall be clearly labeled.
   c. Diagram shall be in accordance with NEMA/ICS standards.

2. Size, type and rating of all system components.
3. Unit frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Manufacturer’s product data sheets for all components.

I. Submittals shall be complete and electrical contractor shall review and approve all accessories required for control wiring prior to submittal

1.03 REGULATORY REQUIREMENTS

A. The MCC shall conform to Underwriters Laboratory (UL) 845, current revision, CSA, EEMAC, NEMA ICS-2, the latest version of the National Electrical Code, and the Canadian Electrical Code. The MCC shall be manufactured in an ISO 9001 certified facility.

1.04 WARRANTY

A. An eighteen-month warranty shall be provided on materials and workmanship from date of owner acceptance/substantial completion after completion of startup.

PART 2 PRODUCT

2.01 MANUFACTURERS

A. Square 'D' or Cutler Hammer.

B. Additions to existing MCCs shall be the same as the original manufacturer.

2.02 SEISMIC CERTIFICATION

A. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All MCC equipment shall be Seismically Certified. Supplier shall submit Seismic Certfication for this equipment in accordance with Specification Section 01 45 36 (“Equipment Seismic Certification”).

2.03 MATERIALS

A. Steel material shall comply with UL 845 and CSA requirements.

B. Each MCC shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, free-standing assembly. A removable 7 gauge structural steel lifting angle shall be mounted full width of the MCC shipping block at the top. 10 gauge bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the shipping block. Vertical sections made of welded side-frame assembly formed from a minimum of 12 gauge steel. Internal reinforcement structural parts shall be of 12 and 14 gauge steel to provide a strong, rigid assembly. The entire assembly shall be constructed and packaged to withstand normal stresses included in transit and during installation.

C. Each entire MCC assembly (including all sub-components) shall be rated to withstand (and provide proper breaker functionality within) the fault current ratings listed on the plans. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. The fault current ratings listed shall be assumed to be at the input terminals of the associated MCC.

2.04 MCC FINISH

A. All steel parts shall be provided with UL and CSA listed acrylic/alkyd baked enamel paint finish, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat.

B. Pre-treatment shall include:

1. Hot alkaline cleaner to remove grease and oil.
2. Iron phosphate treatment to improve adhesion and corrosion resistance.

C. The paint shall be applied using an electro-deposition process to ensure a uniform paint coat with high adhesion.

D. The standard paint finish shall be tested to UL 50 per ASTM B117 (5% ASTM Salt Spray) with no greater than 0.125 in (3 mm) loss of paint from a scribed line.

E. Paint color shall be #49 medium light gray per ANSI standard Z55.1-967 (60-70 gloss) on all surfaces unless specified otherwise. Paint color of additions to existing MCCs shall match that of the existing MCC. Control station plates and escutcheon plates shall be a contrasting gray.

2.05 STRUCTURES

A. Structures shall be totally enclosed, dead-front, free-standing assemblies. Structures shall be capable of being bolted together to form a single assembly.

B. The overall height of the MCC shall not exceed 90 in (2286 mm) (not including base channel or lifting angle). Lifting angles, of 3 in (76 mm) in height, shall be removable. The total width of one section shall be 20 in (508 mm); (widths of 25 in (630 mm), 30 in (760 mm), and 35 in (890 mm) can be used for larger devices). The total depth of each section shall be 20 in (508 mm) unless shown otherwise.

C. Structures shall be NEMA/EEMAC type 1 unless shown/specified otherwise.

D. Each 20 in wide standard section shall have all the necessary hardware and bussing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Vertical bus openings shall be covered by manual bus shutters.

E. Each section shall include a top plate (single piece or two-piece). NEMA/EEMAC type 12 shall also include a bottom plate. Top and bottom plates shall be removable for ease in cutting conduit entry openings.

F. All MCC components, terminations, wiring, etc. shall be fully accessible from the front of the MCC unless noted otherwise.

2.06 WIREWAYS

A. Structures shall contain a minimum 12 in (305 mm) high horizontal wireway at the top of each section and a minimum 6 in (152 mm) high horizontal wireway at the bottom of each section. These wireways shall run the full length of MCC to allow room for power and control cable to connect between units in different sections.

B. A full-depth vertical wireway shall be provided in each MCC section that accepts modular plug-in units. The vertical wireway shall connect with both

the top and bottom horizontal wireway. The vertical wireway shall be 4 in (102 mm) wide minimum with a separate hinged door. There should be a minimum of 80 in^2 (516 cm^2) of cabling space available for 20-inch-deep sections. Access to the wireways shall not require opening control unit doors. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units shall open directly into the MCC horizontal wireways.

C. All wireway doors shall be hinged and shall be held shut by captive hardware.

2.07 BARRIERS

A. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece rigid non-conductive barrier. The barrier design shall allow qualified personnel to slide the barriers both left and right, to allow access to the bus and connections for maintenance without having to remove the barrier. Barrier sliding shall occur via an upper and lower track system.

B. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short circuit. These supports shall have openings every 3 in (75 mm) for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.

C. Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a fishtape inserted through the conduit or wireway areas.

2.08 BUSSING

A. All bussing and connectors shall be tin-plated copper.

B. The main horizontal bus shall be rated as indicated on plans and shall extend the full length of the MCC. Bus ratings shall be based on 65° C maximum temperature rise in a 40° C ambient. Provisions shall be provided for splicing additional sections onto either end of the MCC.

C. The horizontal bus splice bars shall be pre-assembled into a captive bus stack.

This bus stack is installed into the end of the MCC power bus to allow the installation of additional sections. The main bus splice shall utilize four bolts, two on each side of the bus split, for each phase. Additional bolts shall not be required when splicing higher amperage bus. The splice bolts shall secure to self clenching nuts installed in the bus assembly. It shall be possible to maintain any bus connection with a single tool.

D. A neutral bus and/or neutral lugs (with amperage rating equal to that of the main horizontal bus) shall be provided for all 4-wire motor control centers.

E. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of copper and plating as the main bus, and shall be rated 300 A or 600 A continuous based on UL standards (and the associated loads connected to the bus). The vertical bus shall be connected directly to the horizontal bus stack without the use of risers or other intervening connectors. It shall be possible to maintain the vertical to horizontal bus connection with a single tool. "Nut and bolt" bus connections to the power bus shall not be permitted. When a back-to-back unit arrangement is utilized, separate vertical bus shall be provided for both the front and rear units.

F. A tin-plated copper ground bus shall be provided that runs the entire length of the MCC. The ground bus shall be rated for 25% (minimum) of the main horizontal bus amperage. Compression lugs shall be provided in the MCC for a ground cable, sized to accommodate the grounding connections shown on plans. The ground bus shall be provided with six (6) holes for each vertical section to accept customer-supplied ground lugs for any loads requiring a ground conductor.

G. Each vertical section shall have a tin-plated copper vertical ground bus that is connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.

H. The system shall be rated for an available short circuit capacity as indicated on plans. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. Interrupting ratings shall be full ratings. Series ratings will not be allowed unless specifically shown otherwise on drawings.

2.09 TYPICAL UNIT CONSTRUCTION

A. Units with circuit breaker disconnects through 400 A frame, and fusible

switch disconnects through 400 A, shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

B. All circuit breakers rated (or able to be adjusted to) 1200A or higher shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.

C. All circuit breakers shall have adjustable magnetic trip settings. Provide a field adjustable breaker to allow for one breaker for each NEMA size starter. The adjustment range shall include current range to encompass the entire range of each size starter. There shall also be adjustments to select either standard or high inrush magnetic settings, from 6 times to 13 times motor full load current. If a standard, non adjustable, magnetic only trip breaker is furnished for a combination starter unit, the manufacturer shall include in the bid cost to furnish and install replacement breakers at jobsite if equipment changes dictate.

D. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.

E. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All plug-on units shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-on unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment.

F. A lever handle operator shall be provided on each disconnect. With the unit stabs engaged onto the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit. All circuit breaker operators shall include a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door. Clear indication of disconnect status shall be provided, by adhering to the following operator handle positions:

1. Handle "On" position shall be up or to the left and within 45 degrees of being parallel to the face of the equipment.
2. Handle "Off" position shall be down or to the right and within 45 degrees of being parallel to the face of the equipment.
3. The minimum separation between the "On" and "Off" positions shall be 90 degrees.

4. On Circuit Breaker disconnects, the handle "Tripped" position shall be perpendicular to the face of the equipment +/- 30 degrees. Minimum separation between "On" and "Tripped" shall be 30 degrees. Minimum separation between "Tripped" and "Off" shall be 45 degrees.

G. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.

H. A non-defeatable interlock shall be provided to prevent installing or removing a plug-in unit unless the disconnect is in the OFF position.

I. The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.

J. Provisions shall be provided for locking all disconnects in the OFF position with up to three padlocks.

K. Handle mechanisms shall be located on the left side to encourage operators to stand to the left of the unit being switched.

L. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.

M. All unit doors shall be hinged and shall be held shut by captive hardware.

N. Interiors of all units shall be painted white.

2.10 COMPONENTS FOR TYPICAL UNITS

A. Main Lugs

1. Main and sub-feed lugs shall be provided with AL/CU compression lugs suitable for the quantities and sizes of conductors required.

B. Circuit Breakers

1. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.

2. Circuit breakers shall be quick-make and quick-break, whether actuated automatically or manually. Circuit breakers shall have inverse time tripping characteristics with automatic release which shall trip free of the handle. Circuit breaker handles shall be three distinct positions—"OFF", "ON", and "TRIPPED". When a circuit breaker opens on overload or short circuit, the operating handle shall automatically assume the "TRIPPED" position.

C. Combination Starters

1. All combination starters shall utilize a unit. Magnetic starters shall be furnished in all combination starter units unless specifically shown otherwise. All starters shall utilize full NEMA/EEMAC rated contactors (size 1 minimum).
2. Starters shall be provided with a three-pole, external (door mounted) manual reset, solid state overload relay . Solid state overload relay shall have switch-selectable trip class and shall provide protection from:
   a. Overload.
   b. Phase Unbalance.
   c. Phase Loss.
   d. Ground Fault (Class II detection).
3. Unless specifically shown otherwise, each combination starter shall be furnished with a control circuit transformer including two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads (including motor space heaters and other similar loads where specified). The transformer rating shall be fully visible from the front when the unit door is opened. Unless otherwise indicated, control voltage shall be 120V AC. Control power shall be provided by individual unit control power transformers.
4. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
5. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.
6. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.
7. Each starter shall be equipped with a minimum of the following control devices:

a. Door-mounted reset button.
b. Two (2) field-reversible (N.O./N.C.) auxiliary contacts
c. For reversing and two-speed starters: Four (4) field-reversible (N.O./N.C.) auxiliary contacts
d. Additional control devices as indicated on plans.

D. Terminal Blocks

1. Wiring within all units shall be type B, with unit-mounted control terminal blocks for each field wire.
2. Terminal blocks shall be the pull-apart type 600 volt and rated at 25 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.

E. Nameplates

1. Each unit shall be properly labeled with an engraved phenolic nameplate with a white background and black letters.
2. Each pilot device shall be properly labeled with a legend plate or an engraved phenolic nameplate.

F. Wiring

1. All wiring shall be identified on each end with hot stamped or shrink tube type permanent wire markers to correspond with numbering shown on wiring diagrams.

G. Wiring Diagram

1. A job-specific, custom wiring diagram for each unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to each unit (whether the components are mounted internal or external to the soft start enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.

H. Control Components:

1. All pushbuttons, pilot lights, selector switches and other control devices shall be separate, standard size (full 30mm) and shape, heavy duty oil-tight units.
2. All pilot lights to be cluster LED type & push to test.
3. Relays:
    a. Control relays shall have the following characteristics, unless noted otherwise:
        1) General purpose, plug-in type.
        2) Minimum mechanical life of 10 million operations.
        3) Coil voltage as indicated or required by application.
        4) Single-break contacts rated 12 amperes, resistive at 240 volts.
        5) Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each individual relay shall have 3PDT contacts. Where required, multiple control relays shall be provided (to provide the required quantities of contacts) for each “relay” function shown on plans/diagrams.
        6) Furnished with RC transient suppressor to suppress coil-generated transients to 200% of peak voltage.
        7) LED on/off indicator light and manual operator.
        8) Industry standard wiring and pin terminal arrangements.
        9) Equal to Square D 8501KP series with matching plug-in socket.
    b. Interposing/isolation relays used to isolate input/output field wiring from PLC inputs/outputs shall be terminal-block style. Terminal-block style relays shall have the following characteristics, unless noted otherwise:
        1) Minimum mechanical life of 10 million operations.
        2) Single-break contacts rated 6 amperes, resistive at 120 volts.
        3) One (1) N.O. contact per relay.
        4) Furnished with integral transient protection.
        5) LED on/off indicator light.
        6) DIN-rail mounted.
        7) Equal to Square D type Zelio RSL.
    c. Timer relays shall be electronic, adjustable plug-in devices meeting the following characteristics, unless noted otherwise:
        1) General purpose, plug-in type.
        2) Minimum mechanical life of 10 million operations.
        3) Single-break contacts rated 10 amperes, resistive at 240 volts.
        4) Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each relay shall have DPDT contacts (2 N.O. & 2N.C.). Where required, multiple timer or control relays

shall be provided (to provide the required quantities of contacts) for each “relay” function shown on plans/diagrams.

5) Rotary-thumbwheel adjustments for time value, timing range and function.
6) Time value adjustments from .05 seconds to 999 hours
7) Selectable Timing Functions, including the following:
   (a) On Delay
   (b) Interval
   (c) Off Delay
   (d) One Shot
   (e) Repeat Cycle-Off
   (f) Repeat Cycle-On
   (g) On/Off Delay
   (h) One Shot Falling Edge
   (i) Watchdog
   (j) Trigger On Delay
8) Accuracy shall be $\pm$ 2% and repeatability shall be $\pm$ 0.1%.
9) Furnished with integral transient protection.
10) LED indicator light(s) for “timing” and “on/off status”
11) Held in place with hold-down spring
12) Equal to Square D type JCK with matching plug-in socket.

2.11 SOFT START CONTROLLERS

A. Refer to Section 26 29 16.

2.12 QUALITY CONTROL

A. The entire MCC shall go through a quality inspection before shipment. This inspection shall include:

1. Physical Inspection of:
   a. Structure.
   b. Electrical conductors, including:
      1) bussing.
      2) general wiring.
      3) units.

2. Electrical Tests
   a. General electrical tests include:
      1) power circuit phasing.
      2) control circuit wiring.
      3) instrument transformers.
      4) meters.
      5) ground fault system.

6) device electrical operation.

b. AC dielectric tests shall be performed on the power circuit.

3. Markings/Labels, include:
   a. instructional type.
   b. Underwriters Laboratory (UL)/Canadian Standards Association (CSA).
   c. inspector's stamps.

4. The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

B. The motor control center design shall be in accordance with the latest applicable standards of NEMA and Underwriters Laboratories.

2.13 SPECIAL REQUIREMENTS

A. Where the schedules and diagrams show deviations from these Specifications, the schedules and diagrams shall take precedence, but only for the particular feature.

PART 3 EXECUTION

3.01 PACKING/SHIPPING

A. The MCC shall be separated into shipping blocks no more than three vertical sections each. Shipping blocks shall be shipped on their sides to permit easier handling at the jobsite. Each shipping block shall include a removable lifting angle, which shall allow an easy means of attaching an overhead crane or other suitable lifting equipment.

3.02 STORAGE

A. If the MCC cannot be placed into service reasonably soon after its receipt, store it in a clean, dry and ventilated building free from temperature extremes. Acceptable storage temperatures shall be determined by the manufacturer. Anti-condensation space heaters shall be provided during equipment storage as directed by the manufacturer.

3.03 LOCATION

A. Motor control centers shall not be placed in hazardous locations. The area chosen shall be well ventilated and totally free from humidity, dust and dirt. Where the minimum temperature of the area is less than 0° C (32° F), space

heaters shall be provided within the motor control center. Where the minimum temperature of the area is greater than 40° C (104° F) ventilation fans and/or air conditioning units shall be provided within the motor control center as required to provide adequate cooling for each unit. For indoor locations, protection shall be provided to prevent moisture entering the enclosure .

B. Motor control centers shall be located in an area with a minimum of 4 ft (1219 mm) of free space in front of front-of-board construction. This free space shall give adequate room to remove and install units. A minimum of 0.5 in (13 mm) space should be provided between the back of front-of-board MCCs and a wall, 6 in (152 mm) required for damp locations.

C. The MCCs shall be assembled in the factory on a smooth level surface so that all sections are properly aligned. A similar smooth and level surface shall be provided for installation. An uneven foundation will cause misalignment of shipping blocks, units, and doors. The surface under a MCC shall be of a non-combustible material unless bottom plates are installed in each vertical section.

3.04 INSTALLATION

A. Motor control centers shall be installed on six inch thick concrete pads unless specifically shown otherwise. Pad shall extend a minimum of four inches to all sides and shall have beveled edges.

B. Orientation of motor control centers shall be as shown on the Engineer's drawings. Space requirements are critical on this project and therefore special care shall be taken to ensure that equipment will fit in the designated space. To ensure proper coordination, the MCC manufacturer shall submit with shop drawings a 1/2"=1'-0" scale floor plan of each electrical room showing all columns, doors, walls and proposed equipment. Manufacturer shall not bid equipment that will not fit in available space.

C. All motor control center dimensions and clearances shall be carefully checked and coordinated with the proper trades to ensure proper mounting space and support prior to roughing in equipment.

D. Motor control centers shall be grounded in two places as specified on drawings.

E. Verify all accessories as shown on drawings. Perform all necessary additions and modifications to make the motor control center to the Engineer's drawings.

F. A job-specific, custom wiring diagram for each unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to each unit (whether the components are mounted internal or external to the soft start enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.

G. Operations and Maintenance Manuals and a listing of the nearest and most convenient source of replacement parts and service shall be provided to the owner for all MCC components, control wiring, etc.

H. Operations and Maintenance Manuals shall include hardcopy printouts of all device settings and programming.

I. For safety, reliability, and continuity of warranty, any modifications, alterations, etc. required to conform to the requirements of this specification shall be performed by the MCC manufacturer only. Distributor modifications, third party packaging, etc. of a manufacturer's standard product are specifically disallowed.

J. Services shall include a minimum of eight (8) hours of field/classroom training for owner's personnel on routine operation and maintenance of the specified units.

3.05 SPARE PARTS

A. The following spare parts shall be provided at no extra cost to the Owner:

1. One of each type and size of control fuse.

END OF SECTION 26 24 19

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 DESCRIPTION

A. Wiring Devices

B. Plates

C. Finishes

PART 2 PRODUCTS

2.01 WIRING DEVICES AND PLATES

A. Switches shall be AC type, extra-heavy duty industrial grade (unless otherwise shown) of ratings shown on drawings. Switches shall be as manufactured by Hubbell, P & S, Sierra, Bryant, GE, Arrow Hart or equal.

B. Receptacles shall have blade configuration and shall be heavy duty industrial grade (unless otherwise shown) of current and voltage rating as shown on drawings. Receptacles shall be as manufactured by Hubbell, P & S, Sierra, Bryant, GE, Arrow Hart or equal.

C. All GFCI-type receptacles shall continuously self-test and shall trip/deny power if the receptacle does not provide proper GFCI protection or if the line/load terminations are miswired and shall provide visual indication of power status, trip conditions, ground fault conditions and end-of-life status.

D. Each wiring device shall have a plate (see “Finishes” section below for specific requirements).

2.02 FINISHES

A. All wiring devices (switches, receptacles, etc.) shall be colored to match the coverplates described below. For instance, all items covered by stainless steel, aluminum or malleable iron plates shall be gray in color.

1. Exceptions:
    a. Emergency wiring devices shall be red.
    b. Isolated ground wiring devices shall be orange.

B. Coverplates for recessed, wall-mounted electrical items (switches, receptacles, telephone outlets, etc.) shall be stainless steel unless shown otherwise.

C. Coverplates, trim rings, etc. for recessed, floor-mounted electrical items (floor outlets, underfloor duct junctions, etc.) shall match finish of building hardware (302/304 stainless steel, brass, etc.) in area installed.

D. Coverplates for exposed electrical items (switches, receptacles, telephone outlets, etc.) shall be of same material as exposed boxes (see Outlet Box Specification for required material type) and shall have beveled edges.

E. Coverplates for receptacles in wet locations shall be metallic, in-use type, rated for wet locations per NEC requirements unless noted otherwise.

F. See “Electrical Identification” specification section for coverplate labeling requirements.

PART 3 EXECUTION

3.01 GENERAL MOUNTING

A. Symbols on drawings and mounting heights are approximate. The exact locations and mounting heights shall be determined on the job, and it shall be the Contractor's responsibility to coordinate with all trades to secure correct installation. For example, Contractor shall coordinate exact mounting heights over counters, in or above backsplashes, in block walls, and at other specific construction features.

B. Verify all door swings with Architectural. Locate boxes for light switches within four inches of door trim on swing side (not hinge side) of door.

C. Devices and associated plates shall not be used as support; outlet boxes shall be rigidly supported from structural members.

D. Mount all straight-blade receptacles vertically with ground pole up, unless specifically noted otherwise.

E. Unless otherwise shown or required by local handicap codes, outlet boxes shall be the following distances above the finished floor unless otherwise noted.

1. Receptacles and telephone outlets in offices and other finished areas: 1’-6” to the center of the box.
2. Receptacles and telephone outlets in equipment rooms and other unfinished areas: 4’-0” to the center of the box.
3. Receptacles over counters: As Noted
4. Switches, general: 4’-0” to the top of the box.
5. Fire Alarm Pull Stations: 4’-0” to the top of the box.

6. Fire Alarm Audio/Visual Devices: As shown on fire alarm shop drawings (Entire lens shall be above 80” and below 96” per NFPA 72).
7. Push-button, etc., general: 4’-0” to the top of the box.
8. Other device types: verify with engineer prior to rough-in.

END OF SECTION 26 27 26

SECTION 26 28 13
FUSES

PART 1 GENERAL

1.01 GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:

1. Fuses

PART 2 PRODUCTS

2.01 FUSES

A. Fuses - 600 volts and less - shall be furnished and installed by electrical contractor who will maintain fuses in original new condition until installed. Fuses shall not be installed until equipment is ready to be energized.

B. Fuses 601 to 6000 amperes shall be time-delay, Class L type with an “O” ring to provide seal between the end bells and the glass melemine fuse barrel. Terminals shall be penned. Fuses must hold 500% rating for a minimum of 4 seconds and clear 20 times rated current in .01 seconds or less. Fuses shall be current-limiting and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes r.m.s. symmetrical. Bussmann Hi-Cap, time-delay, Class L fuses.

C. All other fuses for power, light and motor circuits shall be dual-element, Class RK5 type with separate overload and short-circuit elements. The overload element shall incorporate a spring activated thermal unit having a 284 Degree Fahrenheit melting point alloy and with a heat sink that will provide time-delay of a minimum of 10 seconds at 500% rating. Fuses shall be current-limiting and be listed by Underwriters Laboratories, Inc. with an interrupting rating of 200,000 amperes r.m.s. symmetrical. Bussmann Low-Peak, dual-element, Class RK5 fuses.

D. Fuses shall be installed in fluorescent fixtures on the line side of the ballast by the fixture manufacturer who will size the fuses for each application. Bussmann GLR fuses installed in HLR fuseholder.

E. Fuses for all other ballast-controlled lighting fixtures shall have fuses installed on the line side of the ballast either in the housing or handhole of lighting standards for easy access. Bussmann FNQ fuse with HPF holder for all applications. Bussmann FNQ fuse with HPF holder for all applications except

lighting Standards where Bussmann HEB-JJ holder with FNQ fuse will be used.

2.02 MANUFACTURER

A. Fuses shall be as manufactured by Bussmann Manufacturing or approved equal. Approved substitutions will be allowed that provide required electrical safety overload and short-circuit performance. Electrical contractor shall submit one copy each of fuse and fuse holder manufacturers bulletins that fully describe performance for substitution approval consideration. The bulletins shall be submitted to the Electrical Design Engineer at time of bid submittal.

PART 3 EXECUTION

3.01 SPARE FUSES

A. Spare fuses shall be provided by the electrical contractor. 10% (minimum of 3) of each size and type will be placed in a Spare Fuse Cabinet mounted on the wall of the electrical room.

END OF SECTION 26 28 13

SECTION 26 28 16
SAFETY SWITCHES AND FUSES

PART 1 GENERAL

1.01 DESCRIPTION

A. Safety Switches

B. Fuses

C. Branch Feeders

D. Feeders

PART 2 PRODUCTS

2.01 SAFETY SWITCHES

A. Safety switches shall be quick-make, quick-break, NEMA heavy duty type HD, fused or nonfused as shown. Switch blades shall be fully visible in the off position.

B. Safety switches shall be furnished with transparent internal barrier kits to prevent accidental contact with live parts. Barriers shall provide finger-safe protection when the switch door is open and shall allow use of test probes and removal of fuses without removing barrier.

C. Fused switches shall have provisions for class R, rejection type fuses.

2.02 FUSES (600V)

A. Fuses for all branch switches shall be Bussman Mfg. Co., Dual Element, Class “R” Fusetron.

B. Fuses for main switch/switches shall be Bussman Mfg. Co. Hi-Cap.

2.03 MANUFACTURER

A. Safety switches shall be as manufactured by Square 'D' or Cutler Hammer.

B. Fuses shall be as manufactured by Bussman Mfg. Co. or equal.

PART 3 EXECUTION

3.01 SAFETY SWITCHES

A. Safety switches shall be installed as shown on the plans and in accordance with N.E.C.

B. Locations shown for safety switches on plans are diagrammatical only. Exact locations shall be field coordinated by contractor as required to provide code-required clearances.

C. Switch enclosures shall be rated NEMA I indoors in dry locations and NEMA 4X stainless steel outdoors and in wet or process areas.

D. Adequate support shall be provided for mounting safety switches. Safety switches shall not be mounted to the associated equipment (unless the safety switch is furnished with the equipment).

3.02 FUSES

A. Fuses shall be sized as shown on drawings, unless a smaller size is required by the associated equipment supplier, in which case the contractor shall provide fuses sized as directed by the associated equipment supplier at no additional cost.

B. Provide not less than one spare set of fuses for each size used. Provide an additional spare set for each five sets of same size fuses used.

END OF SECTION 26 28 16

SECTION 26 29 00
MANUFACTURED CONTROL PANELS

PART 1 GENERAL

1.01 SCOPE

A. This section describes control stations, PLC panels, motor control panels, manufactured control panels, and other similar panels specified herein. Specifications herein are intended as an extension of requirements in other Divisions of these specifications where reference is made to Electrical Specifications.

1.02 DEFINITIONS

A. “Control Stations”: Enclosures (with all required accessories) containing only door-mounted pushbuttons, indicator lights and/or selector switches (no electronic components or starter/controller equipment).

B. “Control Panels”: Enclosures (with all required accessories) containing equipment/devices other than door-mounted pushbuttons, indicator lights and/or selector switches (such as electronic components, starter/controller equipment, etc.).

1.03 SUBMITTALS

A. Provide the following for each control panel:

1. A job-specific, custom wiring diagram
    a. The wiring diagram shall clearly show all components (whether the components are mounted internal or external to the control panel enclosure).
    b. All wires and terminal blocks shall be clearly labeled.
    c. Diagram shall be in accordance with NEMA/ICS standards.
2. Size, type and rating of all system components.
3. Unit frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Manufacturer’s product data sheets for all components.

B. A Bill of Materials shall be included with catalog information on all components.

C. Information shall be included on any proprietary logic component sufficient to demonstrate its ability to perform the required functions.

D. The following calculations shall be submitted:

1. Thermal calculations showing amount of air conditioning or ventilation and heating required for each control panel, per ambient requirements listed below and operating temperature limitations of all equipment/devices within each control panel. Where possible, forced air ventilation shall be utilized rather than air conditioning. Panel shall be oversized, interior equipment/devices shall be derated, and solar shielding shall be provided as required to allow the use of forced air ventilation as the cooling method. Air conditioning, ventilation, and/or heating equipment shall each have ratings/capacities at least 20% larger than required by calculations below unless noted otherwise:
   a. Thermal calculations used for sizing cooling/ventilation systems for each control panel located in exterior or non-conditioned spaces shall assume:
      1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.
      2) Full solar contact where applicable (not applicable where enclosures are fully protected from solar contact using solar shields separated from panel enclosure with standoffs or similar).
      3) No wind.
      4) Heat loss from interior equipment (electronics, etc.) per equipment supplier's information.
   b. Thermal calculations used for sizing heating systems for each control panel shall assume:
      1) Ambient exterior air temperature ranges of -5 degrees F to 105 degrees F.
      2) No heat loss by interior components of control panel.
      3) No solar gain on exterior of control panel.
      4) Doubling of heating wattage required to account for wind where control panels are located outdoors.
      5) Minimum temperature difference (due to heating) of 10 degrees F to prevent condensation, regardless of equipment temperature limitations.

2. Load calculations showing the sizing of all power supplies provided (with spare capacity as specified). Power supplies shall each have ratings/capacities at least 20% larger than required by load calculations unless noted otherwise.
3. Load calculations showing the sizing and anticipated runtime of all Uninterruptible Power Supply systems provided (with spare capacity as specified).

PART 2 PRODUCTS

2.01 GENERAL

A. Control panels shall be Underwriters' Laboratories labeled by the panel manufacturer. Control panel manufacturers not capable of applying the U.L. label to their products are unacceptable.

B. All human interface equipment/devices (indicator lights, selector switches, pushbuttons, time switches, displays, keypads, and other similar items used for control, adjustments or monitoring) shall be mounted on the non-energized side of enclosure door(s) in such a way as to be accessible without exposing the user to energized parts.

2.02 RATINGS

A. All Control Panels shall have short circuit current ratings at least equal to the lesser of the following, unless noted otherwise on plans:

1. The short circuit current rating of the electrical distribution equipment that feeds the Control Panel.
2. 150% of the available fault current at the Control Panel as determined by a Short Circuit Current study prepared by a licensed professional electrical engineer.

B. All equipment/devices installed within control panels shall be rated to operate in ambient temperatures of 50 degrees C (122 degrees F) or higher.

2.03 ENCLOSURES

A. All enclosures (with any required accessories or auxiliary items) shall fit within the space shown on the Plans. Any costs associated with furnishing equipment which exceeds the available space shall be borne by the Contractor.

B. Enclosures (with any required accessories or auxiliary items) shall be suitable for the environment where installed.

C. Enclosure materials shall be as follows unless noted otherwise:

1. Control Stations:
   a. Where located in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.): NEMA 4X of non-metallic construction (with non-metallic hardware) compatible with the associated chemical(s).

b. Where located in other wet, process or outdoor areas: NEMA 4X of type 304 stainless steel construction (with stainless steel hardware).
c. Where located in dry, non-process, indoor areas (such as electrical rooms): NEMA 1 of die cast zinc/aluminum construction.

2. Control Panels:
a. Where located in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.): NEMA 4X of non-metallic construction (with non-metallic hardware) compatible with the associated chemical(s).
b. Where located in other wet, process or outdoor areas: NEMA 4X of type 304 stainless steel construction (with stainless steel hardware).
c. Where located in dry, non-process, indoor areas (such as electrical rooms): NEMA 1 or 12.

D. Control Panel Enclosure Construction:

1. Non-metallic control panel enclosure material, where specified, shall be reinforced polyester resin or equivalent, with a minimum thickness of 3/16 inch for all surfaces except those requiring reinforcement. Panels shall be precision molded to form a one piece unit with all corners rounded. Exterior surfaces shall be gel-coated to provide a corrosion-resistant maintenance-free satin finish which shall never need painting. Color pigments shall be molded into the resin. Color shall be grey.
2. Metallic control panel enclosures, where specified, shall be fabricated using a minimum of 14 gauge steel for wall or frame mounted enclosures and a minimum of 12 gauge for freestanding enclosures. Continuously weld all exterior seams and grind smooth. Reinforce sheet steel with steel angles where necessary support equipment and ensure rigidity and preclude resonant vibrations.
3. Use pan-type construction for doors.
4. Door widths shall not exceed 36-inches.
5. Mount doors with full length, heavy duty piano hinge with hinge pins.
6. Provide gasket completely around each door opening.
7. Mount and secure all internal components to removable back plate assembly.
8. For NEMA 1 or 12 enclosures, provide handle-operated key-lockable three point stainless steel latching system for each door.
9. For NEMA 4X enclosures, provide provisions for padlocking all doors and provide clamps on three (3) sides of each door.

E. Control panel enclosures (and associated backpanels and other similar

accessories) shall be manufactured by Hoffman Engineering Co., or Saginaw Control & Engineering.

2.04 CONTROL PANEL ACCESSORIES:

A. Cooling systems shall be provided if so required by the application to maintain temperatures within the acceptable ranges of the interior equipment. In no case (regardless of temperature ratings of internal equipment) shall maximum temperatures within control panels be allowed to exceed 50 degrees C (122 degrees F). Thermostats shall be provided to control cooling without need of manual operation. Thermostat setpoints shall be as per recommendations of the equipment suppliers. See above for thermal calculation requirements. Cooling units shall be as manufactured by Hoffman Engineering Co., Rittal or approved equal and shall be thermostatically controlled.

B. Space heaters shall be provided for condensation and temperature control. Thermostats AND hygrostats (or combination hygrotherm controllers) shall be provided to control heating requirements (based on temperature and relative humidity within enclosure) without need of manual operation. Setpoints shall be as per recommendations of the equipment suppliers. See above for thermal calculation requirements. Space heaters and associated control devices shall be as manufactured by Hoffman Engineering Co., Rittal, Stego or approved equal.

C. NEMA 4X control panels shall be provided with vapor-phase corrosion inhibitor(s) (chemical combinations that vaporize and condense on all surfaces in the enclosed area, to protect metal surfaces/devices within the enclosed area from corrosion). Corrosion inhibitor shall be Hoffman #AHCI series (sized as required by the enclosure volume to be protected) or equal.

D. For outdoor panels, stainless steel solar shields for front, top and each side of panel, supported to associated panel face with standoffs as required (to allow free air flow between solar shield and panel enclosure), shall be provided where required to limit solar loading on panel to allow use of a ventilated panel design rather than an air-conditioned panel design.

E. Provide a sun shield over all LCD displays in exterior-mounted panels. Sun shield shall be collapsible to fully protect LCD display from UV light when not in use, shall provide side and top shielding when in use, shall be constructed of stainless steel and shall be installed such as to maintain NEMA 4X ratings of enclosures.

F. Provide a clear polycarbonate gasketted hinged door or window to encompass all indicators, controllers, recorders, etc. mounted on NEMA 4 and 4X

enclosures.

G. Provide interior mounting panels and shelves constructed of minimum 12 gauge steel with white enamel finish. Provide metal print pocket with white enamel finish on inside of door.

H. Provide interior LED light kit, mounted at top of interior of panel, and switched to turn “ON” when door is opened for the following control panels:

1. Control panels with outer dimensions greater than 20” wide or 30” high.
2. Control panels containing PLCs or other similar programmable devices.

I. Control panels containing VFDs or Reduced Voltage Soft Starters shall include a door mounted digital keypad for adjusting the starter parameters and viewing process values and viewing the motor and starter statuses without opening the enclosure deadfront door.

2.05 CONTROL COMPONENTS

A. General:

1. All pushbuttons, pilot lights, selector switches and other control devices shall be separate, standard size (full 30mm) and shape, heavy duty oil-tight units.
   a. Devices in extremely corrosive areas (chlorine rooms, fluoride rooms, etc.) shall be of non-metallic construction.
   b. Devices in other areas shall be of chrome-plated construction.

2. All components and devices so that connection can be easily made and so there is ample room for servicing each item.
3. Door-mounted indicators, recorders, totalizers and controllers shall be located between 48” and 72” above finished floor level.
4. Door-mounted indicator lights, selector switches and pushbuttons shall be located between 36” and 80” above finished floor level.
5. All devices and components shall be adequately supported to prevent movement. Mounting strips shall be used to mount relays, timers and other devices suitable for this type of mounting.

B. Pilot Lights:

1. All pilot lights to be cluster LED type & push to test.

C. Pushbuttons:

1. All STOP operators within control stations located at equipment shall be provided with lockout provisions and a minimum of two (2) sets of contact blocks.
2. Emergency shutoff pushbutton devices shall be as follows unless noted otherwise:
    a. 2 ¼" diameter, mushroom-style, maintained contact push buttons
    b. With a minimum of one (1) normally open dry contact and three normally closed dry contacts.
    c. Connections made such that pushing "in" the button will shutoff the associated equipment.
    d. Provided with a red engraved nameplate with ½" lettering to read "Emergency Shutoff".

D. Relays:

1. Control relays shall have the following characteristics, unless noted otherwise:
    a. General purpose, plug-in type.
    b. Minimum mechanical life of 10 million operations.
    c. Coil voltage as indicated or required by application.
    d. Single-break contacts rated 12 amperes, resistive at 240 volts.
    e. Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each individual relay shall have 3PDT contacts. Where required, multiple control relays shall be provided (to provide the required quantities of contacts) for each "relay" function shown on plans/diagrams.
    f. Furnished with RC transient suppressor to suppress coil-generated transients to 200% of peak voltage.
    g. LED on/off indicator light and manual operator.
    h. Industry standard wiring and pin terminal arrangements.
    i. Equal to Square D 8501KP series with matching plug-in socket.

2. Interposing/isolation relays used to isolate discrete output field wiring (and where required for voltage translation for other discrete signals) to/from PLC inputs/outputs shall be terminal-block style. Terminal-block style relays shall have the following characteristics, unless noted otherwise:
    a. Minimum mechanical life of 10 million operations.
    b. Single-break contacts rated 6 amperes, resistive at 120 volts.
    c. One (1) N.O. contact per relay.
    d. Furnished with integral transient protection.
    e. LED on/off indicator light.
    f. DIN-rail mounted.

g. Equal to Square D type Zelio RSL.

3. Timer relays shall be electronic, adjustable plug-in devices meeting the following characteristics, unless noted otherwise:
   a. General purpose, plug-in type.
   b. Minimum mechanical life of 10 million operations.
   c. Single-break contacts rated 10 amperes, resistive at 240 volts.
   d. Contacts as shown on wiring diagrams plus a minimum of one (1) spare N.O. contact and one (1) spare N.C. contact. At a minimum, each relay shall have DPDT contacts (2 N.O. & 2N.C.). Where required, multiple timer or control relays shall be provided (to provide the required quantities of contacts) for each "relay" function shown on plans/diagrams.
   e. Rotary-thumbwheel adjustments for time value, timing range and function.
   f. Time value adjustments from .05 seconds to 999 hours
   g. Selectable Timing Functions, including the following:
      1) On Delay
      2) Interval
      3) Off Delay
      4) One Shot
      5) Repeat Cycle-Off
      6) Repeat Cycle-On
      7) On/Off Delay
      8) One Shot Falling Edge
      9) Watchdog
      10) Trigger On Delay
   h. Accuracy shall be $\pm$ 2% and repeatability shall be $\pm$ 0.1%.
   i. Furnished with integral transient protection.
   j. LED indicator light(s) for "timing" and "on/off status"
   k. Held in place with hold-down spring
   l. Equal to Square D type JCK with matching plug-in socket.

2.06 CONFORMAL COATINGS

A. All printed circuit boards within electronic devices (PLCs, RTUs, controllers, I/O modules, power supplies, touchscreens, Ethernet switches, radios, etc.) installed in panels located in non-conditioned or exterior/process areas shall be conformal-coated for harsh environments.

2.07 DC POWER SUPPLIES

A. DC Power supplies shall be provided where specified elsewhere, or as required by design of system. Power supplies shall be industrial type, AC-to-

DC switching, output voltage as required, 120vac input, size as required for the initial application plus 50% spare capacity.

B. Redundant power supplies with diode isolation shall be provided so that the loss of one power supply does not affect system operation. The back-up supply systems shall be designed so that either the primary or the back-up supply can be removed, repaired, and returned to service without disrupting the system operation.

C. Power supply output shall be protected by secondary overcurrent protection device(s).

D. The power distribution from multiloop supplies shall be selectively fused so that a fault in one instrument loop will be isolated from the other loops being fed from the same supply.

E. Each power supply shall meet the following requirements.

1. Regulation, line: 0.4% for input from 105 to 132vac.
2. Regulation, load: 0.8%
3. Ripple/Noise: 15mV RMS / 200 mV peak to peak
4. Operating temperature range: 0 deg C - 60 deg C
5. Overvoltage protection
6. Overload Protection
7. Output shall remain within regulation limits for a least 16ms after loss of AC power at full load.
8. Output status indicator.
9. UL listing

F. Power supplies shall be manufactured by Puls, Sola, Phoenix Contact or equal.

2.08 UNINTERRUPTIBLE POWER SUPPLIES

A. Uninterruptible power supplies (UPSs) shall be provided where specified elsewhere, or as required by design of system. Power supplies shall be industrial type, size as required for the initial application plus 50% spare capacity unless noted otherwise.

B. Battery runtime shall be as specified elsewhere. If no other specification for battery runtime is specified, battery runtime shall be 12.5 minutes at full load.

C. UPSs shall be double-conversion, on-line type.

D. UPSs shall be rated for operation in -20 degrees C to 55 degrees C ambient

temperatures.

E. UPS batteries shall be hot-swappable and 12-year rated when installed in 25 degrees C environment and 4-year rated when installed in 50 degrees C environment.

F. UPSs shall include dry contacts for the following alarm points:

1. Loss of Input Power Alarm
2. Low Battery Alarm

G. UPSs shall be manufactured by Falcon UPS or approved equal.

2.09 DISCONNECTS

A. A main disconnect switch or circuit breaker shall be supplied integral to all control panels. The main disconnect or circuit breaker shall be accessible/operable without exposing the operator to energized sections of the control panel(s), and shall be lockable in the open/off position.

B. Individual circuit breakers shall be provided integral to the manufactured control panel for each separate power circuit originating within the control panel.

C. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated (or can be adjusted to is 1200A or higher, breakers shall be electronic trip and shall be provided with arc energy-reducing maintenance switching (with local status indicator) to reduce arc flash energy per NEC 240.87 requirements.

D. Manufacturers:

1. Square 'D' or Cutler Hammer.

2.10 COMBINATION STARTERS

A. All combination starters shall utilize a unit disconnect. Magnetic starters shall be furnished in all combination starter units unless specifically shown otherwise. All starters shall utilize full NEMA/EEMAC rated contactors (size 1 minimum).

B. Starters shall be provided with a three-pole, external (door mounted) manual reset, solid state overload relay. Solid state overload relay shall have switch-selectable trip class and shall provide protection from:

1. Overload.

2. Phase Unbalance.
3. Phase Loss.
4. Ground Fault (Class II detection).

C. Unless specifically shown otherwise, each combination starter or each group of starters shall be furnished with a control circuit transformer including two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads (including motor space heaters and other similar loads where specified). The transformer rating shall be fully visible from the front when the unit door is opened. Unless otherwise indicated, control voltage shall be 120V AC. Control power shall be provided by individual unit control power transformers.

D. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.

E. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.

F. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.

G. Each starter shall be equipped with a minimum of the following control devices:

1. Door-mounted reset button.
2. Two (2) field-reversible (N.O./N.C.) auxiliary contacts
3. For reversing and two-speed starters: Four (4) field-reversible (N.O./N.C.) auxiliary contacts
4. Additional control devices as indicated on plans.

H. Control Wiring Terminal Blocks

1. Terminal blocks shall generally be:
   a. Feed-thru, screw-in type
   b. DIN rail mounted
   c. Furnished with the stationary portion of the block secured to the unit bottom plate

d. Furnished with unit-mounted control terminal blocks for each field wire.
e. Rated for the voltage and current of the proposed application per UL/NEC standards.
f. Sized (by supplier) for the associated wire gauges/types/quantities.
g. Phoenix Contact UT-4 series, Weidmuller WDU-4 series (or equivalent) unless required otherwise by application.

I. Nameplates

1. Each unit shall be properly labeled with an engraved phenolic nameplate with a white background and black letters.
2. Each pilot device shall be properly labeled with a legend plate or an engraved phenolic nameplate.

J. Manufacturers:

1. Square 'D' or Cutler Hammer.

2.11 WIRING

A. Refer to Section 26 05 19 for all wiring types/applications.

B. All wiring shall be identified on each end with hot stamped, shrink tube type, or self-laminating vinyl permanent wire markers to correspond with numbering shown on wiring diagrams.

C. All connections shall be made on terminals with no splices.

D. All wiring runs shall be along horizontal or vertical routes to present a neat appearance. Angled runs will not be acceptable. Group or bundle parallel runs of wire in plastic wire duct where practical.

E. All wiring runs shall be securely fastened to the panel or wire duct by means of plastic wire ties. Adequately support and restrain all wire runs to prevent sagging or movement.

F. AC power wiring and instrumentation/analog wiring shall be run separate.

G. Color code all internal wiring (not field wiring) as follows:

1. Line and load circuits: Black (B)
2. AC control wiring: Red (R)
3. Externally-Powered control wiring: Yellow (Y)
4. Neutral wiring: White (W)
5. Low voltage DC(+)pos: Blue (BL)

6. Low voltage DC(-)neg: Blue/White Tracer (BL/W)
7. Grounding: Green (G)

H. Terminal strips shall be provided for all input and output wiring. No more than two (2) wires shall be connected to one (1) terminal block.

2.12 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. General

1. Function: Protect the system against damage due to electrical surges.

B. Application: As a minimum, provide surge and transient protection (with proper grounding) at the following locations as described below:

1. Power Input High Frequency Noise Filtering:
   a. 120VAC Control panels with integral UPSs, PLCs, or other electronic/microprocessor equipment that is susceptible to failure or improper operation due to high frequency/harmonic input transients shall be provided with series-connected high-frequency noise filters on the line input (downstream of any panel main disconnects/breakers). Filters shall be as manufactured by Edco/Emerson/Islatrol or equal (exact type(s) as required by application).

2. Power Input Surge Protection:
   a. Provide surge protection device at any connection of 120VAC power to panels containing programmable logic controllers, remote I/O equipment, UPS's, transmitters, radios, VFDs, Reduced Voltage Soft Starters or other electronic equipment. Device shall:
      1) Be mounted internal to the associated panel, with dedicated overcurrent protection.
      2) Be of two-part (base and SPD), DIN-rail mountable construction.
      3) Have 15kA total nominal discharge current per line (based on 8/20µs waveform).
      4) Have maximum continuous operating voltage (MCOV) rating as required by the associated circuit voltage.
      5) Visually indicate operational status.
      6) Be Dehn DEHNguard series or equal by MTL Technologies, or may be combined with the High Freqency Noise Filtering device required above.
   b. Provide surge protection device at any connection of multi-pole AC power to panels containing programmable logic controllers,

remote I/O equipment, UPS's, transmitters, radios, VFDs, Reduced Voltage Soft Starters or other electronic equipment. Device shall:

1) Be mounted internal to the associated panel, with dedicated overcurrent protection.
2) Provide protection for all phases.
3) Have 40kA (per phase) peak surge current rating.
4) Have maximum continuous operating voltage (MCOV) rating as required by the associated circuit voltage.
5) Visually indicate operational status.
6) Be Square D SDSA or HWA series or equal.

3. Analog I/O Panel Terminations Surge Protection:
   a. Provide surge protection device at the PLC (or similar) panel connection of each analog I/O signal. Device shall:
      1) Be mounted internal to the associated panel.
      2) Be of two-part (base and SPD), DIN-rail mountable construction.
      3) Have 10kA total nominal discharge current per line (based on 8/20µs waveform).
      4) Have maximum continuous operating voltage (MCOV) rating as required by the associated signal.
      5) Be Dehn Blitzductor XT series or equal by MTL Technologies.

4. Discrete I/O Panel Terminations Surge Protection:
   a. Provide isolation relay at the PLC (or similar) panel connection of each discrete output signal (within the associated panel). See above for isolation relay requirements.

5. Low Voltage Power Supply Load Side Surge Protection:
   a. Provide surge protection device at the PLC (or similar) panel on the load side of each low voltage power supply that has low voltage connections extending external to the panel. Device shall:
      1) Be mounted internal to the associated panel.
      2) Be of two-part (base and SPD), DIN-rail mountable construction.
      3) Have 10kA total nominal discharge current per line (based on 8/20µs waveform).
      4) Have maximum continuous operating voltage (MCOV) rating as required by the associated utilization voltage.
      5) Be as manufactured by Dehn, MTL Technologies, or Phoenix Contact.

6. Network Panel Terminations Surge Protection:

a. Provide surge protection device at the PLC (or similar) panel connection of each network cable. Device shall:
   1) Be mounted internal to the associated panel.
   2) Be of DIN-rail mountable construction.
   3) Have 1kA total nominal discharge current per line (based on 8/20µs waveform).
   4) Be designed specifically for the associated network connection type (Ethernet, RS485, RS232, etc.).
   5) Be MTL Zonebarrier series or equal.

7. Antenna Cable Terminations Surge Protection:
   a. Provide surge protection device at the connection of antenna cable to the radio panel. Device shall:
      1) Be mounted internal to the associated panel.
      2) Provide coarse protection via replaceable gas-filled surge voltage arrestor
      3) Be Phoenix Contact CN-LAMBDA series or equal.

C. Installation and grounding of suppressor: As directed by manufacturer. Provide coordination and inspection of grounding.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide enclosure mounting supports as required for floor, frame or wall mounting. All supports in exterior, wet or process areas shall be stainless steel unless noted otherwise. All floor-mounted panels or other similar distribution equipment shall be mounted on 6” concrete housekeeping pads unless specifically shown otherwise.

B. All enclosures used outside shall be solid bottom unless otherwise specified. All cable and piping openings shall be sealed watertight. Cable and piping shall enter the enclosure as shown on drawings or specified herein.

C. All equipment and components shall be solidly grounded to the control panel. One grounded terminal unit shall be provided in each control panel for connection to plant ground system. Grounding digital and analog components shall be performed in accordance with the instrument supplier’s installation recommendations. Signal ground shall be solidly connected to the ground system so as to prevent ground loops

3.02 PAINTING

A. For enclosures other than NEMA 4X stainless steel or fiberglass:

1. Completely clean all surfaces so that they are free of corrosive residue. Then, phosphatize all surfaces for corrosion protection.
2. Prime with two (2) coats and finish with one coat of factory finish textured polyurethane. Paint shall be Sherwin-Williams Polane “T’ or approved equal.
3. Color to be selected during shop drawing review phase.

3.03 IDENTIFICATION & DOCUMENTATION

A. Refer to specification section 26 05 53 for additional requirements.

B. Control panel power supply source, type, voltage, number or circuit ratings shall be identified inside control panels and on drawings.

C. All interior devices and components shall be identified with thermal transfer labels with black letters on white background. Labels shall be placed on the subpanel and not the component. Marking system shall be a Brother “PTouch II” or equal. Lettering shall be 1/4" high.

D. All front panel mounted devices such as push buttons shall be identified by the use of engraved bakelite nameplates or legend plates. Nameplates shall be 1/8” thick, white with black core.

E. Where a panel includes a PLC or other network-connected device that is intended to be connected to another system (such as a plant SCADA system) via a network connection, the panel supplier shall provide an Interface Control Document (ICD) to the other system supplier (such as the SCADA Integrator). This document shall itemize the following for each networked parameter that is capable of being monitored or controlled by the other system:

1. Parameter Name/Function (ex: Pump No. 1 On/Off Status)
2. Parameter Type (discrete or analog, input or output)
3. Parameter register ID/location

F. Where a panel includes a touchscreen or other programmable HMI display and is to be monitored by another system (such as a plant SCADA system), the panel supplier shall provide copies of the HMI display code and screenshots of all proposed HMI screens to the other system supplier (such as the SCADA Integrator) for their use in duplicating the associated HMI.

G. A job-specific, custom wiring diagram for each control panel (not including control stations without relays) shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to the panel (whether the components are mounted internal or external to the enclosure).

All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated panel, and submitted to the owner with the as-built documentation.

3.04 OWNER TRAINING

A. Fully train the owner in the proper operation of all control panels/equipment, describing and demonstrating full operation, including function of each door-mounted device.

3.05 SPARE EQUIPMENT

A. Provide the following spare equipment:

1. Fuses: 10% (minimum of 3) of each size and type utilized, mounted within a pocket within the associated control panel.
2. Where control panel contains programmable controller (or similar equipment): Flash drive containing copies of all final programs utilized within the control panel, with provisions/cable assemblies as required to connect the flash drive provided to the controller to download the programs. Flash drive shall be attached to retractable cord (long enough to reach the associated port) attached to the inside of the panel door.

END OF SECTION 26 29 00

SECTION 26 29 16
REDUCED VOLTAGE SOFT STARTERS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. These specification requirements are for solid state reduced voltage motor controllers rated 600VAC and below, herein referred to as soft starters.

B. They are for use with AC motors to reduce the current in-rush as well as mechanical shocks that can result from starting or stopping a motor across the line.

1.02 QUALITY ASSURANCE

A. The electronic “soft starter” shall be listed by an independent testing laboratory in accordance with UL 508 - Industrial Control Equipment.

B. The soft start shall carry the CE mark for indication of compliance to low voltage and EMC directives in accordance with EN / IEC 60947-4-2.

C. The manufacturer shall be a certified ISO 9001 facility.

1.03 SUBMITTALS

A. Submittals shall be furnished in accordance with Specification Section 26 05 00.

B. Provide the following for each Soft Start unit:

1. A job-specific, custom wiring diagram
   a. The wiring diagram shall clearly show all control components connected to the starter (whether the components are mounted internal or external to the soft start enclosure).
   b. All wires and terminal blocks shall be clearly labeled.
   c. Diagram shall be in accordance with NEMA/ICS standards.
2. Size, type and rating of all system components.
3. Seismic Certification.
4. Enclosure frontal elevation and dimension drawings.
5. Internal component layout diagrams.
6. Available conduit entry and exit locations.
7. Manufacturer’s product data sheets for all components.

C. Standard catalog sheets showing voltage, horsepower, maximum current

ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated Soft Starter shall be provided.

1.04 WARRANTY

A. An eighteen-month warranty shall be provided on materials and workmanship from the date of owner acceptance/substantial completion after completion of startup.

PART 2 PRODUCT

2.01 MANUFACTURERS

A. The soft starter equipment shall be:

1. Square 'D' or Cutler Hammer.
2. Or pre-approved equal meeting the detailed requirements of this specification. Note that all “named” Manufacturers are obligated to meet the detailed requirements of this specification. Any proposed exceptions shall be clearly stated at bid time, citing the reason for noncompliance, and the cost for providing a conforming product. Failure to provide a detailed list of proposed exceptions may cause a bid to be deemed non-responsive. The Engineer will be the sole determiner of the acceptability of a proposed exception.

2.02 GENERAL DESCRIPTION

A. Refer to Specification Section 26 24 19 (Motor Control Centers) or Specification Section 26 29 00 (Manufactured Control Panels) as applicable for additional requirements (for enclosure, component types, etc.).

B. Seismic Certification

1. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All separately-enclosed starter equipment shall be Seismically Certified. Supplier shall submit Seismic Certfication for this equipment in accordance with Specification Section 01 45 36 (“Equipment Seismic Certification”).

C. The soft starter shall be provided complete with a main circuit breaker disconnect means for Type 1 short circuit overcurrent protection as follows:

1. Short circuit withstand rating shall be equal to or greater than the AIC rating listed on the plans for the distribution equipment (motor control center, panelboard, switchboard, etc.) that feeds the soft starter.

2. Where the soft starter installed within a motor control center, refer to Motor Control Centers Specification Section 26 24 19.
3. Sized by manufacturer per NEC requirements for corresponding motor load.

D. The motor shall be automatically protected from solid state component failure by the following means:

1. Isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.

E. The soft starter shall utilize an SCR bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors.

1. SCR stacks shall be arranged horizontally for proper heat management.
2. Heat sinks sized for specified Starts Per Hour without requiring auxiliary cabinet cooling fans.

F. The soft start shall provide torque control for linear acceleration independent of motor load or application type without external feedback. The gating of the SCRs shall be controlled in such a manner to ensure stable and linear acceleration ramp.

G. The soft starter shall be controlled by a microprocessor that continuously monitors the current and controls the phasing of the SCRs. Analog control algorithms will not be allowed.

H. All soft starter power ratings shall utilize the same control board/module.

I. A shorting contactor shall be standard on soft starters in all enclosure configurations. Protective features and deceleration control options integral to the soft starter shall be available even when the shorting contactor is engaged.

2.03 MOTOR DATA

A. Each Soft Starter shall be sized to operate the AC motors defined to match load schedules and other specification documents as follows:

1. Motor Horsepower and voltage rating(s) – See electrical drawings and schedules.
2. Motor full load amperes, RPM and service factor ratings as stated within the individual motor specification documents.

B. The Soft Starter manufacturer shall be responsible for verifying each exact motor amperage, horsepower, voltage, RPM and service factor with motor

equipment supplier prior to submitting shop drawings.

2.04 ENVIRONMENTAL RATINGS

A. The soft start shall be designed to operate in an ambient temperature 0°C to 40°C (14°F to 104°F). For ambient temperatures between 40°C and 60°C (104°F and 140°F), derate the current by 2% per °C above 40°C (104°F).

B. Storage temperature range shall be -25°C to 70°C (-13°F to 158°F).

C. Maximum relative humidity shall be 95%, non-condensing or dripping water, conforming to IEC 60947-4-2.

D. The soft starter shall be designed to operate in altitudes up to 1000m (3300 ft). For higher altitudes, derate by 2.2% for each additional 100 m (330 ft) with a maximum of 2000m (6600 ft).

2.05 ELECTRICAL RATINGS

A. The soft starter shall be capable of operation between + / - 10% of nominal voltage rating.

B. The soft start shall automatically adapt for operation at 50 or 60 Hz, with a frequency tolerance of +/- 5%. By configuration, it shall be capable of operation at a supply line frequency that can vary by +/- 20% during steady state operation.

C. The soft start unit amperage shall be the greater of the following:

1. 110% of the NEC amperage rating associated with the horsepower rating shown on the plans (for heavy duty Class 20 starting).
2. 100% of the unit amperage rating shown on the plans (for heavy duty Class 20 starting).

D. The soft start shall be capable of supplying 400% of rated full load current (of the soft starter) for 23 seconds at maximum ambient temperature. The soft starter shall also be capable of 10 evenly spaced starts per hour at 400% of full rated current (of the soft starter) for 12 seconds per start.

E. The soft start shall have a coordinated short circuit rating equal to or in excess of the minimum value listed on the piece of distribution equipment that feeds the soft start. This rating shall be listed on the nameplate. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings.

F. The SCRs shall have a minimum P.I.V. rating of 1800 Vac. Lower rated SCRs with MOV protection are not acceptable.

G. A seismic qualification label shall be provided for all wall and floor mount units to comply with the latest IBC and NFPA 5000 guidelines where installed in seismic zones C, D, E or F.

2.06 ADJUSTMENTS AND CONFIGURATIONS

A. All programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments is prohibited.

B. Digital indication shall provide, as a minimum, the following conditions:

1. Soft starter status - ready, starting/stopping, run.
2. Motor status - current, torque, thermal state, power factor, operating time, power in kW.
3. Fault status - Motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor underload, maximum start time exceeded, external fault, serial communication fault, line phase reversal fault, motor overcurrent fault.

C. The soft starter shall be preset to the following for adjustment-free operation in most applications:

1. Linear (torque-controlled) acceleration ramp of 15 seconds.
2. Current limitation to 300% of the motor full load current rating.
3. Class 10 overload protection.
4. Motor current preset per NEC / NFPA 70 table 430.150 for standard hp motors.

D. The exact acceleration ramp time/type, current limitation, overload protection type and motor current shall be set in the field by the startup technician prior to equipment startup as recommended/approved by the motor supplier.

E. A digital keypad shall be utilized to configure the following operating parameters as required:

1. Motor full load amps adjustable from 40 to 130% of the soft starter's rating.
2. Current limitation on starting adjustable from 150 to 700% of the motor current rating, not to exceed 500% of the soft starter rating.

3. Linear (torque-controlled) acceleration ramp adjustable from 1 to 60 seconds.
4. Initial torque adjustable from 10 to 100% of nominal motor torque.
5. Torque limit adjustable from 10 to 200% of nominal motor torque.
6. Maximum start time adjustable from 10 to 999 seconds.
7. Voltage boost adjustable from 50 to 100% of the nominal supply voltage.
8. Selection of freewheel, soft stop or braking.
9. Linear (torque-controlled) deceleration ramp time adjustable from 1 to 60 seconds.
10. Threshold to change to freewheel from a controlled deceleration ramp to freewheel stop: adjustable from 0 to 100% of the nominal motor torque.
11. Braking torque level adjustable from 0 to 100% effectiveness.
12. Selection of Class 2, 10, 10A, 15, 20, 25 or 30 motor thermal overload protection.

F. A digital keypad shall be utilized to configure the following controller parameters as required:

1. Selectable automatic reset operation.
2. Cancellation of the torque control loop for multi-motor installations.
3. Adjustment of the stator loss estimation for specialty motors.
4. Assignment of soft starter inputs and output control terminals.
5. Activation of line phase reversal protection.
6. Reset of motor thermal state.
7. Return to factory settings.
8. Activation of test mode for use with low power motors.
9. Indication of elapsed time in hours of starting, running and stopping.

G. Output relays shall provide the following status indications:

1. One Form A (N.O.) minimum for indication of fault.
2. One Form A (N.O.) for indication that acceleration ramp is complete and current is below 130% motor FLA (end of start).
3. One Form A (N.O.) assignable to one of the following functions: motor thermal alarm, motor current level alarm or motor underload alarm.

H. Additional inputs and outputs shall be available to provide the following status indications:

1. Two assignable control inputs for the following functions: force to freewheel stop, external fault input, disable serial link control, external motor overload reset or general fault reset.

2. Two assignable logic-level signal outputs for the following functions: motor thermal overload alarm, “motor powered” signal, motor overcurrent alarm, or motor underload alarm.
3. One analog output shall be available for 4 to 20 milliamp indication of motor current, motor torque, motor power, motor thermal state, or power factor.
4. Other inputs/outputs as shown on electrical drawings.

I. Relay and I/O functions listed above shall be isolated with respect to common.

2.07 PROTECTION

A. A microprocessor-based thermal protection system shall be included which continuously calculates the temperature-rise of the motor and soft starter and provides:

1. A motor overload pre-alarm that indicates by relay contact or logic output that the motor windings have exceeded 130% of its rated temperature rise. This function shall be for alarm only.
2. A motor overload fault shall stop the motor if the windings have exceeded 140% of temperature-rise.
3. An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant ensuring the memorization of the thermal state even if power is removed from the soft starter.

B. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.

C. The integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation.

2.08 CONTROL OPTIONS

A. The soft starter control circuit shall be fed from the line supply and be completely independent of the power circuit and separate from the control logic.

B. The peripheral soft starter control circuitry shall be operated at 120 Vac 60 Hz from a control power transformer included within the enclosure.

C. Operator devices shall be door mounted, functions/types as shown on drawings.

D. All operator devices shall be remote-mounted using supplied 120 Vac control logic. Clearly labeled terminals shall be provided for field installation.

E. All wiring shall be clearly identified on each end to match the wiring diagram(s) provided with the soft starter.

F. Refer to Specification Section 26 24 19 (Motor Control Centers) or Specification Section 26 29 00 (Manufactured Control Panels) as applicable for all operator device and control component requirements (for pushbuttons, indicator lights, selector switches, relays, control wiring, etc).

2.09 COMMUNICATIONS

A. The RVSS shall be able to be connected to communication network type(s) as indicated on plans or required by the SCADA Integrator (exact network/protocol type(s) required shall be as directed by the facility SCADA Integrator). Where no specific network connections are specified on plans or required by the SCADA Integrator, the RVSS shall be provided with at least one of the following network communication options:
   a. Modbus RTU serial
   b. Ethernet TCP/IP
   c. Ethernet IP

B. The communication shall be able to provide access to the control, to the adjustment and to the supervision of the soft starter.

C. No additional compensation will be granted to provide gateways, network components, etc. to properly communicate with the facility SCADA system. Equipment supplier is responsible for verifying all network connection requirements with the SCADA Integrator prior to bid.

2.10 INPUT SURGE PROTECTION

A. Each RVSS that does not have an upstream isolation contactor, and is not mounted within an MCC that has its own main bus surge protection shall be provided with a 3-phase, line-side surge protection device rated 80kA (per phase) or greater. The lead length between the surge protection device and the drive terminals shall be 12” or less. The surge protection device shall be designed / located / isolated such as to prevent / limit potential physical damage to other components within the enclosure if the surge protection device fails.

2.11 SHORTING CONTACTOR

A. A microprocessor shall control the operation of the shorting contactor via an output relay.

B. The shorting contactor shall close, shorting the SCRs after the acceleration

ramp is compete and motor current is below 130% of motor FLA, and open on a stop command to allow a deceleration ramp.

C. Overload protection integral to the soft starter shall continue to protect the motor when shorting is engaged.

2.12 FULL VOLTAGE BYPASS STARTER

A. Where specifically shown on contract drawings, a full voltage NEMA-rated bypass starter with melting alloy overload protection shall be included to provide motor operation in the case of soft starter failure. A "RVSS/BYPASS" selector switch shall be mounted on the enclosure door. The melting alloy protection shall provide overload protection if the "RVSS/BYPASS" selector switch is in the "BYPASS" position, and the RVSS shall provide overload, etc. protection if the "RVSS/BYPASS" selector switch is in the "RVSS" position.

B. Where a bypass is provided, the operator shall have full control of the bypass starter by operation of a RVSS/BYPASS selector switch mounted to the front of the starter door.

C. Where a bypass is provided, a NEMA-rated RVSS line isolation contactor shall be sequenced with the NEMA-rated bypass starter to provide isolation of each starter from the other.

2.13 ISOLATION CONTACTOR

A. An IEC or NEMA-rated isolation contactor shall be provided that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.

B. The isolation contactor shall be located on the line side of the associated controller.

PART 3 EXECUTION

3.01 TESTING

A. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

B. Power semiconductors shall be fully tested for proper electrical characteristics, including dv/dt and di/dt.

C. All subassemblies shall be inspected and/or tested for conformance to quality assurance specifications.

D. Each completed unit shall be functionally tested prior to shipment to assure conformance to the specifications.

3.02 DELIVERY, STORAGE AND HANDLING

A. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.

B. Equipment shall be stored indoors in a clean, dry environment as directed by the equipment supplier. Energize anti-condensation space heaters if so required.

1. Verify that the location is ready to receive work and the dimensions are as indicated.
2. Do not install Soft Starter equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.03 INSTALLATION

A. Installation shall comply with manufacturer's instructions, drawings and recommendations.

B. A job-specific, custom wiring diagram for each soft start unit shall be provided to the contractor prior to installation for making the appropriate electrical connections. The wiring diagram shall clearly show all control components connected to the starter (whether the components are mounted internal or external to the soft start enclosure). All wires and terminal blocks shall be clearly labeled. A laminated copy of the final wiring diagram for each unit shall be installed inside the door of the associated unit.

C. Operations and Maintenance Manuals shall be provided to the owner for all Soft Starter components, control wiring, etc.

D. Operations and Maintenance Manuals shall include hardcopy printouts of all device settings and programming.

E. For safety, reliability, and continuity of warranty, any modifications, alterations, etc. required to conform to the requirements of this specification shall be performed by the Starter manufacturer only. Distributor modifications, third party packaging, etc. of a manufacturer’s standard product are specifically disallowed.

3.04 START UP AND TRAINING

A. The services of a qualified manufacturer's service representative shall be available to install, test, and start up all soft starts furnished under this specification. The schedule of the startup(s) shall be determined by the contractor.

B. Services shall include a minimum of eight (8) hours of field/classroom training for owner’s personnel on routine operation and maintenance of the specified units.

3.05 SPARE PARTS

A. The following spare parts shall be provided at no extra cost to the Owner:

1. One of each type and size of control fuse.
2. Three of each type and size of power fuse.

END OF SECTION 26 29 16

SECTION 26 32 13
GENERATOR SETS

PART 1 GENERAL

1.01 SCOPE

A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.

B. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.

C. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.02 CODES AND STANDARDS

A. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of the latest editions of the following standards/codes where applicable:

1. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
2. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
3. International Building Codes.
4. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
5. NFPA99 – Essential Electrical Systems for Health Care Facilities.
6. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.

B. The generator set and supplied accessories shall meet the requirements of the latest editions of the following standards where applicable:

1. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.

2. UL142 – Sub-base Tanks
3. UL1236 – Battery Chargers
4. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

C. The generator set and supplied accessories shall meet all applicable Environmental Protection Agency (EPA) TIER Emission Level or Emission Certification requirements and any local requirements in effect at the time the generator set is ordered (for the proposed location of the generator).

D. The control system for the generator set shall comply with the following requirements.

1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
2. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
4. FCC Part 15, Subpart B.
5. IEC8528 part 4. Control Systems for Generator Sets
6. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
7. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
8. UL1236 –Battery Chargers.

E. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.03 ACCEPTABLE MANUFACTURERS

A. Caterpillar

B. Cummins/Onan

PART 2 PRODUCTS

2.01 GENERATOR SET

A. General

1. The generator systems are part of a paralleling system. Paralleling switchgear for this system shall be provided by the generator supplier. Generator supplier shall provide all options/accessories/provisions/configuration/etc. as required for a complete/fully-functional paralleling system. Refer to Paralleling Switchgear specification section 26 23 00 for additional system requirements.

B. Ratings

1. The generator set assembly (including both the motor/engine assembly and the generator assembly) shall operate at 1800 rpm, and the generator shall produce a 60 Hz waveform.
2. Seismic Certification
   a. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All Generator equipment shall be Seismically Certified. Supplier shall submit Seismic Certfication for this equipment in accordance with Specification Section 01 45 36 (“Equipment Seismic Certification”).

3. Voltage and phase ratings shall be as shown on plans.
4. Minimum kW rating (and associated alternator sizing) shall be the greater of the following:
   a. Minimum kW rating listed on plans.
   b. Ratings required to provide skVA as follows (shall be documented with reports in submittals using generator sizing software described in Part 3 below):
      1) If so listed on plans, the step loads fed by the generator at voltage/frequency dip criteria specified.
      2) If so listed on plans, the skVA rating specified.
      3) If neither of the above are listed on plans, generator shall be sized to accommodate a block load of 100% of the Total Demand Load listed on plans, with a maximum voltage dip of 20% and a maximum frequency dip of 10%.

5. kVA rating shall be 1.25 times the kW rating (based on .8 PF).
6. Unless shown otherwise on plans, the generator set shall be rated based on the following site conditions:
   a. Altitude of project site.
   b. Ambient temperatures up to 120 degrees F.

7. The generator set rating shall be based on emergency/standby service unless noted otherwise.

C. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The engine-generator set shall be capable of accepting a single step load of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Minimum motor starting capability shall be as shown on plans. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified skVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 20% unless shown otherwise on plans.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.
6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.
7. The generator set shall share real and reactive load proportionally within plus or minus 3% with all other generator sets in the system.
8. The time required to automatically start, accelerate to rated speed and voltage, and synchronize all generator sets to the system bus on a normal power failure shall not exceed 15 seconds under normal power failure conditions (first generator shall begin suppling emergency power within 10 seconds of normal power failure per Life Safety Code requirements).

D. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. The engine-generator set shall be rated for the seismic conditions for the installation location as mapped by the US Geological Survey and required by local building codes.
3. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a

UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

E. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept compression terminations of the number and size as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required overcurrent protection located at panelboard(s) external to the generator set unless shown otherwise on plans. Where a load center or panelboard is shown within the generator enclosure on the plans, this load center/panelboard shall be furnished with the generator and shall comply with the applicable panelboard and identification sections of this specification.
3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

2.02 ENGINE AND ENGINE EQUIPMENT

A. The engine shall be diesel, 4 cycle, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:

1. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed and operating in various isochronous or parallel states. The governing system shall include a programmable warm up at idle and cooldown at idle function. While operating in idle state, the control system shall disable the alternator excitation system.
2. Skid-mounted radiator and cooling system rated for full load operation in 120 degrees F (49 degrees C) ambient as measured at the generator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H_2O restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to

verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.

3. Electric starter(s) capable of three complete cranking cycles without overheating.
4. Positive displacement, mechanical, full pressure, lubrication oil pump.
5. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
6. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
7. Replaceable dry element air cleaner with restriction indicator.
8. Flexible supply and return fuel lines.
9. Engine mounted battery charging alternator and solid-state voltage regulator.
10. Block heater
    a. Engine mounted, thermostatically controlled, block heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
    b. The block heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The block heater installation shall be specifically designed to provide proper venting of the system. The block heaters shall be installed using quick disconnect couplers to isolate the heaters for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
    c. The block heater shall be provided with a DC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the block heater system.
    d. The block heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification. If the heater quantities or wattage ratings are different than shown on plans, contractor shall be responsible for

providing the properly-rated circuits (with circuit breakers) as required to the heater(s).

11. Provide vibration isolators, spring & pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
12. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.
13. Provide critical-grade exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
14. A UL listed/CSA certified voltage regulated battery charger shall be provided for each engine-generator set. The charger shall be located at the generator unless shown otherwise on plans. Output amperage, Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
    a. Loss of AC power - red light
    b. Low battery voltage - red light
    c. High battery voltage - red light
    d. Power ON - green light and N.O. relay contact

2.03 FUEL TANK

A. Refer to "Sub-Base Fuel Tank" Paragraph below for fuel tank requirements.

2.04 AC GENERATOR

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.

B. The generator shall be capable of delivering rated output (kVA) at rated

frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

D. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

2.05 GENERATOR SET CONTROL

A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

B. The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

C. The generator set mounted control shall include the following features and functions:

1. Control Switches
   a. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
   b. The integrity of the generator remote start circuit shall be monitored for broken, disconnected or shorted wires. Loss of integrity shall start the generator.
   c. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.

d. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
e. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

2. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:
   a. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output.
   b. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
   c. The control system shall log total number of operating hours, total kWH, and total control on hours, as well as total values since reset.

3. Generator Set Alarm and Status Display.
   a. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright exterior day lighting conditions.
   b. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. Conditions required to be annunciated shall include:
      1) low oil pressure (warning)
      2) low oil pressure (shutdown)
      3) oil pressure sender failure (warning)
      4) low coolant temperature (warning)
      5) high coolant temperature (warning)
      6) high coolant temperature (shutdown)
      7) high oil temperature (warning)
      8) engine temperature sender failure (warning)
      9) low coolant level (warning or shutdown - selectable)
      10) fail to crank (shutdown)

11) fail to start/overcrank (shutdown)
12) overspeed (shutdown)
13) low DC voltage (warning)
14) high DC voltage (warning)
15) weak battery (warning)
16) low fuel (warning)
17) high AC voltage (shutdown)
18) low AC voltage (shutdown)
19) under frequency (shutdown)
20) over current (warning)
21) over current (shutdown)
22) short circuit (shutdown)
23) ground fault (warning) (if genset breaker is rated 1000A or greater)
24) over load (warning)
25) Genset circuit breaker tripped (warning)
26) emergency stop (shutdown)

4. Engine Status Monitoring.
   a. The following information shall be available from an analog status panel on the generator set control :
      1) engine oil pressure (psi or kPA)
      2) engine coolant temperature (degrees F or C)
      3) battery voltage (DC volts)

5. Engine Control Functions.
   a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
   b. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
   c. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
   d. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

e. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

f. The control system shall include all interfaces necessary for proper operation with the paralleling equipment provided under this contract. The generator set supplier shall be responsible for complete compliance to all specification requirements for both the generator set and the paralleling equipment.

6. Alternator Control Functions:

a. The generator set shall include an automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, with local indication of setting level.

b. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

c. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445. This protection may be provided using a

microprocessor-based programmable relay system designed to protect the alternator system from damage, or using programmable electronic-trip LSI breaker(s), programmed/set by the generator supplier to ensure full protection of the alternator system.

d. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

e. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

f. When required by National Electrical Code or indicated on project drawings, the control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.

g. The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

7. Other Control Functions

a. The generator set shall be provided with a network communication module to allow network communication with the generator set control by remote devices. The control shall communicate all engine and alternator data, and allow starting and stopping of the generator set via the network in both test and emergency modes.

b. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is out of acceptable limits. During engine cranking (starter engaged), the low voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

8. Dry Contacts/Relays for Remote Monitoring:
   a. The control system shall provide ten (10) programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. Five (5) of these relays shall be preconfigured (and labeled accordingly) to indicate:
      1) generator set operating at rated voltage and frequency
      2) common warning
      3) common shutdown
      4) load shed command and
      5) low fuel warning.
   b. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

2.06 GENERATOR REMOTE MANUAL STOP STATION

A. Each generator set shall be furnished with a remote manual stop station of a type to prevent inadvertent or unintentional operation per NFPA 110 requirements.

B. Stop station pushbutton shall be red, non-illuminated, push-pull, mushroom-type, maintained-contact, 1 5/8” diameter, 30mm base, heavy-duty, oil-tight, water-tight unit) mounted within guarded enclosure to prevent inadvertent operation and labeled with engraved nameplate (white letters on red background) to read: “GENERATOR EMERGENCY STOP” (or similar with specific generator name where so identified on drawings).

C. Exact stop station type shall be coordinated with generator controls supplier to ensure a fully-functional system per NFPA 110 requirements.

2.07 GENERATOR MAIN LINE CIRCUIT BREAKER(S)

A. The generator set shall be provided with a mounted main line circuit breaker(s), sized as shown on plans. The circuit breaker(s) shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

B. The main line circuit breaker(s) shall be provided with auxiliary contacts to indicate trip/off alarm conditions to the generator set control system.

2.08 OUTDOOR WEATHER-PROTECTIVE ENCLOSURE

A. The generator set shall be provided with a weatherproof, sound-attenuated, outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank (if applicable) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

B. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 76 dBA (including exhaust noise) at any location 7 meters from the generator set in a free field environment:

C. The enclosure shall include vertical air discharge hoods as required to redirect discharge air upwards and reduce noise accordingly.

D. The enclosure shall be insulated with non-hydroscopic materials.

E. The enclosure shall be rated for the wind and seismic conditions for the installation location as mapped by the US Geological Survey and required by local building codes.

F. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:

1. Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.
2. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.
3. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.
4. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.
5. Salt Spray, per ASTM B117-90, 1000+ hours.
6. Humidity, per ASTM D2247-92, 1000+ hours.
7. Water Soak, per ASTM D2247-92, 1000+ hours.

G. Painting of hoses, clamps, wiring harnesses, and other non-metallic service

parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

H. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.

I. A factory-mounted critical exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.

J. The enclosure shall include the following maintenance provisions:

1. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
2. External radiator fill provision.

K. If so shown on the plans, provide a factory-mounted and wired electrical distribution panel to serve the generator set and enclosure. The provisions required include:

1. 100-amp distribution panelboard installed inside enclosure and fed by a 120/208VAC power feeder installed by the contractor (unless shown otherwise on plans).
2. Two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure (all factory-wired).
3. Two three-way switches controlling three AC lamps mounted in vapor tight and gasketted fixtures (all factory-wired).
4. Factory-wired normal AC service from the panelboard to the engine coolant and alternator heaters, and battery charger.

2.09 SUB-BASE FUEL TANK

A. Provide a sub-base fuel tank for the generator set, sized to allow for full load operation of the generator set for 48 hours. The sub-base fuel tank shall be UL142 listed and labeled. Installation shall be in compliance to NFPA37. The fuel tank shall be a double-walled, steel construction and include the following features:

1. Emergency tank and basin vents.
2. Mechanical level gauge.

3. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.
4. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
5. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level
6. Basin drain.
7. Integral lifting provisions.

B. The equipment, as installed, shall meet all local and regional requirements for above ground tanks.

C. Where the generator design/layout, sub-base fuel tank height, and/or concrete housekeeping pad for the generator set causes any circuit breaker handle, control device, metering display or other similar item to be located higher than 6’-7” above finished floor, the supplier shall provide an aluminum grating platform complete with stairs and handrails meeting all applicable code requirements for proper access to these items. The platform and stairs shall be permanently mounted to a concrete base as recommended by the system supplier. Alternatively, the supplier may relocate (at the factory) these items to be below 6’-7” above finished floor.

2.10 SEQUENCE OF OPERATION

A. The maximum elapsed time allowed from loss of normal power to restoration of power to emergency circuits from generator through transfer switch shall be 10 seconds.

B. Generator set shall start upon receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.

1. The integrity of the generator remote start circuit shall be monitored for broken, disconnected or shorted wires. Loss of integrity shall start the generator.

C. The generator set shall complete a time delay start period as programmed into the control.

D. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:

1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two

attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.

2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.
3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
4. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand or load govern state.

E. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

F. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

G. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

PART 3 EXECUTION

3.01 SUBMITTALS.

A. Within 10 days after award of contract, provide six sets of the following information for review:

1. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.
2. A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
3. Seismic Certification.
4. Manufacturer's certification of prototype testing.
5. Manufacturer's published warranty documents.
6. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.

7. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
8. Generator sizing software report(s) showing compliance with all specification requirements and any additional motor starting requirements indicated in contract documents.
9. Time-current-curves demonstrating that the generator alternator relaying or breaker protective device(s) provide proper protection for the alternator by a comparison of the trip characteristic of the breaker with the thermal damage characteristic of the alternator.
10. Manufacturer's installation instructions.

3.02 FACTORY TESTING.

A. The generator set supplier shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

B. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks notice for testing.

C. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

3.03 INSTALLATION

A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring, fuel lines, etc. between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

C. Generator equipment shall be installed on concrete housekeeping pads.

Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.

D. Remote stop station type, labeling and location shall be submitted by contractor to engineer and local fire marshal for approval prior to rough-in. Location shall be outside the room housing the prime mover (where so installed within a room) or elsewhere on the premises where the prime mover is located outside the building. Contractor shall provide all interconnections from remote stop station to generator set as required by generator set supplier for a fully-functional system.

E. Equipment shall be initially started and operated by representatives of the manufacturer.

F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

3.04 ON-SITE ACCEPTANCE TEST:

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include the following (performed in accordance with NFPA 110):

1. "Cold start" test.
2. Four (4) hour full load test. Provide resistive load banks and make temporary connections as required.
3. One step rated load pickup test.
4. Power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

C. Upon completion of the manufacturer's site start-up and checkout, the contractor shall leave the diesel tank half full of fuel for use by the owner.

3.05 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to not less than 5 persons. Training date shall be coordinated with the facility owner.

3.06 SERVICE AND SUPPORT

A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

B. The generator set shall be distributed and serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

C. The manufacturer of the generator set shall own, maintain and make available (to engineer, free of charge) generator set sizing software that calculates voltage dip, frequency dip, THDI and THDV of proposed generator/alternator set using the following inputs:

1. Summary of step loads including load type (across-the-line motor, VFD, Fire Pump, Fluorescent Lighting, UPS, etc.).
2. Generator Set Duty (Standby, Prime, Continuous).
3. Maximum Ambient Temperature.
4. Project site altitude.
5. Generator Fuel type.
6. Voltage/Phase/Frequency.

D. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.07 WARRANTY

A. The generator set and associated equipment shall be warranted for a period of not less than 2 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 26 32 13

SECTION 26 36 23
AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 SCOPE

A. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: voltage sensors on all phases of both sources, power switch mechanism, permanently attached manual operation provisions, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.

B. The manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided. Technicians specifically trained to support the product shall service the transfer switches.

1.02 CODES AND STANDARDS

A. The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:

1. CSA 282, Emergency Electrical Power Supply for Buildings
2. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
3. NFPA99 – Essential Electrical Systems for Health Care Facilities
4. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
5. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
6. NEMA ICS10-1993 – AC Automatic Transfer Switches.

B. The transfer switch assembly shall comply with the following standards:

1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
2. EN55011, Class B Radiated Emissions
3. EN55011, Class B Conducted Emissions
4. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity.
5. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
6. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
7. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
8. IEC 1000-4-6 Conducted Field Immunity
9. IEC 1000-4-11 Voltage Dip Immunity.
10. IEEE 62.41, AC Voltage Surge Immunity.

11. IEEE 62.45, AC Voltage Surge.
12. UL1008 – Transfer Switches. Transfer switches shall be UL1008 (latest edition) listed. UL1008 transfer switches may be supplied in UL891 enclosures if necessary to meet the physical requirements of the project.

C. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.03 ACCEPTABLE MANUFACTURERS

A. Cummins/Onan

B. Caterpillar

C. Russelectric

D. ASCO

E. Eaton

PART 2 PRODUCTS

2.01 POWER TRANSFER SWITCH

A. Ratings

1. Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, voltage and ampere ratings, enclosure type, and accessories.
2. Seismic Certification
   a. This facility has been categorized as Seismic Risk Category 4 and Seismic Design Category D. All ATS equipment shall be Seismically Certified. Supplier shall submit Seismic Certfication for this equipment in accordance with Specification Section 01 45 36 (“Equipment Seismic Certification”).
3. Main contacts shall be rated for 600 Volts AC minimum.
4. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
5. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes equal to or greater than the

required ratings shown on the drawings (at the specified voltage). The transfer switch shall be third party listed and labeled for use with the specific protective device(s) (both normal and emergency) installed in the application. All rating information including associated overcurrent devices shall be submitted with shop drawings. Where WCR is dependent on setting of upstream overcurrent device, transfer switch shall be field marked with the required settings of the associated device. When a power distribution system electrical study (including short circuit stud, etc.) is a part of the project, contractor shall further verify that all proposed equipment is properly rated (per the results of the study) prior to submitting shop drawings. The transfer switch and its upstream protection shall be coordinated.

B. Construction

1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
2. Transfer switches shall be of the Programmed (Delayed) Transition type. Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de-energized conditions.
3. The switch shall completely disconnect the load from both sources for an adjustable period of time to allow regenerative voltage to decay to a safe level prior to connecting to the new source.
4. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
5. All wiring shall be UL listed 105 degree C, 600 volt rated, and sized as required. Each wire, device or function shall be identified with a source and destination by silk-screen or similar permanent identification. Circuit boards shall be connected wiring harnesses by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
6. Bus structures shall be constructed from silver plated copper or tin plated aluminum with bolted joints for all three phases, with a full neutral, and a 1/4 x 2 inch ground bus extending through all sections.
7. The framework and all other sheet metal components of the system shall be primed with a rust-inhibiting primer, and finished with two coats of satin finish ANSI 61 gray enamel, or manufacturer’s standard color.

8. All door mounted control components shall be industrial type oil-tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty and durability control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.
9. Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation or shall be indicated by mechanical flags. Barriers shall be provided to prevent inadvertent contact with any voltage of greater than 50VDC.
10. Transfer switches shall be 4-pole with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Equipment using overlapping neutral contacts is not acceptable.

C. Connections

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU compression lugs suitable for the quantities and sizes of power conductors required.

2.02 TRANSFER SWITCH CONTROL

A. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.

1. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
2. High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch (when used) enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
3. “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.

4. "TEST" pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
5. "RESET/LAMP TEST" pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
6. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via an operator display panel.
7. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
    a. Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance. Line to neutral voltages shall be displayed for 4-wire systems.
    b. Display source status, to indicate source is connected or not connected.
    c. The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
        1) Set nominal voltage and frequency for the transfer switch.
        2) Adjust voltage and frequency sensor operation set points.
        3) Set up time clock functions.
        4) Set up load sequence functions.
        5) Enable or disable control functions in the transfer switch, including program transition.
        6) Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
    d. Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall be incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
    e. Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.

f. Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.

B. Internal Controls

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
   a. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
   b. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
   c. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
   d. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
   e. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
   f. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
   g. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
3. The transfer control shall incorporate a series of diagnostic LED lamps.
4. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control

system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature. The program/delayed transition time setting (time in which load is not connected to either source during transfer) shall be initially set at 10 seconds to allow motors to properly decay per MG-1 standard

5. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).
6. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
7. The control system shall be designed and prototype tested for operation in ambient temperatures from -40C to +70C. It shall be designed and tested to comply with the requirements of the noted voltage surge and RFI/EMI standards.
8. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
9. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational. The battery power supply shall be monitored for proper condition, and the transfer switch shall include an alarm condition to indicate low battery condition.

C. Control Interface

1. The transfer switch shall provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.
2. The integrity of the generator remote start circuit shall be monitored for broken, disconnected or shorted wires. Loss of integrity shall start the generator.
3. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
4. The transfer switch shall provide additional relay contacts to indicate the following conditions: Utility Source Available, Load Connected to Utility, Generator Source Available, Load Connected to Generator, Pre-Transfer Warning (adjustable 0-59 second time delay).

5. The transfer switch shall be provided with a network communication card, and configured to allow LonMark compliant communication with the transfer switch and other network system components. The network shall provide a redundant start signal to the generator set(s) in the system.

2.03 ENCLOSURE

A. Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70. The cabinet door shall include permanently mounted key type latches.

B. If not specifically indicated otherwise on plans, transfer switch equipment enclosures shall meet the following minimum requirements:

1. For dry interior locations: NEMA 1 or better (unless shown otherwise on plans).
2. For wet interior (pump stations, etc.) or exterior locations: NEMA 3R or better (unless shown otherwise on plans).

C. The cabinet shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

D. Note size and access requirements for the transfer switch (and associated equipment) and provide equipment that will fit into the space allowed and comply with code-specified access requirements.

2.04 BATTERY CHARGING

A. The transfer switch/generator set combination shall be provided with a battery charger for the generator set starting batteries. Refer to Generator Sets Specification Section 26 32 13 for specific requirements. Supply power failed indication shall be displayed on the ATS control panel.

2.05 SEQUENCE OF OPERATION

A. Programmed (Delayed) Transition Sequence of Operation

1. Normal State:
   a. Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the

loads when normal source fails. The normal position of the transfer switch is connected to source 1 (connected to the utility), and no start signal is supplied to the genset.

2. Normal Power Failure and Restoration:
   a. When the transfer switch senses a power failure on source 1, it shall complete a pre-programmed time delay start sequence, and then send a start signal to the generator set.
   b. The generator set shall immediately start and accelerate to rated voltage and frequency.
   c. The transfer system shall complete a programmable time delay sequence, and then transfer to source 2 by delayed (programmed) transition. The transfer switch shall accomplish this by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later (to allow motor loads to decay per NEMA MG-1 standard).
   d. On return of source 1 to acceptable voltage and frequency levels, the control system shall initiate a time delay retransfer sequence. On completion of the time delay sequence, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later (to allow motor loads to decay per NEMA MG-1 standard). The timing sequence for the contact operation shall be programmable in the controller. The control system shall transfer loads back to source 1 in the reverse sequence to that which was used to connect loads to source 2.
   e. If the generator set fails during this period and normal source is available, the transfer switch shall automatically reconnect the system loads to the normal service.
   f. The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set.

3. Generator Set Exercise (Test) With Load Mode (Delayed (programmed)Transition). The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
   a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
   b. The transfer switch shall issue a compatible start command to the generator set as follows:
      1) On generators rated 50kW and greater, the transfer switch shall cause the generator set to start and run at idle until it has

reached normal operating temperature. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.

2) On generators rated less than 50kW, the generator set shall immediately start and accelerate to rated voltage and frequency.

c. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later (to allow motor loads to decay per NEMA MG-1 standard). The timing sequence for the contact operation shall be programmable in the controller.

d. The generator set shall operate connected to the load for the duration of the exercise period.

e. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later (to allow motor loads to decay per NEMA MG-1 standard). The timing sequence for the contact operation shall be programmable in the controller.

f. The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set.

g. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

h. If the generator set fails during the exercise period and normal source is available, the transfer switch shall automatically reconnect the system loads to the normal service.

4. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:

a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.

b. The transfer switch shall issue a compatible start command to the generator set as follows:

1) On generators rated 50kW and greater, the transfer switch shall cause the generator set to start and run at idle until it has

reached normal operating temperature. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.

2) On generators rated less than 50kW, the generator set shall immediately start and accelerate to rated voltage and frequency.

c. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.

d. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

PART 3 EXECUTION

3.01 POWER COMPANY APPROVAL

A. The transfer switch shall be designed to meet all applicable power company requirements for connection to the power company's system, and if applicable, shall be on the power company's approved list of automatic transfer switches. Contractor shall ensure that transfer switch is specifically approved by power company for connection to their system prior to purchasing the transfer switch.

3.02 FACTORY TESTING

A. The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be submitted. Test process shall include calibration of voltage sensors.

3.03 SERVICE AND SUPPORT

A. The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

B. The transfer switch shall be serviced by a local service organization that is trained and factory certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

C. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

D. After generator set installation, the generator set supplier shall conduct a complete operation, basic maintenance, and emergency service seminar for up to 5 persons employed by the facility owner. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures. The class duration shall be at least 4 hours in length, and include practical operation with the installed equipment.

3.04 WARRANTY

A. The automatic transfer equipment shall be warranted (by the generator supplier when a generator is supplied within the project) for a period of not less than 2 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 26 36 23

SECTION 26 41 00
LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. Furnish and install all materials and labor required to provide a complete and functional Lightning Protection and Common Grounding System as indicated, in strict accordance with this section of the Specifications and the applicable Contract Drawings.

1.02 STANDARDS & QUALITY ASSURANCE

A. The lightning protection system shall comply with all requirements of the latest edition of each of the following codes and standards. The latest edition of these codes and standards form a part of this specification:

1. U.L. Standard 96A.
2. Lightning Protection Institute - Installation Code LPI-175.
3. N.F.P.A. 780.

B. Equipment manufacturer shall be certified by the Lightning Protection Institute, and products approved for UL listing. All materials shall be manufactured by one of the following manufacturers:

1. Bonded Lightning Protection Systems
2. East Coast Lightning Protection
3. Erico/Eritech Lightning Protection
4. Harger Lightning Protection
5. Preferred Lightning Protection
6. Robbins Lightning
7. Thompson Lightning Protection

C. For approval of LPI manufacturer other than specified, complete proposed material data and installation drawings shall be submitted to Engineer for review not less than 10 days prior to bid date.

D. In order to insure integrity of installation, the system shall be installed under the direct jobsite supervision of a Certified Master Installer/Designer, who has qualified under the LPI's Certification Program as a Master Installer/Designer.

1.03 SUBMITTALS

A. Complete shop drawings of the entire lightning protection system showing the

type, size, mounting details, and location of all equipment, grounds, cable routings, roof materials (for coordination of lightning protection system materials), etc., shall be submitted to the Architect-Engineer for approval prior to start of work.

B. Submittals shall document the local manufacturer's representative's Certified Master Installer/Designer qualifications from LPI.

PART 2 PRODUCTS

2.01 SYSTEM

A. System materials in general shall be copper, copper alloy or aluminum with high-copper content bronze castings or aluminum castings (all compatible with associated surface materials and installed per UL, NFPA & LPI standards), and shall comply in weight, size and composition for the class of structure to be protected. The system shall consist of all necessary cables, air terminals, mounting bases, fittings, couplings, connectors, fasteners, surge protection devices, etc., as required to give a complete and coordinated system.

B. Copper conductors shall be utilized for all downleads and below-grade conductors.

C. Aluminum components shall be utilized in cases where copper is not compatible with mounting surfaces.

D. All ground rods shall be copper-clad steel.

E. All cable and all air terminals shall bear proper UL labels.

F. Air terminals shall have blunt tips.

G. System design shall be concealed wherever practical, with roof perimeter cables concealed in parapet walls, and mid-roof cables installed under roof slabs. Exposed cable on parapet walls will only be accepted if structural details preclude cable concealment. Cable drops for roof penetrations at downlead locations shall be made with solid-bar thru-roof connectors, with copper rod flashings. Bond rebars top and bottom at each downlead position and risers. Primary and secondary bonding of roof metals and equipment shall also be under roof slabs. Ground level, intermediate and roof level potential equalization shall be provided per current building Code classifications.

H. All system fittings except cable holders, regardless of Structure classification,

shall be heavy-duty type made from bronze or aluminum castings and secured with bolted-pressure clamps. Pressure plates made from stamped or pressed metal parts, or fittings utilizing crimp-type pressure devices will not be allowed. All bolts, screws, and related type hardware shall be stainless steel.

I. Contractor shall coordinate with the roofing contractor to insure compatibility of any adhesive with the roofing system in use.

J. Cable fasteners shall be substantial in construction, electrolytically compatible with the conductor and mounting surface, and shall be spaced according to LPI, UL, and NFPA code requirements.

K. Where applicable, an approved bimetal transition fitting shall be used at the roof level to change from aluminum roof conductor to copper downlead cable.

L. Surge protection devices shall be provided on the power, telecommunications and other conductive electrical services at the points of entrance into the building(s) as required by UL96A in order to obtain the UL Master Label Certificate of Inspection. It shall be the responsibility of the electrical contractor to install or verify that a proper surge protection device has been installed on the each of the building electrical services to meet this requirement. This may require surge protection devices in addition to those specifically shown on plans or called out within other specifications.

PART 3 EXECUTION

3.01 SUPERVISION AND CERTIFICATION

A. The manufacturer's local representative shall be a Certified Master Installer/Designer under the LPI program, and shall provide direct jobsite technical supervision to Contractor's personnel during installation to insure compliance with all Code requirements. Upon job completion, Contractors shall furnish Owners with written certification on UL Master Label "C",that system is installed in compliance with above Standards.

END OF SECTION 26 41 00

SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (<1000 V) power distribution and control equipment.

B. The specified unit(s) shall provide effective high energy transient voltage surge suppression, surge current diversion and high frequency noise attenuation in all electrical modes for equipment connected downstream from the facility's meter or load side of the main overcurrent device. The unit(s) shall be connected in parallel with the facility's wiring system.

C. The unit(s) shall be designed and manufactured in North America by a qualified manufacturer of suppression filter system equipment. The qualified manufacturer shall have been engaged in the commercial design and manufacturer of such products for minimum of ten (10) years.

D. All products that are submitted according to these specification will be required to meet this specification in it's entirety for both service and distribution TVSS systems. Any product that is submitted and does not comply with all parts of this specification will be subject to rejection.

1.03 DEFINITIONS

A. VPR: Voltage Protection Rating.

B. SPD: Surge Protective Device(s)

C. $I_{(n)}$: Nominal Discharge Current

1.04 SUBMITTALS

A. See specification section 26 05 00.

B. Product Data: For each type of product indicated. Include:

1. Maximum Single Impulse Surge Current Rating.
2. Surge Life (Repetitive Surge) Rating.
3. UL1449 (Latest Edition) Voltage Protection Ratings (VPR).
4. UL1449 (Latest Edition) Nominal Discharge Current (In).
5. Product dimensions and weights.
6. Furnished specialties and accessories.

C. Qualification Data:

D. Safety Agency File Number.

E. ISO 9001-2008 Certification.

F. ISO 1401-2001 Certification.

G. Operation and Maintenance Data: For SPDs to include all submittal data and any applicable operation and maintenance manuals.

H. Warranties: Sample of special warranties.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

B. The unit shall be UL 1449 Listed and CUL Approved as a Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference Filter

C. Provide 2nd party certified data demonstrating SPD response to ANSI/IEEE C62.41.2-2002 standard waveforms when tested according to IEEE C62.45.

D. Comply with NFPA 70.

E. All SPDs provided within this project at the service entrance, distribution panels, and sub-panels shall be from the same manufacturer.

1.06 PROJECT CONDITIONS

A. Service Conditions: Rate SPDs for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 150 deg F.

3. Humidity: 0 to 95 percent, non-condensing.

1.07 COORDINATION

A. Where field-mounted SPD's are specifically shown on plans, coordinate locations of field-mounted SPDs to allow adequate clearances for maintenance.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

1.09 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. Replaceable Protection Modules: 1 of each size and type installed, where field-replaceable modular SPDs are provided.
2. Fuses: 1 of each size and type installed, where field-replaceable fuses are provided.

PART 2 PRODUCTS

2.01 SURGE PROTECTIVE DEVICES

A. Manufacturer:

1. Integral Devices: Surge Protective Devices shall be as manufactured by the distribution equipment manufacturer (Square D, etc.), or by Surge Suppression Inc. if all of the performance of this specification are met and all UL listing of the equipment manufacturer are met.
2. External Devices (where specifically specified on plans): Surge Protective Devices shall be as manufactured by the distribution equipment manufacturer (Square D, etc.) or Surge Suppression Inc.

B. Each Surge Protective Device shall:

1. Be internal to the associated distribution equipment (without violating any applicable UL listings) unless specifically shown otherwise on plans.

2. Be UL 1449 (Latest Edition) listed.
3. Have short-circuit current rating complying with UL 1449 (Latest Edition), that matches or exceeds the short-circuit rating of the associated distribution equipment.
4. Be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
5. Have fuses, rated at 200-kA interrupting capacity.
6. Have a minimum UL 1449 Nominal Discharge Current (I_n) Rating of 20kA.
7. Be fabricated using bolted compression lugs.
8. Provide suppression for all ten (10) modes of protection.
9. Have LED indicator lights for power and protection status of each phase.
10. Have audible alarm, with silencing switch, to indicate when protection has failed.
11. Have form-C contacts rated at 2 A and 24-V ac minimum, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with facility monitoring and control system if monitoring by that system is required by plans or other specifications.
12. Have six-digit transient-event counter, mounted to front of equipment door, set to totalize transient surges (externally mounted SPD's may have the transient –event counter monted on the visible face of the SPD).
13. Meet all UL 96A requirements (for Lightning Protection Systems) where the device is installed at a service entrance of the facility. At a minimum, these devices shall:
    a. Be marked as Type 1 or Type 2 SPDs with product Identity consisting of "Surge Protective Device" or "SPD", and identifying all ratings so required by UL96A and the 4 digit alpha numeric Control Number.
    b. Have a minimum UL 1449 Nominal Discharge Current (I_n) Rating of 20kA.
    c. Be UL listed and labeled with holographic label.

C. Peak Single-Impulse Surge Current Rating shall be meet the following minimums unless specifically shown otherwise on plans:

Application	**Per Phase**	**Per Mode**
Service Entrance Devices	240 kA	120 kA
Downstream Devices	160 kA	80 kA

D. The ANSI/UL 1449 voltage protection rating (VPR) in grounded wye circuits, the SPDs shall not exceed the following:

Modes	**208Y/120V**	**480Y/277V**	**600Y/347V**
L-N,L-G, N-G	800	1200	1500
L-L	1200	2000	2500

E. The ANSI /UL 1449 VPR for 240/120 V, 3-wire or 4-wire circuits with high leg shall not exceed the following:

Modes	**240/120V**
L-N,L-G, N-G	1200/800

2.02 ENCLOSURES

A. Where external units are specifically specified on plans, units not mounted within electrical distribution equipment (such as switchboards, MCC's, etc.) shall be provided in enclosures with NEMA enclosure ratings that match or exceed the NEMA enclosure ratings of the equipment from which the units are fed. For example, a unit fed from a NEMA 4X stainless steel panelboard shall also be mounted within a NEMA 4X stainless steel enclosure.

PART 3 EXECUTION

3.01 INSTALLATION

A. All SPD's shall be integrally-mounted within the associated distribution equipment unless specifically shown otherwise on plans.

B. Install SPDs at service entrance on load side, with ground lead bonded to service entrance ground.

C. Install SPDs downstream of the service entrance with conductors or buses between suppressor and points of attachment as short and straight as possible. The lead lengths between the TVSS unit and the equipment being protected shall not exceed fourteen (14) inches without approval from the engineer. Do not bond neutral and ground. Leads shall be as straight as possible with no sharp bends.

D. Where externally-mounted SPD's are specifically shown on plans, provide circuit breaker as directed by the SPD supplier as a dedicated disconnecting means for SPD unless otherwise indicated.

3.02 FIELD QUALITY CONTROL

A. Ensure that interiors are free of foreign materials and dirt.

B. Check and test switches, pushbuttons, meters for proper operation.

C. Check and test indicating lights for proper operation and color.

D. Perform manufacturer's on site field test procedures.

3.03 STARTUP SERVICE

A. Do not perform insulation resistance (MEGGER) tests of the distribution wiring equipment with the SPDs installed. Disconnect all wires, including neutral, before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.04 SYSTEM WARRANTY

A. The SPD system manufacturer shall warranty the entire SPD system against defective materials and workmanship for a period of ten (10) years from the date of substantial completion. This warranty is in effect as long as the unit is installed in compliance with the manufacturer's installation, operation, and maintenance manual, UL Listing requirements, and any applicable national or local electrical codes.

B. Any SPD device which shows evidence of failure or incorrect operation, including damage as the result of lightning strikes, during the warranty period shall be replaced by the manufacturer at no charge to the owner. Warranty will provide for multiple exchanges of any inoperable devices at any time during the warranty period which starts at the date of substantial completion of the system to which the surge suppressor is installed.

C. The manufacturer is required to have a nationwide network of factory-authorized local service representatives for repair and service of this product. The manufacturer shall have a dedicated 1-800 telephone number for service problems and questions. This number shall be manned by a knowledgeable factory employee to ensure prompt response to any emergency situation that may arise.

END OF SECTION 26 43 00

SECTION 26 44 00
ELECTRICAL HEAT TRACING SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. This specification covers the requirements of materials and support services for heat-tracing systems. Heat tracing systems (including insulation and all accessories) shall be provided on all piping installed exposed in exterior locations or where otherwise indicated on plans unless noted otherwise.

1.02 CODES, APPROVALS, AND STANDARDS

A. The electric heat-tracing system shall conform to this specification. It shall be designed, manufactured, and tested in accordance with the applicable requirements of the latest edition of the following codes and standards.

1. ANSI American National Standards Institute
2. CEC Canadian Electrical Code
3. CSA CSA International
4. FM FM Approvals
5. IEC International Electro-Mechanical Commission
6. IEEE Institute Of Electrical and Electronics Engineers
7. ITS Intertek Testing Services (Intertek ETL SEMKO)
8. NEC U.S. National Electrical Code (NFPA 70)
9. NEMA National Electrical Manufacturers Association
10. NESC National Electrical Safety Code
11. UL Underwriters' Laboratories, Inc.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Heat Tracing:

1. Raychem/Tyco Thermal Controls.
2. Thermon.
3. Nelson Heat Tracing.
4. Chromalox.

B. Insulation:

1. Armstrong World Industries, Inc.

2. Babcock & Wilcox; Insulationg Products Division
3. CertainTeed Corporation
4. Knauf Fiber Glass GmbH
5. Manville Products Corp.
6. Owens-Corning Fiber Glass Corp.
7. Pittsburg Corning Corp.
8. Rubatex Corp.

2.02 SELF-REGULATING HEATING CABLES

A. All heat-tracing applications with continuous exposure (maintain) temperatures from 150°F (65°C) to 250°F (121°C) or intermittent exposure temperatures from 185°F (85°C) to 420°F (215°C) shall use self-regulating cables.

1. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.
2. Self-regulating heating cable shall be designed for a useful life of 20 years or more with “power on” continuously, based on the following useful life criteria:
   a. Retention of at least 75 percent of nominal rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
   b. Retention of at least 90 percent of nominal rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 746B, IEC 216-1 Part 1.
3. A warranty against manufacturing defects for a period of 10 years shall be available.
4. All cables shall be capable of passing a 2.5 kV dielectric test for one minute (ASTM 2633) after undergoing a 0.5 kg-m impact (BS 6351, Part 1, 8.1.10).

2.03 FREEZE-PROTECTION SYSTEMS

A. The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.

B. The heating cable shall have a tinned copper braid with a resistance less than

the heating cable bus wire resistance as determined in type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.

C. In order to provide rapid heat-up, to conserve energy, and to prevent overheating of fluids and plastic pipe, the heating cable shall have the following minimum self-regulating indices:

1. Table K.1 Minimum Self-Regulating Indices

Heating cable	S.R. index (W/°F)	S.R. Index (W/°C)
3 W/ft	0.038	0.068
5 W/ft	0.060	0.108
8 W/ft	0.074	0.133
10 W/ft	0.100	0.180

D. The self-regulating index is the rate of change of power output in watts per degree Fahrenheit or watts per degree Celsius, as measured between the temperatures of 50°F (10°C) and 100°F (38°C) and confirmed by the type test and published data sheets.

1. In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self- ignition, the cable shall produce less than 0.5 watts per foot (1.64 watts per meter) when energized and heated to 350°F (177°C) for 30 minutes. After this test, if the cable is reenergized, it must not have an increasing power output leading to thermal runaway.
2. In order to confirm 3.1B, the self-regulating heating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between 50°F (10°C) and 210°F (99°C), allowing at least six minutes of dwell time at each temperature.
3. The heating cable shall be Raychem® BTV-CT or BTV-CR self-regulating heater, with continuous exposure (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C), as manufactured by Tyco Thermal Controls.

2.04 THERMOSTATS AND CONTACTORS

A. Freeze protection systems shall operate using self-regulating control or with the DigiTrace AMC-1A or DigiTrace AMC-F5 thermostat and the DigiTrace E104-100A or DigiTrace E304-40A contactor in nonhazardous locations, and DigiTrace AMC-1H thermostat with Digitrace E307-40A contactor in hazardous locations, as supplied by Tyco Thermal Controls.

B. Where heat tracing is applied to emergency showers and/or emergency eye wash systems (or other systems where the heated piping system provides

water that may be applied to persons in emergency or non-emergency situations), the sensor (that determines whether the heat tracing system is ON or OFF) shall be placed on the associated pipe or tank wall rather than in ambient air (such as to prevent the heat tracing system from overheating the associated liquid).

2.05 END SEAL

A. An above-insulation, lighted end seal kit shall be provided for each heat trace circuit termination as per the manufacturer's installation details. The kit shall be E-100-LBTV2 as supplied by Tyco Thermal Controls.

2.06 INSULATION

A. All components of the insulation, including covering, mastics and adhesives shall have a flame-spread rating of not over 25, and a smoke development rating of not over 50. Ratings shall be as established by tests in accordance with ASTM E 84 and Federal Specification standards. The integrated insulation assemblies shall also conform to the above specifications. Insulation shall be applied in strict accordance with the manufacturer's instructions.

B. Description:

1. This type of insulation shall be employed for process, cold-and hot water, steam, and condensate piping and equipment with surface temperatures up to 850 degrees F. Pipe insulation and jacketing shall be applied to piping where shown, and shall include fittings, flanges, and valves. Pipe insulation shall be molded-type pipe covering, made of fibrous glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature. Unless otherwise specified the insulation thickness shall be 1" minimum.
2. The insulation shall be oversized for installation over electric heating cable. Insulation shall have a factory-applied white fire-retardant vapor-barrier jacket of kraft paper and aluminum foil laminated together and reinforced with fiberglass yarn. Fittings and valves shall be covered with the same material as the pipe, cut in segments to fit snugly without open spaces, held in place with copper wire or cement, and then covered with the same jacketing material as the pipe. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-barrier cement before installation of the finish jacket. Pipe insulation and vapor-barrier shall be continuous through hangers and supports. Insulation shall be coordinated with the pipe hangers and supports and where insulation protection shields are provided the top half section of pipe insulation at support locations shall be of the same specified density, and

the bottom half insulation segments provided between the pipe and the insulation protection shields shall have a density of not less than 6 lb/cu ft. All insulation shall be covered with smooth aluminum weatherproof metal or plastic preformed jacketing with a factory attached moisture barrier. The jacket for the fittings shall consist of precision-formed smooth-sided sections and shall be sized to cover and protect the insulated fitting. Each section shall be manufactured from aluminum or PVC, and all joints shall be sealed with silicon mastic or solvent welding, to provide a continuous, air and weathertight joint. Strapping shall be 1/2-inch wide, Type 3003 aluminum or stainless steel.

PART 3 EXECUTION

3.01 GENERAL

A. Heat tracing shall be provided along full length of all exposed piping or vessels located outside of buildings or in other areas designated on plans (such as by insulated piping in areas subject to cold temperature). Insulation shall be provided over all heat traced pipes.

B. The vendor shall provide a detailed design utilizing standard heat-tracing design software, such as Tyco Thermal Controls TraceCalc® Pro design software or equal. At minimum, the design must provide the following:

1. Circuit identification number
2. Maintain temperature
3. Line size and insulation
4. Heat loss for pipe, valves, and supports
5. Amount and type of heating cable required
6. Spiral requirements
7. Heating cable service voltage
8. Heating cable power output at the maintain temperature
9. Minimum and maximum maintain temperature vs. minimum and maximum ambient temperatures
10. Circuit breaker and transformer sizing

C. A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.

D. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

1. Bolted flanges (per pair): Two times pipe diameter
2. Valves: Four times valve length

3. Pipe hanger or support penetrating insulation: Three times pipe diameter

E. The entire system shall be installed in compliance with the manufacturer’s recommendations for a fully-functional, code-compliant system.

F. All insulation shall be installed by a qualified insulation contractor in strict accordance with the manufacturer's recommendations and the requirements of these specifications.

G. All piping insulation shall be installed following required testing and approval of piping.

3.02 IDENTIFICATION

A. Heat tracing systems shall be labeled at the field connection of power to the heat tracing equipment per the requirements for Utilization Equipment within Specification Section 26 05 53.

B. Heat traced piping, vessels, etc. shall be identified with appropriate caution signs or markings at intervals not exceeding 20 feet on center per NEC requirements.

3.03 TESTING

A. Factory inspections and tests for self-regulating, power limiting, series constant wattage and constant wattage (MI) heater cables shall include but are not limited to the following:

1. Testing shall be done per the latest IEEE Std. 515 test section and applicable manufacturer’s standards.
2. In the field, all heater cables shall be meggered. The following separate field megger readings shall be taken on each self-regulating and each M.I. heater cable:
   a. Heater cable shall be meggered when received at jobsite before installation.
   b. Heater cable shall be meggered after installation, but before insulation is applied.
   c. Heater cable shall be meggered after insulation has been installed.
3. All three of the above field megger readings shall be greater than 20 megohms. Otherwise, the heater cable is not acceptable and shall be replaced.
4. Field megger tests shall be recorded for each heater cable, and certified reports shall be submitted to the user.

END OF SECTION 26 44 00

SECTION 26 50 00
LIGHTING MATERIALS AND METHODS

PART 1 GENERAL

1.01 DESCRIPTION

A. Lighting Fixtures

B. Drivers

1.02 SUBMITTALS

A. Complete submittals shall be provided identifying all lighting fixture types and options, all lamp types (where applicable) and compliance with all contract requirements. The absence of clear submittal information specifically listing exceptions/deviations from detailed contract requirements will be understood to indicated that the contractor/supplier intends to meet all contract requirements. Refer to specification section 26 05 00 for additional requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Lighting fixtures shall be furnished as shown on plans and specified herein. It shall specifically be the responsibility of Contractor to verify exact types ceilings, walls, etc. and recessing depth of all recessed fixtures and furnish the specific mounting trims and accessories of the specified and/or accepted fixture specifically for the ceiling, wall etc. in which each fixture is to be installed.

B. Base bid manufacturers are listed on the lighting fixture schedule. Manufacturers listed without accompanying catalog numbers are responsible for meeting the quality standards, efficiency, maximum wattages and photometric distributions set by the specified product.

C. All lighting fixtures shall be so designed and shall have drivers and other similar items so installed as to function without interruptions or failures when operating in the environment in which they are proposed to be installed. Special attention shall be given to environments with potentially high ambient temperatures such as attic spaces, exterior soffits, confined interior soffits, coves, unconditioned spaces, etc. and shall be addressed by providing fixtures with suitable high ambient temperature ratings, remote mounting of drivers/ballasts, providing approved ventilation, etc. as directed by fixture

manufacturer and approved by engineer, at contractor's expense.

D. All fixtures installed such as to create penetrations through fire rated ceiling or wall assemblies shall be labeled as suitable for that purpose or installed with covers, tenting or other means as required to maintain the fire rating of the assembly.

2.02 LED LUMINAIRES

A. For the purpose of these specifications, LED Luminaires shall be defined as the entire LED fixture assembly including LED array, drivers, housing, electronics, etc. that compose the lighting fixture.

B. Furnish and install LED Luminaire of proper size, type, efficacy, delivered lumen output, color temperature, distribution pattern, operational life, and CRI as shown on drawings.

C. LED Luminaires shall be tested in accordance with LM-79 and LM-80 standards.

D. LED drivers shall comply with NEMA 410 standards for inrush current, etc.

E. Exterior, pole mounted LED Luminaires shall be provided with an easily-serviceable, UL recognized surge protection device that meets a minimum 10kA Category C Low operation (IECC C62.41.2-2002). Device shall be wired in front of light engine(s) and driver(s) and shall fail "open" such as to prevent fixture operation after a surge protection failure.

F. LED Luminaires shall have a guarantee-warranty of at least five years unless specifically noted otherwise on contract documents.

G. LED Luminaire assembly shall comply with ambient temperature requirements specified in General section above.

2.03 STEMS/PENDANTS

A. Hangers shall be approved ball aligner type swivel, 30 degrees from vertical with swivel below canopy.

B. Stems/Pendants shall be rigid conduit unless specified otherwise on plans. Proposed stem/pendant types shall be submitted for review prior to shipment of light fixtures from factory.

C. Stems/Pendants shall be provided as required to prevent swaying of fixtures due to HVAC system airflow or other similar occurrences.

D. Shall be painted the same color as the fixture trim unless noted otherwise.

2.04 MANUFACTURER

A. Fixtures and stems shall be manufactured as shown in fixture schedule or approved equals.

B. Drivers shall be as manufactured by Philips/Advance, GE, Lutron, Magnatec, Motorola, EldoLED or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION OF LIGHTING FIXTURES

A. Support:

1. Support of all lighting fixtures shall be responsibility of electrical contractor. All lighting fixture supports shall be installed in accordance with lighting fixture supplier's recommendations.
2. Contractor shall coordinate installation requirements for all wall-mounted fixtures (especially for wall-mounted fixtures on uneven wall surfaces, etc.) as required to assure a level/flat mounting surface and level/plumb/secure finished installation. Contractor shall provide flat mounting plates or other mounting provisions where necessary. Any proposed mounting plates, etc. shall be submitted to and approved by project architect prior to ordering materials.
3. Fixtures shall be supported independent of ceiling from structural members of building.
4. Lay-in fixtures shall be supported by four (4) taut 12 gauge hanger wires connected from each corner of the fixture to the structure above so that fixture is supported independent of the ceiling.
5. Other recessed light fixtures (including recessed downlights) shall be supported with two (2) taut 12 gauge hanger wires connected from opposing corners of the light fixture to the structure above so that fixture is supported independent of the ceiling.
6. Pendant mounted fixtures shall be directly supported from the structure above using a 9 gauge hanger wire or an approved alternate support without using the ceiling suspension system for direct support.
7. Tandem fixtures may utilize common hanger wires.
8. All lay-in fixtures shall be attached to ceiling grid by means of approved clips and in accordance with the N.E.C.
9. Contractor shall submit typical hanging detail to Engineer before installing any fixtures.

B. Connections:

1. All grid fixtures shall be wired by flex individually to junction and not wired fixture to fixture.
2. All flex shall contain 3 conductors (3rd wire ground). Ground wire shall be securely grounded at each end. Other conductors shall be connected by approved connectors.

C. Row-Mounted fixtures:

1. All stems on row-mounted fluorescent fixtures shall be installed as follows (except fixtures with slide grip hangers):
   a. One stem shall be installed in the first fixture knockout from end of row (on the first and last fixture of the row).
   b. One stem shall be installed between each two fixtures. Stem shall center joint where fixtures join and shall attach by use of "joining plates".

2. All fixtures in continuous rows other than recessed grid type shall be connected by nipples with locknuts bushings.

D. Coordination:

1. Contractor shall coordinate all dimensions & locations of light fixtures prior to rough-in to ensure proper fit and coordination with other trades.
2. Contractor shall verify exact ceiling types being installed and shall adjust fixture trim types accordingly (prior to submitting light fixture shop drawings).

END OF SECTION 26 50 00

SECTION 27 05 00
AUXILIARY SYSTEM CABLES, 0-50V

PART 1 GENERAL

1.01 DESCRIPTION

A. Cables rated for 0V-50V application

PART 2 PRODUCTS

2.01 GENERAL

A. Unless specified otherwise, all cables within the scope of this specification section shall:

1. Be rated for exposed cable tray installation.
2. Be plenum rated (Class 1 Control cabling and Instrumentation cabling installed in conduit or exposed in cable tray in non-plenum areas is not required to be plenum-rated).
3. Be UL-rated for the proposed application.
4. Be multi-conductor with overall outer sheath as required by the application. The insulation of each conductor within the overall multi-conductor cable shall be uniquely color-coded. Ground conductors (when provided) within the multi-conductor cable shall have green insulation. Conductors with green insulation shall not be used for conductors other than ground.
5. Utilize copper conductors.
6. Have wire gauge as required to limit voltage drop to acceptable limits determined by the system supplier and to meet all applicable code requirements.
7. Where installed underground, within slab-on-grade or in exterior locations, be rated for wet locations.
8. Where required for specific systems, meet the specific requirements (conductor quantity, wire gauge, insulation type, shielding, etc.) of the system supplier.

2.02 INSTRUMENTATION CABLING

A. In addition to above requirements, and unless specified otherwise, Instrumentation cabling shall:

1. Be #16awg minimum.
2. Be rated for 300V.
3. Have aluminum foil shielding.

4. Have stranded, twisted conductors.
5. Have PVC insulation/jacket with ripcord.
6. Be manufactured by Belden, AlphaWire or General Cable.

2.03 CLASS 1 CONTROL CABLING (120VAC CONTROL CIRCUITS, ETC.)

A. In addition to above requirements, and unless specified otherwise, Class 1 control cabling shall:

1. Be rated for 600V.
2. Be industrial grade.
3. Have stranded conductors.
4. Have sunlight/oil-resistant PVC/Nylon insulation and jacket with ripcord.
5. Be manufactured by Belden, AlphaWire or General Cable.

2.04 CLASS 2 & 3 CONTROL CABLING (FED FROM CLASS 2 OR 3 POWER SUPPLIES)

A. In addition to above requirements, and unless specified otherwise, Class 2 & 3 control cabling shall:

1. Be rated for 300V.
2. Be shielded if so recommended by the system supplier/integrator.
3. Have twisted conductors.
4. Have plenum-rated insulation/jacket with ripcord.
5. Be manufactured by AlphaWire, Belden, General Cable, Superior Essex or West Penn.

2.05 NETWORK CABLING

A. Furnish and install all Ethernet, Fiber Optic and Backbone Copper Telephone cabling in accordance with all BICSI requirements and in accordance with other applicable specification sections.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Routing:

1. All wires and cables shall be installed in conduit unless specifically noted otherwise. Where conduit is not otherwise required by contract documents, 0-50V Cabling located within concealed, accessible ceiling

spaces (such as above lay-in ceilings) may be run without conduit if the following requirements are met:

a. Cabling is plenum-rated, multi-conductor.
b. Cabling is supported by cable tray or with J-hook supports on intervals not to exceed 5'-0" on center. Cabling shall be supported solely from the cable tray or j-hooks supported from the building structure, without using piping, ductwork, conduit or other items as supports.
c. Cabling is neatly formed, bundled and tied with plenum-rated Velcro straps on intervals not to exceed 30" on center.
d. Properly-sized conduit(s) are provided wherever cabling enters an inaccessible or exposed area (such as above gyp board ceilings, within walls or through walls).
e. Cabling is not a part of a Fire Alarm System, Smoke Control System, Emergency Generator Control System or other life-safety related system.

2. End bushings shall be provided on both ends of all raceway terminations.
3. No splices shall be pulled into conduit.
4. No cabling shall be pulled until conduit is cleaned of all foreign matter.

B. Penetrations:

1. All fire/smoke barrier penetrations shall be made in accordance with a U.L. listed assembly.
2. For cabling not installed in conduit:
   a. Fire/smoke barrier penetrations shall be sealed utilizing an enclosed fire-rated pathway device (STI EZ Path or equal) containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and tested to the requirements of applicable ASTM/UL1479 standards.

3. For cabling installed within conduit from endpoint to endpoint:
   a. Fire/smoke barrier penetrations shall sealed utilizing fire caulk or other equivalent firestop systems around perimeters of conduits per UL requirements.

4. For cabling installed within cable trays:

a. Fire/smoke barrier penetrations shall be sealed with one of the following methods:
   1) Continuous cable tray through the penetration, with a combination of large firestop pillows and small firestop pillows contained, supported and secured (to prevent unauthorized removal) on both sides by aluminum wire mesh and firestop putty. Firestop pillows shall be STI Series SSB or equal and Firestop putty shall be STI Spec Seal or equal.
   2) Cable tray broken at the penetration, with fire/smoke barrier penetrations sealed utilizing an enclosed fire-rated pathway device (STI EZ Path or equal) containing a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to remove or reinstall firestop materials. The pathway shall be UL Classified and tested to the requirements of applicable ASTM/UL1479 standards.

C. Excess Cabling:

1. Excess cabling shall be neatly coiled within all junction boxes, pullboxes, wireways, etc. and at all terminations as required to allow future re-termination of cabling.

D. Terminations:

1. All conductors/cabling (including spare conductors) shall be properly terminated unless specifically directed otherwise. See below for general termination hardware requirements.
2. Cabling shall be neatly formed, bundled and tied at all terminations.

3.02 SPLICES/CONNECTIONS/TERMINATIONS:

A. Network Cabling:

1. Network and fiber optic cabling shall be continuous from endpoint to endpoint and shall not be spliced unless specifically noted otherwise.

B. Control Cabling:

1. Connections shall be made with T & B Sta-Kon wire joints EPT66M, complete with insulating caps. To be installed with WT161 Tool or C nest of WT11M Tool, Ideal Super - Nuts (not wire nuts), Ideal Wing Nuts, or Buchanan Elec. Products B Cap or Series 2000 Pressure

connectors complete with nylon snap on insulators to be installed with C24 pressure tool.

C. Shielded cabling:

1. Unless directed otherwise by the system supplier, 0-50V cable shielding shall be grounded at the PLC/control panel end only (not at the field device end) with a termination kit as directed by the PLC/control panel supplier.
2. Shielded cabling shall be continuous from endpoint to endpoint and shall not be spliced without prior written approval from the Engineer.

3.03 LABELING

A. Refer to Specification Section 26 05 53 for all labeling requirements.

END OF SECTION 27 05 00

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SUBMITTALS

A. Action Submittals: Drawings clearly showing clearing, grubbing, and stripping limits.

1.03 QUALITY ASSURANCE

A. Obtain Engineer’s approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.04 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 1/2 acre.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or Site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

A. As follows, but not to extend beyond Project limits:

1. Excavation Excluding Trenches: 5 feet beyond top of cut slopes.
2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
3. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping and Scalping: 2 feet beyond toe of permanent fill.
4. Structures: 10 feet outside of new structures.
5. Roadways: 5 feet from outer edges of proposed road.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 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. Flush with ground surface.

D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.04 GRUBBING

A. Grub areas within limits shown or specified.

3.05 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.

3.06 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 separately from other excavated material.

3.07 DISPOSAL

A. Clearing and Grubbing Debris: Dispose of debris offsite.

B. Scalpings: As specified for clearing and grubbing debris.

C. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite or in waste disposal areas shown or approved by Engineer.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3 (600 kN-m/m3)).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

D. Relative Density: As defined in Section 31 23 23, Fill and Backfill.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

F. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing, and Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under Earthfill: In areas not supporting foundations, pavement structures and structural fill, compact upper 12 inches to minimum of 90 percent relative compaction as determined in accordance with ASTM D698.

B. Under Pavement Structure, Foundations and Structural Fill: Compact the upper 12 inches to minimum of 98 percent relative compaction as determined in accordance with ASTM D698.

3.03 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to Optimum Moisture Content uniformly throughout.

B. Wet Subgrade: Aerate material to Optimum Moisture Content uniformly throughout by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

A. Proof-roll subgrade with equipment specified in Article Compaction to detect soft or loose subgrade or unsuitable material, as determined by Engineer.

B. In-Place Density Tests: In accordance with ASTM D6938. As a minimum, Contractor is to test as follows:

1. One in-place density test for each prepared subgrade per structure or per 5,000 square feet, whichever results in more tests.
2. One in-place density test per lift.

C. Additional tests as determined by the Engineer if tests results indicate compaction does not meet specifications. Engineer will retain independent Quality Assurance geotechnical firm to perform testing to verify results.

3.05 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact, or
2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 DEFINITIONS

A. Common Excavation: Removal of material not classified as rock excavation.

B. Rock Excavation: Excavation of solid material which by demonstration cannot, in Engineer's opinion, be reasonably loosened or ripped by single-tooth, hydraulically operated ripper mounted on crawler tractor in good condition and rated at minimum 410 flywheel horsepower; and which must be systematically drilled or broken by power-operated hammer, hydraulic rock breaker, expansive compounds, or other similar means prior to removal.

1.02 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan, Detailing:
    a. Methods and sequencing of excavation.
    b. Proposed locations of stockpiled excavated material.
    c. Proposed onsite and offsite spoil disposal sites.
    d. Numbers, types, and sizes of equipment proposed to perform excavations.
    e. Anticipated difficulties and proposed resolutions.
    f. Reclamation of onsite spoil disposal areas.

1.03 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees 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.

1.05 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02 41 00, Demolition, prior to excavating.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

C. Dewatering: As specified with Section 31 23 19.01, Dewatering.

D. Excavation Support: Install and maintain shoring, bracing, and sloping as necessary, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement, which may damage existing facilities, adjacent pavements, utilities, adjacent property, damage or delay the Work, or endanger life and health, and completed Work. Install and maintain as required by OSHA or other applicable local, state and federal governmental regulations.

E. Excavation Safety: The Contractor shall be solely responsible for performing all excavations in a safe manner. Provide appropriate measures to retain excavation side slopes to ensure that persons working in or near the excavation are protected.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Undercut existing fill materials a minimum of 5 feet below the bottom of the slab elevation and 5 feet outside the perimeter of the pad. All organic and unsuitable material shall be excavated and removed from these areas.

C. Do not overexcavate other areas without written authorization of Engineer.

D. Remove or protect obstructions as shown and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.

3.02 UNCLASSIFIED EXCAVATION

A. All excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered, as necessary, within the limits of construction and anticipated excavation depths as shown on Drawings and references.

3.03 STRUCTURAL OVEREXCAVATION

A. For equipment pads, structural slabs, and mat foundations not supported by drilled piers, undercut and over-excavate the existing fill materials and soft soils for a minimum of 5 feet below bottom of slab, foundation elevation, and 5 feet beyond the perimeter of the structure.

B. Replace overexcavated material with a minimum of 12 inches of foundation stabilization rock followed by structural fill or additional crushed stone in accordance with Section 31 23 23, Fill and Backfill.

3.04 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches 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: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work. Pipe of greater strength or superior pipe bedding, when approved in writing by Engineer, may be used in lieu of maintaining the pipe widths shown or specified.

3.05 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.06 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.

3.07 DRAINAGE AND DEWATERING

A. Contractor shall provide and maintain drainage and dewatering equipment to remove and dispose of all surfaces and ground water entering excavations, or other parts of the Work. Excavations shall be kept dry during subgrade preparation work and shall continue to be kept dry until structure is to be built, therein is inspected by the Engineer and backfill operations are completed and approved. All dewatering operations shall be performed in accordance with Section 31 23 19.01, Dewatering.

1. Water used for working or processing, resulting from dewatering operations, or containing contaminants that will reduce the quality of water downstream of the discharge points, shall not be directly discharged and shall be diverted through settling basins or filters prior to being discharged.

3.08 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

B. Dispose of debris resulting from removal of 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 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

SECTION 31 23 19.01
DEWATERING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Water control plan.
2. Well permits.
3. Discharge permits.
4. Water Level Elevations Observed in Observation Wells: Submit same day measured.
5. Settlement Benchmark Elevations: Submit weekly record.
6. Inflow Measurements: Submit weekly record.

1.02 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, means of measuring inflow to excavations, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of each system, including extraction wells, piezometers and observation wells, conveyance piping, pumps, sedimentation control facilities, discharge locations, and other components necessary to facilitate sufficient dewatering.
3. Design calculations demonstrating adequacy of proposed dewatering systems and components.
4. Water control plan and design calculations shall be stamped by professional engineer, licensed in the State of Alabama.

B. If system is modified during installation or operation, revise or amend and resubmit Water Control Plan. Do not commence excavation until revised and amended Water Control Plan has been received and approved.

C. Review of Contractor’s Water Control Plan (original and any subsequent revisions) shall be only for compliance with specific stated requirements for its content and that it is stamped by a licensed engineer as specified and not for accuracy of content or for adequacy of the Plan, both of which shall be solely the responsibility of Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. Remove and control water during periods when necessary to properly accomplish Work.

3.02 SURFACE WATER CONTROL

A. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, including artesian and perched groundwater and until backfilled to final grade.

B. Dewatering systems shall include extraction wells or well points, and other equipment and appurtenances installed outside structural limits and sufficiently below lowest point of excavation, or to maintain specified groundwater elevation.

C. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To allow required compaction of subgrade.
3. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
4. To relieve artesian pressures and resultant uplift of excavation bottom.
5. To allow excavation and construction of structures free of water.
6. To prevent instability of faces of excavation.

D. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

E. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

F. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

3.04 MONITORING WELLS

A. Monitoring Groundwater Levels: Install and monitor observation wells at locations approved by Engineer. Measure water levels observed in each observation well at frequency stated in Contractor's Dewatering Plan and whenever system or component failures are discovered and whenever any event, including but not limited to flood, storms, changes in water surface elevation of nearby water bodies, may have caused a change in the groundwater elevation.

3.05 ABANDON WELLS

A. After dewatering wells and groundwater level observation wells are no longer needed, abandon wells, as required by local and State regulations in accordance with Alabama Department of Environmental Management (ADEM).

3.06 SETTLEMENT

A. Monitoring Dewatering-Induced Settlement: Establish monuments for monitoring settlement at locations approved by Engineer. Monitor vertical movement of each settlement monument, relative to remote benchmark selected by Engineer, at frequency stated in Contractor's Dewatering Plan.

3.07 MONITORING FLOWS

A. Monitor volume of water pumped each calendar day from wells, well points, and excavations. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Engineer.

3.08 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. Remove and dispose of solids from treatment facilities per federal, state, and local regulations and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.09 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, bracing, underpinning, or compaction grouting.

3.10 REMEDIATION OF GROUNDWATER DEPLETION

A. If dewatering reduces quantity or quality of water produced by the Coldwater Spring, coordinate with Paul B. Krebs Water Treatment Plant operations and management to address water quality. Restore water quality and production quantity, by approved means, to the Plant prior to beginning the Work or as satisfactory to Anniston Water Works.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   f. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   g. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   h. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM 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 in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

H. Foundation Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

I. Wall Influence Area: Area within planes sloped upward and outward at 45-degree angle from horizontal measured from: 1 foot outside outermost edge at base of wall foundation.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

K. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

L. Imported Material: Materials obtained from sources offsite, suitable for specified use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

O. Earthfill: Fill materials required to raise existing grade in areas other than under structures, pavements, and other facilities.

P. Standard Specifications: When referenced in this section, shall mean the Alabama Department of Transportation, Standard Specifications for Highway Construction, latest Edition.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Pump Station Can manufacturer's recommendations for backfill around each buried tank.
2. Material Source: If Contractor provides any testing it should be by a certified independent testing agency.

B. Informational Submittals:

1. Manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; Section 31 23 19.01, Dewatering; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, Cast-In-Place Concrete.

D. Backfill around buried tanks only after tank is set in position, securely anchored, and ready to be backfilled and Engineer provides authorization to backfill.

E. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests:

1. As necessary to locate acceptable sources of imported material.
2. During production of imported material, provide one test for every 750 tons.

2.02 EARTHFILL

A. Excavated material from required excavations and designated borrow sites, free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.

C. Provide imported material of equivalent quality, if required to accomplish Work.

2.03 STRUCTURAL FILL

A. Structural fill shall be imported or excavated on-site residual material that is clean, free of organic, debris, or deleterious material.

1. Maximum size aggregate: 1-inch crushed gravel or crushed rock.
2. Roots and other organic material shall not exceed 2 percent by weight and the material shall not contain roots with caliper greater than 1/2 inch.
3. Maximum Liquid Limit (LL): 45.
4. Maximum Plasticity Index (PI): 20.

2.04 GRANULAR FILL

A. 1-inch minus crushed gravel or crushed rock.

B. Free from dirt, clay balls, and organic material and other deleterious materials.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.05 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.06 BASE COURSE ROCK

A. As specified in Section 32 11 23, Aggregate Base and Subbase Courses.

2.07 FOUNDATION STABILIZATION ROCK

A. Crushed stone in accordance with ALDOT No. 825 Type B, over geogrid reinforcement Tensar TX 160X or approved equivalent.

B. Where groundwater is present, the crushed stone layer shall consist of No. 24 “surge” stone.

C. Open graded No. 57 crushed stone shall be used for fill placed below groundwater in pipe trenches and below grade walls.

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. 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 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within the influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with structural fill or granular fill, unless otherwise shown. Place structural and granular fill in lifts of 8-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D698.

B. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 8-inch maximum thickness and compact each lift to minimum of 90 percent relative density.

C. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D698.

3.03 FILL

A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earth fill as follows:

1. Allow for 6-inch thickness of topsoil where required.
2. Maximum 8-inch thick lifts.
3. Place and compact fill across full width of embankment.
4. Compact to 90 percent relative compaction as determined in accordance with ASTM D698.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

A. Gradation:

1. One sample from each 750 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, provide one test per lift.

3.05 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base and Subbase Courses.

3.06 REPLACING STRUCTURAL OVEREXCAVATION

A. Replace excavated material with a minimum of 12 inches of foundation stabilization rock over geogrid, followed by compacted structural fill or additional crushed stone placed in 8-inch lifts to the bearing elevation.

3.07 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: Structural fill as shown on Drawings.

2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Structural fill as shown on Drawings.
4. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, 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): Earthfill.
   b. Steep Slopes (Steeper than 3:1):
      1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
      2) Backfilling overexcavated areas is prohibited, unless in Engineer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.08 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 23, Aggregate Base and Subbase Courses.

END OF SECTION

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
   i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   j. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   k. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   l. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   m. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   n. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

A. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

B. Imported Material: Material obtained by Contractor from source(s) offsite.

C. Lift: Loose (uncompacted) layer of material.

D. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

E. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

F. Relative Compaction: 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 as-compacted field dry density or maximum dry density, as determined by Engineer.

G. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

H. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:

1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer’s descriptive literature for marking tapes and tracer wire.

B. Informational Submittals:

1. Catalog and manufacturer’s data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.

PART 2 PRODUCTS

2.01 GEOTEXTILE

A. Properties for Nonwoven Geotextile are:

Description	Amount	ASTM Testing Standard
Weight	4.0 oz/sq yd, minimum	D3776
Grab Strength	120 pounds	D5034
Trapezoidal Tear	50 pounds	D4533
Waterflow Rate	120 gpm/sq ft	D4991

B. Manufacturers and Products:

1. Mirafi, Inc.; Mirafi 140N.
2. Phillips Fibers Corp.; Supac 4NP.

2.02 MARKING TAPE

A. Nondetectable:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 5 mils.
3. Width: 6 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Mutual Industries; Non-detectable Tape.
   c. Presco; Non-detectable Tape.

B. Color: In accordance with APWA Uniform Color Code.

Color*	**Facility**
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.03 TRENCH STABILIZATION MATERIAL

A. ALDOT No. 57 Stone if the depth of the stabilization material is less than 18 inches. Use ALDOT No. 2 Stone if the depth of the stabilization material required is equal to or greater than 18 inches.

2.04 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

1. PVC Irrigation System Piping and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
2. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
3. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.
4. Perforated Pipe: Granular drain material.
5. Conduit and Direct-Buried Cable:
    a. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
    b. Individual Particles: Free of sharp edges.
    c. Maximum Size Particle: Pass a No. 4 sieve.
    d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.05 EARTH BACKFILL

A. Earthfill: As specified in Section 31 23 23, Fill and Backfill.

2.06 GRANULAR FILL

A. Granular fill: As specified in Section 31 23 23, Fill and Backfill.

2.07 SOURCE QUALITY CONTROL

A. Contractor’s testing laboratory to perform gradation analysis in accordance with ASTM C136.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.
4. Do not allow water from the trench to enter the proposed pipeline and do not use the proposed pipeline to convey water from the excavation.
5. Dewater to a level at least 1-foot below the bottom of the excavation until pipe zone material has been installed and compacted.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

A. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

B. Hand grade and compact each lift to provide a firm, unyielding surface.

C. Minimum Thickness: As follows:

1. Pipe 15 Inches and Smaller: 4 inches.
2. Pipe 18 Inches to 36 Inches: 6 inches.
3. Pipe 42 Inches and Larger: 8 inches.

D. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

E. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

F. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.05 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material to 92 percent relative compaction by a minimum of three passes with a vibratory plate compactor only over area between sides of pipe and trench walls. Take care to avoid damaging pipe and pipe coating.

3.06 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping. Install 1-foot above the top of the pipe.

3.07 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Class A Backfill:

1. Use select native material from excavation.
2. Place in lifts not exceeding thickness of 8 inches.
3. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.
4. Replace stockpiled topsoil excavated from excavation.

C. Class D Backfill: Trenches in asphalt roads or paved areas.

1. Backfill using ALDOT 57 stone from top of pipe zone to a point at least 18 inches below top of finished paving surface elevation. Place in lifts not to exceed 8 inches. Compact each lift until it is firm and unyielding with a minimum of 3 passes with a vibratory plate compactor across the entire excavation width.
2. Backfill from depth of 18 inches to top of finished grade using crushed limestone aggregate as specified in Section 825 Type B of the Standard Specifications in lifts not exceeding 8 inches for the full width of the trench and disturbed area. Compact each lift to a minimum of 98 percent relative compaction prior to placing succeeding lifts.

3.08 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6-inches of backfilled trench in areas to be grassed.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.

E. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 32 00
SOIL STABILIZATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section: Official Seed Analysts of North America.

1.02 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted and continue for a period of 8 weeks after planting under this section is completed.

B. Satisfactory Stand: Grass or section of grass that has:

1. No bare spots larger than 3 square feet.
2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.03 SUBMITTALS

A. Action Submittals: Product data for commercial products; seed, fertilizer, and lime.

B. Informational Submittals:

1. Seed certifications.
2. Copies of delivery invoices or other proof of quantities of mulch, lime, and fertilizer.
3. Manufacturer’s Installation Instructions: Commercial products.

1.04 DELIVERY, STORAGE, AND PROTECTION

A. As specified in Section 32 92 00, Turf and Grasses.

1.05 SEQUENCING AND SCHEDULING

A. As specified in Section 32 92 00, Turf and Grasses.

B. Complete soil preparation, seeding, liming, fertilizing, and mulching within 10 days after final grades have been reached.

C. Notify Engineer at least three days in advance of:

1. Materials delivery.
2. Start of planting/seeding activity.

1.06 MAINTENANCE

A. Operations: As specified in Section 32 92 00, Turf and Grasses.

PART 2 PRODUCTS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.

B. Fertilizer shall have the following minimum percentage of plant food by weight:

1. Summer Mix:
   a. Nitrogen: 20 percent.
   b. Phosphoric Acid: 10 percent.
   c. Potash: 10 percent.
2. Winter Mix:
   a. Nitrogen: 16 percent.
   b. Phosphoric Acid: 8 percent.
   c. Potash: 0 percent.

2.02 SEED

A. As specified in Section 32 92 00, Turf and Grasses.

2.03 MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, material fibers become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

B. Straw:

1. As specified in Section 32 92 00, Turf and Grasses. Suitable for spreading with mulch blower equipment.
2. Average Stalk Length: 6 inches.
3. Seasoned before baling or loading.

2.04 EROSION CONTROL MATTING

A. Matting as specified in Section 32 92 00, Turf and Grasses.

B. Manufacturers and Products:

1. Akzo Industries, Asheville, NC; Curlex Mat.
2. North American Green, Evansville, IN; S150 blanket.

2.05 S150 BLANKET TACKIFIER

A. As specified in Section 32 92 00, Turf and Grasses. Derived from natural organic plant sources containing no growth or germination-inhibiting materials.

B. Capable of hydrating in water, and to readily blend with other slurry materials.

C. Wood Cellulose Fiber: Add as tracer, at rate of 150 pounds per acre.

D. Manufacturers and Products:

1. Chevron Asphalt Co.; CSS-1.
2. Terra; Tack AR.
3. J-Tack; Reclamare.

PART 3 EXECUTION

3.01 SOIL PREPARATION

A. Before start of hydroseeding, and after surface has been shaped and graded, and lightly compacted to uniform grade, scarify soil surface to minimum depth of 1 inch.

3.02 SEEDING

A. Prepare 1-inch-deep seed bed. Obtain Engineer’s acceptance prior to proceeding.

B. Apply by hydroseeding method on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.

C. Summer Application:

1. Prepare and apply mix as follows:
   a. Seed Mix: 50 pounds per acre.
   b. Fertilizer, 20-10-10: 650 pounds per acre.

3.03 MULCHING

A. Apply uniformly on seeded areas.

B. Application: Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.

1. Straw: Apply by hand or mechanical means to minimum depth of 2 inches.
2. Wood Cellulose Fiber: 1,000 to 1,500 pounds per acre.

3.04 EROSION CONTROL MATTING

A. Place on seeded slopes 3H:1V and steeper, staple/stake in place and with the appropriate overlap in accordance with manufacturer’s instruction.

3.05 TACKIFIER

A. Apply on areas mulched with straw.

B. Spray on after mulch is in place.

C. Apply in quantities sufficient to equal retention properties of a CSS-1 asphalt emulsion being applied at rate of 400 gallons per acre.

3.06 REINFORCED PLASTIC COVERING

A. Place on areas where hydroseeding and erosion control matting have not controlled erosion.

B. Install in single thickness, strips parallel to direction of drainage.

C. Maintain tightly in place by using sandbags on ropes with a maximum 10-foot grid spacing in all directions.

D. Tape or weight down full length, overlap seams at least 12 inches.

E. Remove at final acceptance, unless notified otherwise by Engineer.

3.07 FIELD QUALITY CONTROL

A. Upon completion of maintenance period and on written notice from Contractor, Engineer will within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, Engineer will make another determination upon written notice from Contractor following the next growing season.

END OF SECTION

SECTION 31 32 19.16
GEOTEXTILE

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. D737, Standard Test Method for Air Permeability of Textile Fabrics.
   b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   e. D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
   f. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   g. D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
   h. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   i. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
   j. D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
   k. D4886, Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).
   l. D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
   m. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
   n. D6193, Standard Practice for Stitches and Seams.

1.02 DEFINITIONS

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.

C. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer material specifications and product literature.
   b. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
   c. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.
2. Samples:
   a. Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile furnished for Project. Label each with brand name and furnish documentation of lot and roll number from which each Sample was obtained.
   b. Field Sewn Seam: 5-foot length of seam, 12 inches wide with seam along center, for each type and weight of geotextile.
   c. Securing Pin and Washer: One each.

B. Informational Submittals:

1. Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.
2. Field seam efficiency test results.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

1.05 SCHEDULING AND SEQUENCING

A. Where geotextile is to be laid directly upon ground surface, prepare subgrade as specified in Section 31 23 13, Subgrade Preparation, first.

B. Notify Engineer whenever geotextiles are to be placed. Do not place geotextile without Engineer's approval of underlying materials.

PART 2 PRODUCTS

2.01 NONWOVEN GEOTEXTILE

A. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding.

B. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.

C. Unseamed Sheet Width: Minimum 6 feet.

D. Nominal Weight per Square Yard: 8 ounces per ASTM D5261.

E. Physical Properties: Conform to requirements in Table No. 31 32 19.16-1.

Table No. 31 32 19.16-1
Physical Property Requirements for Nonwoven Geotextile

Property	Requirement	Test Method
Water Permittivity	0.5 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Apparent Opening Size (AOS)	40 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength, Machine Direction	200 lb/in, MinARV	ASTM D4632
Grab Elongation, Machine Direction	50 percent, MaxARV	ASTM D4632
Puncture Strength	350 lb, MinARV	ASTM D4833
Trapezoid Tear Strength	80 lb, MinARV	ASTM D4533
Abrasion Resistance	30 percent loss, 250 cycles, MaxARV	ASTM D4886
Ultraviolet Radiation Resistance	50 percent strength retention, MinARV after 500 hours	ASTM D4355

2.02 SEWING THREAD

A. Polypropylene, polyester, or Kevlar thread.

B. Durability: Equal to or greater than durability of geotextile sewn.

2.03 SECURING PINS

A. Steel Rods or Bars:

1. 3/16-inch diameter.
2. Pointed at one end.
3. With head on other end sufficiently large to retain washer.
4. Minimum Length: 12 inches.

B. Steel Washers for Securing Pins:

1. Outside Diameter: Not less than 1.5 inches.
2. Inside Diameter: 1/4 inch.
3. Thickness: 1/8 inch.

C. Steel Wire Staples:

1. U-shaped.
2. 10 gauge.
3. Minimum Length: 6 inches.

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.02 SHEET ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

3.03 JOINTS

A. Unseamed Joints:

1. Overlapped.
2. Overlap, unless otherwise shown:
   a. Foundation/Subgrade Stabilization: Minimum 18 inches.
   b. Riprap: Minimum 18 inches.
   c. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.
   d. Other Applications: Minimum 12 inches.

B. Sewn Seams: Made wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by Engineer, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam Efficiency:
   a. Minimum 70 percent.
   b. Verified by preparing and testing minimum of one set of nondestructive Samples per acre of each type and weight of geotextile installed.
   c. Tested according to ASTM D4884.

2. Types:
   a. Preferred: “J” type seams.
   b. Acceptable: Flat or butterfly seams.
3. Stitch Count: Minimum three to maximum seven stitches per inch.
4. Stitch Type: Double-thread chainstitch according to ASTM D6193.
5. Sewing Machines: Capable of penetrating four layers of geotextile.
6. Stitch Location: 2 inches from geotextile sheet edges, or more, if necessary to develop required seam strength.

3.04 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sandbags or other means approved by Engineer.

B. Secure Geotextile with Securing Pins or Staples:

1. Insert securing pins with washers through geotextile.
2. Securing Pin Alignment:
   a. Midway between edges of overlaps.
   b. 6 inches from free edges.
3. Spacing of Securing Pins:

Slope	Maximum Pin Spacing
Steeper than 3:1	2 feet
3:1 to 4:1	3 feet
Flatter than 4:1	5 feet

4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.
6. Where staples are used instead of securing pins, install in accordance with alignment and spacing above. Push in to secure geotextile firmly to subgrade.

3.05 PLACING PRODUCTS OVER GEOTEXTILE

A. Before placing material over geotextile, notify Engineer. Do not cover installed geotextile until after Engineer provides authorization to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.06 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way to completely envelope granular drain material to be placed in trench and with specified overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.07 RIPRAP APPLICATIONS

A. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet.

B. Sew joints where wave run-up may occur.

C. Limit height of riprap fall onto geotextile to prevent damage.

1. Drop Height: 0 foot for greater than 200-pound rock.
2. 3 feet for less than 200-pound rock.

3.08 GEOTEXTILE-REINFORCED EARTH WALL APPLICATIONS

A. Sew exposed joints; extend sewn seams minimum 3 feet behind face of wall.

B. Protect exposed geotextile from damage, ultraviolet light exposure, and deterioration until permanent facing is applied.

3.09 SILT FENCE APPLICATIONS

A. Install geotextile in one piece, or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.

B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

C. Securely fasten geotextile to wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

D. Promptly repair or replace silt fence that becomes damaged.

3.10 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.

B. Repair Procedure:

1. Place patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.
2. Remove interfering material as necessary to expose damaged geotextile for repair.
3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Engineer.

3.11 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in Engineer's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   b. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. C150, Standard Specification for Portland Cement.
   d. C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.02 DEFINITIONS

A. Refer to applicable definitions in Section 31 23 23, Fill and Backfill.

B. Standard Specifications, as used in this section, refer to Alabama Department of Transportation Standard Specifications for Highway Construction, latest edition.

1.03 SUBMITTALS

A. Informational Submittals:

1. Quarry Certificate of Conformance and supporting documentation showing proposed riprap bedding or riprap meet Standard Specification gradation and materials requirements for the Class or Type specified.
2. Certified Test Results:
   a. Riprap:
      1) Gradation.
      2) Abrasion resistance.
      3) Bulk density.
3. Trip tickets showing source, type, and weight of each load of material delivered to Site.

1.04 QUALITY ASSURANCE

A. Riprap Source: Quarry that has produced riprap and has performed satisfactorily on other projects for at least 5 years.

1.05 SCHEDULING AND SEQUENCING

A. Complete subgrade preparation as specified in Section 31 23 13, Subgrade Preparation, and geotextile installation as specified in Section 31 32 19.16, Geotextile, prior to placing riprap.

PART 2 PRODUCTS

2.01 AGGREGATE RIPRAP BEDDING

A. Gravel with Cobbles or Crushed Rock with Cobble-Sized Pieces:

1. Gradation, as determined in accordance with ASTM C136:
   a. Well-graded from coarse to fine.
   b. All pieces pass a 6-inch square opening.
   c. Minimum 85 percent by weight passes 4-inch square opening.
   d. Minimum 10 percent by weight passes No. 4 U.S. standard sieve.
2. Abrasion Resistance: Maximum 35 percent wear when tested in accordance with ASTM C535.

B. Free of roots and other organic or deleterious matter.

C. Onsite material from excavations or designated borrow sources that meets or is processed to meet requirements specified above may be used as riprap bedding in lieu of importing material.

2.02 GEOTEXTILE RIPRAP BEDDING

A. Bedding geotextile as specified in Section 31 32 19.16, Geotextile.

2.03 RIPRAP

A. As specified in Section 610 of the Standard Specifications.

PART 3 EXECUTION

3.01 PLACING RIPRAP

A. Place riprap over geotextile to uniform thickness shown.

B. No mechanical compaction of riprap is required; however, work riprap bedding as necessary to distribute it and to eliminate detrimental voids. Avoid overworking or long pushes that result in segregation of particle sizes.

C. Grade surface of riprap bedding free from irregularities and to tolerances of 0.2 feet from established grade.

D. Place and grade riprap in a manner that avoids subgrade disturbance and displacement or damage to geotextile. Do not push riprap bedding down slope. If wrinkles form in geotextile as riprap bedding is placed, correct them as specified in Section 31 32 19.16, Geotextile.

E. Place riprap on geotextile without puncturing or damaging geotextile. If accidentally damaged, repair geotextile prior to proceeding.

3.02 GROUTING RIPRAP

A. Remove dirt and foreign substances from surfaces of riprap and then moisten.

B. Deposit grout by means of chutes, tubes, or buckets, or place by means of pneumatic equipment or other mechanical methods. Place grout in a continuous operation for any day's run at any one location.

C. Limit flow distance of grout along slope to less than 10 feet.

D. Spade and rod grout into place with suitable spades, trowels, or other approved means immediately after depositing grout. Depths of grout shall be approximately 1/2 the thickness of the riprap.

E. Following placement of grout, thoroughly brush rocks so top surfaces are exposed. Outer rocks shall project 1/3 to 1/4 their diameter above grout surface. Brushing shall follow closely behind rodding such that grout shall not be in place more than 1 hour before brushing.

F. Once brushing of area is complete, no worker or load will be permitted on surface for period of at least 24 hours, or longer if so required by Engineer.

G. Cure grout as provided in Section 03 30 10, Structural Concrete.

END OF SECTION

SECTION 31 41 00
SHORING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Excavation support plan.
2. Movement monitoring plan.
3. Movement measurement and data and reduced results indicating movement trends.
4. Review of excavation support plan and movement monitoring plan shall be only for compliance with topics included, preparation or performance by a registered professional, and similar specified requirements, and not for the accuracy or the adequacy of the plans or facilities, which together with all other matters of health and safety shall be solely the responsibility of Contractor.

1.02 QUALITY ASSURANCE

A. Perform surveys to monitor movements of existing structures and facilities located within 100 feet of excavation.

B. Perform surveys by professional land surveyor licensed in the State of Alabama.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.

3.02 EXCAVATION SUPPORT PLAN

A. Prepare excavation support plan addressing following topics:

1. Details of shoring, bracing, sloping, or other provisions for protection of existing facilities, finished products, and worker protection from hazards of caving ground.
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.
6. Anticipated difficulties and proposed resolutions.
7. The excavation support plan shall be stamped and signed by a professional engineer licensed in the State of Alabama.

B. Coordinate submittals and Excavation Support Plan with dewatering and excavation requirements.

3.03 MOVEMENT MONITORING PLAN

A. Prepare movement monitoring plan addressing following topics:

1. Survey control.
2. Location of monitoring points.
3. Plots of data trends.
4. Interval between surveys.
5. Stamped and signed movement monitoring plan by a professional engineer licensed in the State of Alabama.

3.04 REMOVAL OF EXCAVATION SUPPORT

A. Remove temporary excavation support in a manner that will maintain support as excavation is backfilled.

B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

C. Remove excavation support in a manner that does not leave voids in the backfill.

3.05 TRENCHES

A. Provide adequate safety system meeting requirements of applicable state and local construction safety orders, and federal requirements.

END OF SECTION

SECTION 31 63 29
DRILLED CONCRETE PIERS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI): 306.1, Standard Specification for Cold Weather Concreting.
2. ASTM International (ASTM):
   a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   d. E329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
   e. D6760, Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing.

1.02 DEFINITIONS

A. Bearing Stratum: Formations or layers of rock that support pier and loads imposed on it.

B. Casing: Protective steel casing usually of cylindrical shape, lowered into excavated pier to prevent collapse or cave-in of sidewalls and for purpose of excluding soil and water from excavation.

C. Design Position: The location of the centroid of the pile at cutoff elevation (x, y, and z coordinates) as shown.

D. Deviation: Difference between actual as-constructed horizontal location of center of pier from required location.

E. Drilling Slurry: A mixture of water and mineral in suspension used with or without casing to stabilize excavated pier until casing has been installed or concrete has been placed.

F. Excavation: Drilled pier excavation.

G. Plumbness: Difference in horizontal location of center of pier measured at top and at bottom.

H. Competent Rock: Continuous intact natural material in which the penetration rate with a rock auger is less than 2 inches per 5 minutes of drilling at full crowd force. This excludes discontinuous loose natural materials such as boulders and man- made materials such as concrete, steel, timber, and others. It is rock when it has more than 5 feet of continuous rock without air, water, or soil-filled voids larger than 6 inches.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Commercial materials including cement, admixtures, and fluidifiers.
2. Steel Reinforcement:
    a. Include design calculations.
    b. Show that steel layout and details conform with those shown.

B. Informational Submittals:

1. Subsurface Exploration Plan:
    a. Equipment
    b. Drilling sub-contractor qualifications
    c. Methods and Procedures.
    d. Drilling logs.
2. Drilled Concrete Piers Installer qualifications.
3. Manufacturer’s Certification of Compliance: Commercial products.
4. Certified Test Results: Concrete mix design, including certification of minimum 28-day compressive strength and aggregates.
5. Mill Certificates: Reinforcement steel, spirals, pile anchorage steel, void form material, and other embedded items.
6. Drilled Pier Construction Plan:
    a. Contractor’s equipment, methods, sequence, and procedures to include:
        1) List of proposed equipment.
        2) Pier drilling and casing installation and removal, if any.
        3) Slurry design, method to mix, circulate, and desand.
        4) Method of checking and proving the cleanliness of the pier bottom and soundness of foundation material prior to concreting.

5) Details of steel reinforcement placement.
6) Concrete mix design.
7) Concrete placement plan.
8) Dewatering and water/mud disposal plan.

7. Daily Log and Record: At end of each working day, submit two copies of each record for every pier constructed that day.

1.04 QUALIFICATIONS

A. Contractor should have minimum of 5 years of past successful experience on 10 projects of drilled concrete pier installation.

1.05 SEQUENCING AND SCHEDULING

A. Complete earthwork in vicinity of pier to top elevation of drilled pier prior to commencing pier drilling.

B. Drill pier, clean out, inspect, install reinforcing steel, and place concrete, in a manner to minimize time piers are left open and to prevent deterioration of pier. If acceptable in advance by Engineer, pier may be left open overnight but must be temporarily cased and have a cover placed over top of casing.

PART 2 PRODUCTS

2.01 CONCRETE

A. Meet requirements specified in Section 03 30 00, Cast-in-Place Concrete, except the followings:

1. Strength: Concrete for drilled shafts shall have a minimum compressive strength of 5,000 psi at 28 days.
2. The maximum coarse aggregate size shall be ¾-inch.
3. Slump:
   a. 8 to 10 inches.
   b. One test of the slump shall be performed per truckload of concrete or per batch of concrete mixed on site. All tests shall be done in the presence of the Owner’s representative.
   c. Ensure that drilled shaft concrete maintains a slump of 4 inches or more throughout the drilled shaft concrete elapsed time.
   d. Ensure that the slump loss is gradual as evidenced by slump loss tests described below. The concrete elapsed time is the sum of the mixing and transit time, the placement time and the time required for removal of any temporary casing that could cause the concrete to flow into the space previously occupied by the temporary casing.

4. Slump Control:
    a. Water shall not be added after arrival at jobsite.
    b. Unless otherwise specified, if concrete slump test results are below required slump, slump may be adjusted by adding chemical admixtures in accordance with manufacturer recommendations subject to approval by Engineer.
    c. Re-dosing at site is prohibited.
    d. Measure slump and air content of air-entrained concrete after slump adjustment to verify compliance with specified requirements.
5. Slump Loss Test:
    a. Batch the actual mix design at initial slump specified above and at the highest concrete temperature expected on the job, but no less than 60 degrees F.
    b. Batch at least 4 cubic yards in a mixer truck. Begin timing the test when the mixing water is introduced into the mix.
    c. After initial mixing, measure and record the slump, ambient and concrete temperature, and percent air. Ensure all concrete properties are within specifications.
    d. Mix the concrete intermittently at agitation speed for 30 seconds every 15 minutes.
    e. Measure and record the slump, ambient and concrete temperatures, and percent air after every 15-minute interval until the slump is 3-1/2 inches.
    f. Make certain the concrete maintains a minimum slump of 4 inches at least 4 hours after batching.

B. Slump: 9-inch maximum with no evidence of segregation or excessive bleeding observed during field inspection, testing, and throughout entire placement.

2.02 BENTONITE SLURRY

A. Mix design by Contractor with the following minimum requirements:

1. Viscosity (Measured by March Funnel, Seconds): 30 to 60.
2. Sand Content by Volume (Percent): 6, maximum.
3. pH: 8 to 11.
4. Density: Not less than that required to maintain positive head within excavation and prevent sidewall sloughing and such to allow proper displacement during concreting.

2.03 REINFORCING STEEL

A. Meet requirements specified in Section 03 21 00, Reinforcing Steel, and as indicated below:

1. Deformed Bars: ASTM A615, Grade 60.
2. Spiral Steel Reinforcing: ASTM A82.
3. Rebar Spacers: ASTM A276, Type 304 stainless steel.
4. Centralizers: Plastic.

2.04 TEMPORARY SURFACE CASING

A. Provide to maintain sidewall stability and prevent caving, to exclude groundwater, and as otherwise may be required. Strength shall withstand handling stresses, concrete pressure, and surrounding earth and/or fluid pressures.

B. Steel Casing:

1. ACI 306.1.
2. Inside Diameter: Not less than pier diameter.
3. Length: Extend from above surrounding ground line to depth and height necessary to construct pier.

PART 3 EXECUTION

3.01 DRILLING EQUIPMENT

A. Suitable type and size to produce a drilled pier of required size and length. Drill rigs are to have sufficient capacity to drill through limestone bedrock and prepared to drill at least 10 feet deeper than the estimated drilled pier tip elevation shown in the plans, if necessary.

B. Anticipate and make available at the Job Site all equipment necessary and essential to penetrate soft and hard soils, and weathered to competent limestone, during the construction of the drilled piers. Anticipate karstic conditions including, but not limited to, voids, pinnacles, floating boulders.

C. Capable of producing a pier without disturbance to material along pier or at pier base.

D. Do not use equipment with bent kelley bars or that wobbles during rotation while drilling.

3.02 SUBSURFACE EXPLORATION

A. Prior to construction, a subsurface exploration program shall be performed for the drilled piers. The subsurface exploration program shall consist of drilled boreholes advanced for every drilled pier location, with a minimum diameter of 2 inches using either core drilling, or air drilling such as an air track, as an alternative. The purpose of this exploration is to determine the depth and extent of the competent rock surface at each pier location to establish the piers tip elevation. The Contractor shall plan to advance a minimum of 5-feet continuously into competent rock below the pier tip elevation shown and at the direction of the Engineer.

B. Performing drilling by the suggested method shall allow for clear identification of the subsurface material boundaries, depths, elevations, and the size, extent, and type of voids, if any.

C. At completion of each drilling location, drill holes should be abandoned below the anticipated tip elevation of the pier.

D. Each drilling location shall be advanced a minimum of 10 feet into rock.

E. Survey the ground surface elevation at each drilling location and report to the Engineer.

F. The Contractor shall allow the Engineer and the Owner, at all times, access to the drilling operations. The Engineer will be present onsite to log conditions encountered during the drilling. Drilling sub-contractor shall maintain a drilling log per hole noting changes and subsurface conditions as drilling advances.

G. Drilling shall be conducted under the observation of the Engineer. The Engineer shall be onsite during all drilling. The Engineer will prepare additional detailed logs of the subsurface conditions, including groundwater conditions, encountered and their depths and/or extents.

H. The Engineer will use these logs to confirm the final tip elevation of the drilled piers. The Contractor shall anticipate that the Engineer will require up to 14 calendar days following completion of drilling to confirm the final tip elevations of the drilled piers. Logs prepared by the Engineer will be made available to the Contractor.

3.03 DEWATERING

A. As specified below:

1. Prevent water from entering drilled piers either directly or by infiltration adjacent to pier.
2. Where surface water damages sides or base of a drilled pier, redrill pier and clean base.
3. Upon completion of pier excavation, dewater each pier and maintain water to less than a depth of 2 inches.
4. If water in pier cannot be controlled at or below specified depth, obtain Engineer approval to place concrete by tremie method. If approved, pier shall be allowed to fill with water to natural level prior to placement of concrete.

3.04 TEMPORARY SURFACE CASING

A. Aid in pier alignment, prevent surface sloughing, and as necessary to extend drilled pier casing above surrounding grade to prior cutoff elevations and to sufficient depth to aid in pier alignment and prevent sloughing and caving of near-surface soil.

3.05 EXCAVATION

A. Unclassified: Complete excavation regardless of type of materials encountered.

B. Excavate holes with equipment of the sizes required to construct the drilled piers. Use equipment and methods accepted in the drilled pier construction plan or approved by the Engineer. Inform the Engineer of any deviations from the accepted plan.

C. Rock excavation to be completed using special rock augers, core barrels, air tools, or other methods of excavation to the bottom of the pier.

D. Blasting is not permitted for excavation of rock.

3.06 DRILLED PIER DRILLING

A. Provide Engineer minimum 7 days' notice of and perform only in presence of Engineer or authorized representative.

B. Use temporary casing or drilling slurry to prevent caving and/or water inflow.

C. Perform in continuous operation without interruptions until pier is complete and, in a manner, so as not to disturb material adjacent to pier.

D. Avoid overdrilling of diameter and depth necessary to install casing.

E. Keep void space outside temporary casing to a minimum.

F. Drilling Depth:

1. Approximate depth corresponding to the elevation shown on the Plans. Plans may indicate a minimum depth below apparent bedrock, which may require adjustments to drilling footage (more or less) depending on conditions encountered.
2. Actual depth determined by Engineer during excavation (plus or minus 6 inches) based upon subsurface conditions identified during the drilled pier excavation.

G. For all piers including where temporary casing is used, remove disturbed or loose material from sides and bottom of pier upon completion of pier excavation:

1. Pier Bottom: Remaining debris shall be limited to an average thickness of 1/2 inch with a maximum thickness of 1 1/2 inches.
2. Pier Sides Within Rock Socket: Clean and free of all debris, including mud and cuttings.

H. Defective Piers: Correct piers drilled in excess of specified tolerances by reaming to a larger diameter or by redrilling in correct locations, as determined by Engineer. Fill abandoned piers with specified concrete.

3.07 REINFORCING STEEL

A. As specified in Section 03 30 00, Cast-In-Place Concrete.

B. Spacers: Locate to ensure specified coverage tolerances.

C. Reinforcing Cages:

1. Fasten bars together to form single, rigid, straight unit.
2. Position and securely fasten bars to ensure clearance between reinforcing bars and sides of drilled pier.

D. Ensure reinforcement will remain in place throughout concrete placement and that specified concrete cover is attained and maintained.

E. Rest cage on base of drilled pier or as shown.

3.08 CONCRETE PLACEMENT

A. Place concrete continuously in one pour to top elevation using a hopper with a spout that directs concrete down middle of pier. For uncased sections, extend rigid pipe spout from hopper to beyond bottom of reinforcement steel cage to direct concrete down pier center to prevent concrete from hitting sides of excavation.

B. Adjust rigid pipe spout length as pier is being filled such that maximum drop from bottom of rigid pipe to fresh concrete surface is no greater than 10 feet.

C. Vibrate concrete within top 10 feet of drilled piers with mechanical tools as specified in Section 03 30 00, Cast-In-Place Concrete.

D. Excess Concrete: Remove accumulation at top of pier so pier has a uniform diameter throughout.

E. Tremie Methods: If placement of concrete beneath surface of water or bentonite slurry are used:

1. Keep tremie pipe as near as possible to the bottom of excavation, equip with weight as necessary.
2. Prevent water intrusion into tremie pipe.
3. Equip tremie pipe with a bottom plate or floating plug. Vent as necessary to prevent formation of air pockets.
4. Keep discharge end entirely immersed in concrete at all times.
5. Support tremie pipe so that it can be raised to increase discharge rate or lowered to decrease discharge rate.
6. Provide continuous flow of concrete in order for concrete in tremie pipe to maintain a positive pressure differential at all times to prevent slurry intrusion into the pier concrete.

F. After concrete has attained an initial set as evidenced by absence of bleed water, place a suitable cover that prevents drying of top or contamination with foreign material. A curing compound may be used.

3.09 TEMPORARY CASING REMOVAL

A. Withdraw during concrete placement while concrete is still fluid and plastic, and before initial set.

B. Maintain minimum 5-foot head of concrete on bottom of temporary casing at all times.

C. Take every precaution to prevent caving pier while concrete is being placed.

D. Prevent arching of concrete as casing is removed.

3.10 TOLERANCES

A. Ground surface at time of drilled pier construction shall be at pier top elevation, plus or minus 0.1 foot.

B. Pier Centroid: Not more than 3 inches or 1/24th of pier diameter, whichever is less from design position.

C. Pier Out-of-Plumb: Not to exceed 2 percent of pier length.

D. Concrete Cutoff Elevation: Not to exceed plus 1 inch to minus 2 inches.

3.11 WASTE DISPOSAL

A. Remove spoil and bentonite slurry from Site and dispose of as specified in Section 31 23 16, Excavation.

3.12 CROSSHOLE SONIC LOGGING

A. General:

1. Crosshole Sonic Logging (CSL) is a nondestructive testing (NDT) method that measures the time for an ultrasonic pulse to travel from a signal source inside an access tube to a receiver inside another access tube and evaluates the integrity of drilled pier.
2. The Owner or Engineer will employ the services of a qualified testing company to perform the CSL testing. The Contractor will provide all needed equipment, labor, and access as requested by the testing company and Engineer. Contractor is responsible for installing CSL tubing for all drilled piers per paragraph 3.12.B.
3. All CSL testing will be completed with 10 calendar days of concrete placement; as determined by Engineer when necessary.
4. Prior to beginning the CSL test, ensure that the test probes can pass through and down the tubes to the bottom of every installed tube. If a tube is obstructed, the Contractor, at no additional cost to the Owner, must core a hole within the drilled pier and near the obstructed tube to the depth as directed by the Engineer. The core shall be large enough to accommodate the probe through its full length.

5. The Engineer will evaluate and analyze the CSL test results within 5 business days of their receipt and provide a response regarding the acceptability of the drilled pier tested. The test shall be performed in accordance with ASTM D6760.
6. If CSL testing determines that a drilled pier is defective, then additional verification testing will be required at the direction of the Engineer, with all additional cost covered by the Contractor.

B. Installation Requirements:

1. Drilled piers must be fitted with CSL test tubes to evaluate their integrity.
2. Install the access tubes or pipes as nearly parallel and far as possible from the longitudinal bars. The number of tubes to be installed per each drilled pier diameter shall be enough to confidently determine the integrity of the piers and in accordance with current standards of practice.
3. Securely attach the tubes to the interior of the reinforcement cage with a minimum concrete cover of 3 inches. The tubes may be attached to the exterior of the cage when accepted by the Engineer provided the minimum cover requirement of 3 inches over the tubes is maintained. In all cases, the tubes shall be as near to vertical and parallel to one another as possible.

C. Extend the tubes from the bottom of the drilled pier to at least 3 feet above the top of the drilled pier. The tubes must be watertight and capped to prevent concrete or debris from entering during installation of the cage and concreting. Care must be taken during lifting and lowering the steel reinforcement so as not to damage the tubes. Fill the CSL tubes with clean water prior to concrete placement. Following completion of the CSL tests, remove all the water from the access tubes or drilled holes and fill them with an approved grout.

3.13 FIELD QUALITY CONTROL

A. Contractor is responsible for accommodating the Owner furnished geotechnical observations, special inspections and testing provided in the project’s Statement of Special Inspections on Drawings and Section 01 45 33, Special Inspection, Observation, and Testing.

B. Do not start reinforcing steel or concrete placement until pier excavation has been successfully inspected and accepted by Engineer.

C. Pile Logs and Record: Document for each drilled concrete pier showing as a minimum:

1. Pier number and location.
2. Model and type of drilling equipment.
3. Pier diameter.
4. Pier length, deviation, and plumbness.
5. Depth drilled.
6. Elevation of ground surface at start of drilling.
7. Top and bottom elevations of concrete.
8. Bottom elevation, type, length, and diameter of casing used, if any.
9. Nature and location of obstructions encountered.
10. Any unusual occurrences during drilling.
11. Dewatering, if performed, and depth of water in pier, if any, when concrete is placed.
12. Theoretical and actual volume of concrete placed.
13. Date and time at start of drilling, completion of drilling, inspection, start of concrete placement, and completion of concrete placement.

D. Based on the CSL Test:

1. CSL results will be evaluated by the Engineer. If the Engineer determines that CSL testing indicates significant anomalies or defects, the Engineer will direct the Contractor to core the pier(s) at the location(s) of the defect or anomaly. The coring shall be a minimum of NX sized double tube core barrel. The Engineer will determine the number of cores, length(s), location(s), and testing methodology. Of the coring or core sample testing results confirm the presence of significant anomalies or defects, the drilled pier will be determined to be unacceptable and rejected by the Engineer. Upon rejection of the pier(s), submit a remedial action plan to the Engineer for correction of the rejected work. The remedial action plan shall include detailed pier repair or replacement procedures necessary and will be subject to acceptance by the Engineer. Any modifications to the drilled pier, load transfer mechanisms, and elements affected by the proposed remedial actions will require calculations and working drawings and shall be made and stamped by a Professional Engineer, registered in the State of Alabama.

2. In the event that the Engineer directs the Contractor to core through the concrete, and the coring and associated core sample tests confirm the presence of anomalies or defects, the cost of coring, hole closure, core sample tests, and all labor and materials to perform the accepted remedial actions shall be provided at no additional cost to the Owner and with no extension of the contract time originally granted.
3. In the event that the Engineer directs the Contractor to core through the concrete, and the core or core sample tests do not confirm the presence of anomalies or defects, the cost of the coring, hole closure and associated testing shall be borne by the Owner.
4. Frequent defects as determined by the Engineer will result in a reevaluation of the Contractor's installation procedure and, depending on the frequency and type of defect, may direct the Contractor to change or modify their procedures.
5. Backfill all core holes with concrete meeting the requirements for strength as defined herein.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE AND SUBBASE COURSES

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C29, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
   b. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   c. C117, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C131, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   e. C183, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   f. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).
   g. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft^3 (2700 kN-m/m^3)).
   h. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   i. D2216, Standard Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   j. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   k. D2844, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   l. D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
   m. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   n. D5195, Standard Test Methods for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.
   o. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Base Course: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.

D. Leveling Course: Crushed aggregate placed and compacted on base course to be used for finish grading.

E. Standard Specifications: When referenced in this section, shall mean 2022 Alabama Department of Transportation Standard Specifications.

F. Subbase Course: Sandy, gravelly material placed and compacted on prepared subgrade.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

PART 2 PRODUCTS

2.01 BASE COURSE

A. Type B aggregate as specified in Section 825 of the Standard Specifications.

2.02 LEVELING COURSE AND GRAVEL SURFACING

A. As specified in Section 825 of the Standard Specifications**.**

2.03 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of course from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.02 HAULING AND SPREADING

A. In accordance with Section 230 of the Standard Specifications.

B. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

C. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway or prepared surface without segregation.
3. Should segregation of course from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.03 CONSTRUCTION OF COURSES

A. Construction of Courses: In accordance with Sections 300 and 400 of the Standard Specifications.

3.04 ROLLING AND COMPACTION

A. In accordance with Section 306 of the Standard Specifications, except as modified hereinafter.

B. Commence compaction of each layer of Base after spreading operations and continue until density of 98 percent of maximum density has been achieved as determined by ASTM D698.

C. Roll each layer of material until material does not creep under roller before succeeding layer is applied.

D. Commence rolling at outer edges and continue toward center. Do not roll center of road first.

E. Apply water as needed to obtain specified densities.

F. Place and compact each lift to the required density before succeeding lift is placed.

G. Remove floating or loose stone from surface of preceding course before placing leveling course.

H. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

I. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.05 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate Base and Leveling Course: Within plus or minus 0.04 foot of grade shown at any individual point.

C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

D. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.06 DRIVEWAY RESURFACING

A. Replace gravel surfacing on driveways that were gravel surfaced prior to construction.

B. Provide compacted gravel surfacing to depth equal to original, but not less than 4 inches.

C. Leave each driveway in as good or better condition as it was before start of construction.

3.07 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Provide Engineer at least 2 hours' advance notification prior to testing.
2. Show proof that areas meet specified requirements before identifying density test locations.
3. Refer to Table 1 for minimum sampling and testing requirements for aggregate base course and surfacing.

Table 1
Minimum Sampling and Testing Requirements

Property	Test Method	Frequency	Sampling Point
Gradation	ASTM C117and ASTM C183	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	ASTM D698	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	ASTM D5195, ASTM D6938, and ASTM D2216 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

3.08 CLEANING

A. Remove excess material from the work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO):
    a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
    b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
    c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
    d. M140, Standard Specification for Emulsified Asphalt.
    e. M156, Standard Specification for Requirements for Mixing Plants for Hot-mixed, Hot-laid Bituminous Paving Mixes.
    f. M208, Standard Specification for Cationic Emulsified Asphalt.
    g. R35, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt.
    h. T166, Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Mixtures Using Saturated Surface-Dry Specimens.
    i. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
    j. T209, Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA).
    k. T245, Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus.
    l. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Hot Mix Asphalt (HMA) by Means of Hveem Apparatus.
    m. T247, Standard Method of Test for Preparation of Test Specimens of Hot Mix Asphalt (HMA) by Means of California Kneading Compactor.
    n. T283, Standard Method of Test for Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage.
    o. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate.

p. T312, Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of a Superpave Gyratory Compactor.

2. Asphalt Institute (AI):
   a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
   b. Superpave Series No. 2 (SP-2), Superpave Mix Design.
3. ASTM International (ASTM):
   a. D75, Standard Method of Test for Sampling of Aggregates.
   b. D140, Standard Method of Test for Sampling Bituminous Materials.
   c. D979, Standard Method of Test for Sampling Bituminous Paving Mixtures.
   d. D2041, Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   e. D2489, Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures.
   f. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   g. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   h. D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
   i. E329 REV A, Standard Specification for Agencies Engaged in Construction Inspection Testing, or Special Inspection.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Maximum Aggregate Size: One sieve size larger than the nominal aggregate size.

C. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.

D. Prime Coat: Low viscosity cutback or emulsified asphalt applied to granular base in preparation of paving to coat and bond loose materials, harden the surface, plug voids, prevent moisture migration, and provide adhesion.

E. Reclaimed asphalt pavement (RAP): Removed and/or processed pavement materials containing binder and aggregate.

F. Seal Coat: Term used for various applications of emulsified asphalt, with or without sand or aggregate, to protect the asphalt surface from aging due to wear, degradation from the sun, wind, and water. Also used to improve skid resistance and aesthetics. The term seal coat can be used to define fog seal, slurry seal, chip seal or sand seal, depending on application.

G. Standard Specifications: 2022 Alabama Department of Transportation Standard Specification.

H. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.

1.03 DESIGN REQUIREMENTS

A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of this specification.

1.04 SUBMITTALS

A. Informational Submittals:

1. Asphalt Concrete Mix Formula:
   a. Submit minimum of 15 days prior to start of production.
   b. Submittal to include the following information:
      1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
      2) Bulk specific gravity for each aggregate constituent.
      3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
      4) Properties as stated in Section 410 of the Standard Specifications, for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
      5) Percent of asphalt lost due to absorption by aggregate.
      6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
      7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
      8) Optimum mixing temperature.
      9) Optimum compaction temperature.
      10) Temperature-viscosity curve of asphalt cement to be used.
      11) Brand name of any additive to be used and percentage added to mixture.

2. Test Report for Asphalt Cement:
   a. Submit minimum 10 days prior to start of production.
   b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following materials:
   a. Aggregate: Gradation,
   b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
   c. Prime Coat: Type and grade of asphalt.
   d. Tack Coat: Type and grade of asphalt.
   e. Additives.
   f. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
   a. Mix design.
   b. Asphalt concrete core.
   c. Gradation and asphalt content of uncompacted mix.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329 REV A.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F (10 degrees C) or air temperature is lower than 40 degrees F (4 degrees C). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime Coat: Cutback asphalt, Grade MC-70 conforming to AASHTO M82.

B. Tack Coat:

1. Emulsified Asphalt for Tack Coat or Seal Coat: conform to Section 405 of the Standard Specifications.

C. Sand for Blotter Material or Sand Seal: Clean, dry, with 100 percent passing No. 4 (4.75-millimeter) sieve, and a maximum of 10 percent passing No. 200 (75 (m) sieve.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with written approval of Engineer or Owner.
2. Source Changes:
   a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
   b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Engineer or Owner to confirm that properties are in compliance with design criteria.
   c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

B. Asphalt Concrete:

1. Base Course: Superpave Bituminous Concrete 12.5mm.
2. Wearing Surface Course: Superpave Bituminous Base 12.5mm.
3. Thickness: as shown.
4. Meeting the requirements of Section 424 of the Standard Specifications.

C. Composition: Hot-plant mix of aggregate, mineral filler if required, and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.

D. Aggregate:

1. General: As specified in Sections 801 and 802 of the Standard Specifications.

E. Mineral Filler: In accordance with Section 805 of the Standard Specifications.

F. Asphalt Cement: As specified in Section 804 of the Standard Specifications.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control:

1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
2. Minimize inconvenience to traffic but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

A. In accordance with Section 410 of the Standard Specifications.

3.04 PREPARATION

A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
2. Remove existing material to a minimum depth of 1 inch (25 millimeters).
3. Paint edges of meet line with tack coat prior to placing new pavement.

C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with 32 11 23, Aggregate Base and Subbase Courses.

B. Prime Coat:

1. Heat cutback asphalt, as specified in Section 804 of the Standard Specifications, prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
3. Do not apply when moisture content of upper 3 inches (75 millimeters) of base exceeds optimum moisture content of base, or if free moisture is present.
4. Application Rate: 0.15 gallon to 0.50 gallon per square yard (70 liters to 2.28 liters per square meter) of surface area.
5. Remove or redistribute excess material.
6. Allow a minimum of 5 full days for curing of primed surface before placing asphalt concrete.

C. Tack Coat:

1. Prepare material, as specified in Section 405 of the Standard Specifications, prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
3. Do not apply more tack coat than necessary for the day’s paving operation.
4. Touch up missed or lightly coated surfaces and remove excess material.
5. Application Rate: 0.05 gallon per square yard to 0.15 gallon per square yard (0.25 liter per square meter to 0.70 liter per square meter) of asphalt (residual if diluted emulsified asphalt).

D. Pavement Mix:

1. Prior to Paving:
   a. Sweep primed surface free of dirt, dust, or other foreign matter.
   b. Patch holes in primed surface with asphalt concrete pavement mix.
   c. Blot excess prime material with sand.

2. Place asphalt concrete pavement mix in two equal lifts.
3. Compacted Lift Thickness:
    a. Minimum: Twice maximum aggregate size, but in no case less than 1 inch (25 millimeters).
    b. Maximum: 4 inches (100 millimeters).
4. Total Compacted Thickness: As shown.
5. Sequence placement so that meet lines are straight and edges are vertical.
6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
    a. Offset edge of each layer a minimum of 6 inches (150 millimeters) so joints are not directly over those in underlying layer.
    b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
    c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
9. After placement of pavement, seal meet line by painting a minimum of 6 inches (150 millimeters) on each side of joint with cutback or emulsified asphalt. Cover immediately with sand.

E. Compaction: In accordance with Section 306 and 410 of the Standard Specifications.

F. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
2. Completed Surface or Wearing Layer Smoothness:
    a. Uniform texture, smooth, and uniform to crown and grade.
    b. Maximum Deviation: 1/8-inch (3-millimeter) from lower edge of a 12-foot (3.6-meter) straightedge, measured continuously parallel and at right angle to centerline.
    c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.

3. Transverse Slope Maximum Deviation: (1/4-inch (6-millimeters) in 12 feet (3.6 meters) from rate of slope shown.
4. Finished Grade:
   a. Perform field differential level survey on maximum 50-foot (15-meter) grid and along grade breaks.
   b. Maximum Deviation: 0.02 foot (6 millimeters) from grade shown.

G. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by Engineer.
2. Preparation:
   a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
   b. Seal in dry weather and when temperature is above 35 degrees F (2 degrees C).
3. Application:
   a. Fill cracks over 1/16 inch (1.5 millimeters) in width with asphalt-sand slurry or approved crack sealer prior to sealing.
   b. When sealing patched surfaces and joints with existing pavements, extend minimum 6 inches (150 millimeters) beyond edges of patches.

3.06 PAVEMENT OVERLAY

A. Preparation:

1. Remove fatty asphalt, grease drippings, dust, and other deleterious matter.
2. Surface Depressions: Fill with asphalt concrete mix, and thoroughly compact.
3. Damaged Areas: Remove broken or deteriorated asphalt concrete and patch as specified in Article Patching.
4. Portland Cement Concrete Joints: Remove joint filler to minimum 1/2 inch (12 millimeters) below surface.

B. Application:

1. Tack Coat: As specified in this section.
2. Place and compact asphalt concrete as specified in Article Pavement Application.

3. Place first layer to include widening of pavement and leveling of irregularities in surface of existing pavement.
4. When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 2 inches (50 millimeters).
5. Actual compacted thickness of intermittent areas of 120 square yards (100 square meters) or less may exceed 2 inches (50 millimeters), but not 4 inches (100 millimeters).
6. Final wearing layer shall be of uniform thickness, and meet grade and cross-section as shown.

3.07 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 3 inches (75 millimeters) or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 pounds per linear inch to 300 pounds per linear inch (350 Newtons per linear centimeter to 525 Newtons per linear centimeter). Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least one-half the roller width. Progress toward center of patch overlapping each preceding track by at least one-half width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch (6 millimeters) or minus 0 inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.08 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests:
   a. Asphalt Content, Aggregate Gradation: Once per every 500 tons (400 mg) of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons (900 mg) or once every 8 hours, whichever is greater.
2. Density Tests: Once every 500 tons (450 mg) of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 16 00
CURBS AND GUTTERS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): T 99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in.) Drop.
2. American Concrete Institute (ACI): 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
3. ASTM International (ASTM):
   a. C94, Standard Specification for Ready-Mixed Concrete.
   b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   c. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

1.02 SUBMITTALS

A. Action Submittals:

1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Informational Submittals:

1. Curing Compound: Manufacturer’s Certificate of Compliance and application instructions.
2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Conform to the State of Alabama Standard Specifications for Highway Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Conform to the requirements of the referenced Standard Specification and applicable contract specifications for concrete reinforcing and concrete work.

2.02 EXPANSION JOINT FILLER

A. Preformed asphalt-impregnated, expansion joint material meeting ASTM D994, 1/2-inch thick.

2.03 CONCRETE

A. As specified in Section 03 30 00, Cast-In-Place Concrete.

B. Maximum Aggregate Size: 1-1/2 inch.

C. Slump: 2 inches to 4 inches.

2.04 CURING COMPOUND

A. Liquid membrane forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

PART 3 EXECUTION

3.01 INSTALLATION

A. Perform Work in accordance with the referenced Standard Specification.

3.02 FORMWORK

A. Lumber Materials:

1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed curb.
2. 1-inch dressed lumber, or plywood may be used where short-radius forms are required.

B. Metals: Steel in new undamaged condition.

C. Setting Forms:

1. Construct forms to shape, lines, grades, and dimensions.
2. Stake securely in place.

D. Bracing:

1. Brace forms to prevent change of shape or movement resulting from placement.
2. Construct short-radius curved forms to exact radius.

E. Tolerances:

1. Do not vary tops of forms from gradeline more than 1/8 inch when checked with 10-foot straightedge.
2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.

3.03 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.04 CURB CONSTRUCTION

A. Construct ramps at pedestrian crossings.

B. Expansion Joints: Place at maximum 45-foot intervals at the beginning and end of curved portions of curb and at connections to existing curbs. Install expansion joint filler at each joint.

C. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.

D. Contraction Joints:

1. Maximum 15-foot intervals in curb.
2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.

3. Insert steel sheet to full depth of curb.
4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
5. Finish top of curb with steel trowel and finish edges with steel edging tool.

E. Front Face:

1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
3. Remove and replace defective concrete.
4. Apply curing compound to exposed surfaces of curb upon completion of finishing.

F. Continue curing for minimum of 5 days.

G. Backfill curb with earth upon completion of curing period, but not before seven days has elapsed since placing concrete.

1. Backfill shall be free from rocks 2 inches and larger and other foreign material.
2. Compact backfill firmly.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
   b. A313/A313M, Standard Specification for Stainless Steel Spring Wire.
   c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
   e. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   g. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
   h. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   j. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   k. C150, Standard Specification for Portland Cement.
   l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. F552, Standard Terminology Relating to Chain Link Fencing.
   n. F567, Standard Practice for Installation of Chain-Link Fence.
   o. F626, Standard Specification for Fence Fittings.
   p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
   q. F900, Standard Specification for Industrial and Commercial Swing Gates.
   r. F934, Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.

s. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
t. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
u. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
v. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.
w. F1379, Standard Terminology Relating to Barbed Tape.
x. F1911, Standard Practice for Installation of Barbed Tape.
y. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: C2, National Electrical Safety Code.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.02 DEFINITIONS

A. Terms as defined in ASTM F552.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
      1) Fence, gate posts, rails, and fittings.
      2) Chain link fabric.
      3) Gates and hardware.
      4) Gate operators, motors, and mounting arrangements, switches, and controls; include operating instructions.
      5) Gate access system, including access control features, power and control wiring diagrams, and operating instructions.
      6) Accessories: Barbed wire.

B. Informational Submittals:

1. Manufacturer’s recommended installation instructions.
2. Evidence of Supplier and installer qualifications.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Automatic Gate Operator System Supplier: 5 years' experience in gate operator systems.
2. Automatic Gate Operator System Installer: Experienced installer who has completed chain link fences and gates similar in material, design, and extent to those indicated for Project and whose work has resulted with a record of successful in-service performance with a minimum 3 years' experience.

B. Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

C. Preinstallation Conference: Conduct conference at project Site with gate installer to verify layout and operations of automatic gate operating system.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.06 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation and grading before installing chain link fence and gates.

B. Interruption of Existing Utility Service: Notify owner of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility owner.

1.07 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

1. Faulty operations of gate operators and controls.

2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
3. Deflection of fence fabric beyond limits.

PART 2 PRODUCTS

2.01 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components.

2.02 CHAIN LINK FENCE FABRIC

A. Galvanized fabric conforming to ASTM A392, Type II.

B. Height: 72 inches, unless otherwise shown.

C. Core Wire Gauge: No.6.

D. Pattern: 2-inch diamond-mesh.

E. Diamond Count: Manufacturer’s standard and consistent for fabric furnished of same height.

F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.

G. Wires of Twisted Selvages:

1. Twisted in a closed helix three full turns.
2. Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist.

2.03 POSTS

A. General:

1. Strength and Stiffness Requirements: ASTM F1043, except as modified in this section.
2. Round Steel Pipe, Schedule 40: ASTM F1083.
3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.

4. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches.
5. Protective Coatings:
   a. Zinc Coating: ASTM F1043, Type A external and internal coating.

B. Line Posts:

1. Round Steel Pipe:
   a. Outside Diameter: 2.375 inches.
   b. Weight: 3.65 pounds per foot.

C. End, Corner, Angle, and Pull Posts:

1. Round Steel Pipe:
   a. Outside Diameter: 2.875 inches.
   b. Weight: 5.79 pounds per foot.

D. Posts for Removable Fence Panels: As specified for end, corner, angle, and pull posts.

E. Posts for Swing Gates 8 Feet High and Under:

1. ASTM F900.
2. Round Steel Pipe:
   a. Outside Diameter: As shown on Drawings.

F. Posts for Swing Gates Over 8 Feet High: As recommended by fence manufacturer.

G. Posts for Horizontal Sliding Gates:

1. ASTM F1184, Type II Class 1.
2. Round Steel Pipe:
   a. Outside Diameter: As shown on Drawings.

2.04 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:

1. ASTM F1083.
2. Outside Diameter: 1.66 inches.
3. Weight: 2.27 pounds per foot.

B. Protective Coatings: As specified for posts.

C. Strength and Stiffness Requirements: ASTM F1043, top rail, industrial fence.

2.05 FENCE FITTINGS

A. General: In conformance with ASTM F626, except as modified by this article.

B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands: No exceptions to ASTM F626.

D. Tension Bars:

1. One-piece.
2. Length not less than 2 inches shorter than full height of chain link fabric.
3. Provide one bar for each gate and end post, and two for each corner and pull post.

E. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

F. Tie Wires, Clips, and Fasteners: According to ASTM F626.

G. Barbed Wire Supporting Arms: Pressed steel or cast iron with clips, slots, or other means for attaching strands of barbed wire integral with post cap for each post, with single 45-degree arms for supporting three strands of barbed wire. Arms shall withstand 250 pounds of downward pull at outermost ends of the arms without failure.

2.06 TENSION WIRE

A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type I.

2.07 BARBED WIRE

A. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade:

2.08 BARBED TAPE

A. Series 430 stainless steel hardened to Rockwell (30N) 35-40 minimum; 0.025-inch thick by 1-inch wide before fabrication, die stamped to produce clusters of four pointed needle-sharp barbs at 4 inches on center, minimum 1.2 inches long, offset in alternate directions 0.15 to 0.45 inch.

B. Permanently cold clench stainless steel strip to minimum 230 degrees F around core wire.

C. Core wire: 0.098-inch diameter, high-tensile-strength stainless steel complying with ASTM A313/A313M.

D. Stainless steel strip between barb clusters shall be 1/4-inch wide minimum after cold clenching to create a flange extending out from the wire, tapering off adjacent to the barb cluster to allow maximum barb penetration.

E. Fabrication: Continuous coils of barbed tape as defined in ASTM F1379 for the following characteristics:

1. Configuration: Double coil.
2. Style: Concertina pattern.
3. Coil Diameters: 24-inch inner coil and 30-inch outer coil, plus or minus 2 inches, when coil compressed.
4. Coil Loop Spacing: 12 inches.

F. Clips: Stainless steel, 0.065-inch thick by 0.375-inch wide; capable of withstanding a minimum pull load of 200 pounds for a minimum of 30 seconds without separation, or other damage.

G. Tie Wires: Stainless steel, 0.065-inch diameter.

2.09 GATES

A. General:

1. Gate Operation: Opened and closed easily by one person.
2. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.
3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
4. Gate leaves more than 8-feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.

5. Gate Fabric Height: Same as for adjacent fence height.
6. Welded Steel Joints: Paint with zinc-based paint.
7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
8. Gate Posts and Frame Members: Extend gateposts and frame end members above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.
9. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

B. Cantilever Horizontal Sliding Gates:

1. Comply with ASTM F1184 for single slide gate types II, Class 1with external roller assemblies.
2. Cantilever Gate Support Posts: Spaced on maximum 10 foot centers.
3. Roller Guards: As required per ASTM F1184 for Type II, Class 1 gate.
4. Hangers, roller assemblies, and stops fabricated from galvanized malleable iron.

2.10 GATE OPERATOR SYSTEM

A. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, safety devices, and weatherproof enclosures; coordinate electrical requirements with Division 26, Electrical.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
2. Provide operator with UL approved components.
3. Provide electronic components with built-in troubleshooting diagnostic feature.
4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.

B. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor.

C. Gate Operator:

1. Heavy-duty, high frequency, electrical models designed to open and close gates provided.
2. For each gate, supply manufacturer of gate operator with complete details of gate, hardware, track rollers, adjacent fence posts, and fence construction for development and detailing of gate operator.
3. Furnish with following features:
    a. Metal enclosure, including attachments shall be constructed with finish and design suitable for exterior installation in all-weather environment.
    b. Minimum 1-hp motor, 208V ac, three-phase, 60-Hz electric power, reversible.
    c. Electric motor driven hydraulic power pack with hard rubber wheels in contact with operating type secured to gate. Transmission of opening or closing forces to gate shall be by rotation of wheels against operating type.
    d. Positive limit switch, to sense position of gate and provide control to prevent damage to gate operator.
    e. NEMA 250, Type 12 enclosure for motor control components.
    f. Motor Overload Protection: Industrial quality with manual reset.
    g. 24V ac control circuit to power remote control gate activation devices.
    h. Manual operation feature or disconnect, without use of tools, for easy operation during power failure, malfunction, or emergency.
    i. Aluminum drive rail designed for attachment to sliding gate in manner that reinforces gate assembly.
    j. Gate Travel Speed:
        1) Minimum 1 foot per second.
        2) Speed adjusting feature that provides range of appropriate speeds for slide gate operation is acceptable but not required.
        3) Maximum Gate Weight: 5,500 pounds.
        4) Frequency of Use: Continuous Duty.
        5) Operating Type: Roller chain with manual release.
    k. Compatible with gate operator control devices provided.
    l. Gate operator shall have an Expansion Board that provides functionality for three button control station, key pad operations, and wireless remote controllers.

4. Manufacturers:
    a. Liftmaster.
    b. Hy-Security Gate Operator, Seattle, WA.
    c. Automated Equipment Co., Seattle, WA.
    d. Stanley.
    e. Richards Wilcox, Aurora, IL.

D. Access System:

1. Access by remote control to be provided and compatible with the existing gate operator systems on Site. The current gate operator system is Liftmaster Model IHSL24UL. Contractor to confirm existing gate operator system and compatibility of access control devices with both new and existing systems.
    a. Functionality: Openers to provide the ability to open, close, and pause gate.
    b. Contractor to provide five remote controls.
2. Three button controller shall be installed in plants operator control room. Coordinate final location with Engineer. Control station shall be as specified in electrical contract drawings; compatible supplied with gate operator. Reference electrical specification for new wiring requirements. Control station shall provide the ability to open, close, and holden open gate.
3. Digital keypad in weatherproof enclosure mounted on steel tube post anchored to concrete foundation outside gate. Face lighted unit fully visible at night.
    a. Digital Keypad:
        1) Multiple-programmable code capability of not less than 5 possible individual codes, consisting of 5-digit codes.
        2) Features:
            a) Timed anti-passback.
            b) Limited-time usage.
            c) Capable of monitoring and auditing gate activity.
4. For safety, provide loop detectors minimum of 4 feet away from each side of gate.
5. Gate Operation:
    a. Entry: Gate opens when activated by valid code in reader. Gate closes after adjustable time period up to 90 seconds.
    b. Exit: Gate opens when activated by detector loop in pavement or pushbutton inside gate. Gate closes as for entry.
    c. Override or 7-day timer to allow gate to remain open for up to 12 hours with equipment at rest.

6. Serial communication interface, including cable, with Supervisory Control System specified in Section 40 90 00, Instrumentation and Control for Process Systems, for remote monitoring of gate activity. Gate usage shall send code after each access to plant.
7. Manufacturers:
   a. Liftmaster.
   b. Power Door Engineering, Seattle, WA.
   c. Quentin Control Systems, NW, Inc., Seattle, WA.
   d. Continental Instruments Corp., Westbury, NY.
   e. Richards Wilcox, Aurora, IL.

2.11 CONCRETE

A. Materials: ASTM C387, packaged, dry, combined ingredients with Type I cement.

B. Mixing: In a clean metal container, mix package of dry materials by hand or machine. Following manufacturer's instructions, add clean water in sufficient quantity to produce a slump of 2 inches to 3 inches.

2.12 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel.

PART 3 EXECUTION

3.01 GENERAL

A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete fence and gate installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

D. Drainage Crossings: Where the chain-link fence must cross drainage ditches or swales, the main fence shall be carried across a ditch or swale with additional fence added below.

1. Frames and Bracing: The fence added below shall be fabricated with galvanized round steel pipe conforming to the requirements for top and brace rails.
2. The construction of the frame shall be welded or assembled with corner fittings. The frame shall be rigid and to the extent necessary to maintain a 2-inch clearance between bottom of the frame and finish grade. If necessary to maintain rigidity, attach to the frame a series of 3/8-inch diameter galvanized steel pipe stakes that are embedded a minimum of 2 feet to the sides and bottom of the ditch.
3. Attach chain link fabric securely to frame at intervals not exceeding 12 inches.

3.02 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Posthole Depth:

1. Minimum 3 feet below finished grade.
2. 2 inches deeper than post embedment depth below finish grade.

C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

E. Before concrete sets, crown and finish top of concrete to readily shed water.

F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.04 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 BARBED WIRE SUPPORTING ARMS

A. Barbed wire supporting arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools. Angle single arms to outside of fence.

3.07 TENSION WIRE

A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.08 BARBED WIRE

A. Install barbed wire uniformly in configurations of three strands of barbed wire on supporting arms. Pull wire taut and install securely to supporting arms and secure to end terminal post or terminal arms.

3.09 GATES

A. Install gates according to manufacturer’s written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.

B. Set gate stops in concrete to engage center drop rod or plunger bar.

3.10 GATE OPERATOR SYSTEMS

A. Install gate operator systems in accordance with manufacturer’s recommendations, aligned and true to fence line and grade.

B. Furnish with equipment and accessories necessary for complete installation.

C. Hand excavate holes for pads in firm undisturbed soil to dimensions, depths, and locations as required by gate operator component manufacturer’s written instructions and as shown on the drawings.

D. Vehicle Loop Detector System: Cut grooves in pavement and bury and seal wire loop according to manufacturer’s written instructions. Connect to equipment operated by detector.

3.11 ELECTRICAL GROUNDING

A. Ground fences at a maximum interval of 1,000 feet in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.12 FIELD QUALITY CONTROL

A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.

B. Gate Tests:

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
3. Confirm that latches and locks engage accurately and securely without forcing and binding.

C. Automatic Gate Operator:

1. Energize circuits to electrical equipment and devices.
2. Adjust operators, controls, safety devises, and limit switches.
3. Start units to confirm proper motor rotation and unit operation free of binding. Test and adjust all gate controls for proper operation.
4. Replace damaged and malfunctioning controls and equipment.
5. Lubricate hardware, gate operator and other moving parts.

3.13 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, to train Owner's personnel to adjust, operate, and maintain gates.

3.14 CLEANUP

A. Remove excess fencing materials and other debris from Site.

END OF SECTION

SECTION 32 91 13
SOIL PREPARATION

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C602, Standard Specification for Agricultural Liming Materials.
   c. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   d. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

1.02 SEQUENCING AND SCHEDULING

A. Perform Work specified in Section 31 10 00, Site Clearing, prior to performing Work specified under this section.

PART 2 PRODUCTS

2.01 TOPSOIL

A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Composition: In general accordance with ASTM D5268:

1. Gravel-Sized Fraction: Maximum 5 percent by weight retained on a No. 10 sieve.
2. Sand-Sized Fraction: Minimum 20 to 60 percent passing No. 10 sieve.
3. Silt and Clay-Sized Fraction: Minimum 35 to 70 percent.

C. Organic Matter: Minimum 1.5 percent by dry weight as determined in accordance with ASTM D2974.

D. pH: Range 5.0 to 7.0.

E. Textural Amendments: Amend as necessary to conform to required composition by incorporating sand, peat, manure, or sawdust.

F. Source: Stockpile material onsite, in accordance with Section 31 10 00, Site Clearing. Import topsoil if onsite material is insufficient in quantity.

2.02 SOIL ADDITIVES

A. Sawdust or Ground Bark:

1. Nontoxic, of uniform texture, and subject to slow decomposition when mixed with soil.
2. Nitrogen-treated, or if untreated mix with minimum 0.15 pound of ammonium nitrate or 0.25 pound of ammonium sulfate per cubic foot of loose material.

B. Peat:

1. Composition: Natural residue formed by decomposition of reeds, sedges, or mosses in a freshwater environment, free from lumps, roots, and stones.
   a. Organic Matter: Not less than 90 percent on a dry weight basis as determined by ASTM D2974.
   b. Moisture Content: Maximum 65 percent by weight at time of delivery.

C. Fertilizer: As specified in Section 32 92 00 Turf and Grasses.

2.03 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

B. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

C. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.02 TOPSOIL PLACEMENT

A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.

B. Place one-half of the total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth of 6 inches where seeding and planting are scheduled.

C. Uniformly distribute to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

D. Remove stones exceeding 1-1/2-inch diameter, roots, sticks, debris, and foreign matter during and after topsoil placement.

E. Remove surplus subsoil and topsoil from Site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod, or sprig) and continue for a period of eight weeks after all planting under this section is completed.

B. Satisfactory Stand: Grass or section of grass that has:

1. No bare spots larger than 3 square feet.
2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

A. Action Submittals: Product labels/data sheets.

B. Informational Submittals:

1. Seed: Certification of seed analysis, germination rate, and inoculation:
   a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within six months of date of delivery. Include with certification:
      1) Name and address of laboratory.
      2) Date of test.
      3) Lot number for each seed specified.
      4) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
   b. Mixtures: Proportions of each kind of seed.
2. Seed Inoculant Certification: Bacteria prepared specifically for legume species to be inoculated.
3. Certification of sod; include source and harvest date of sod, and sod seed mix.
4. Certification of sprig type and name.
5. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Sod:

1. Do not harvest if sod is excessively dry or wet to the extent survival may be adversely affected.
2. Harvest and deliver sod only after laying bed is prepared for sodding.
3. Roll or stack to prevent yellowing.
4. Deliver and lay within 24 hours of harvesting.
5. Keep moist and covered to protect from drying from time of harvesting until laid.

C. Sprigs:

1. Cut and deliver only after planting area is prepared for planting.
2. Deliver and plant within 24 hours of harvesting.
3. Keep moist and covered to protect from drying from time of cutting until planted.

D. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

A. Complete Work under this section within three days following completion of soil preparation.

B. Notify Engineer at least three days in advance of:

1. Each material delivery.
2. Start of planting activity.

C. Determined by accepted local practice.

1.06 MAINTENANCE SERVICE

A. Contractor: Perform maintenance operations during maintenance period to include:

1. Watering: Keep surface moist.
2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
3. Mulch: Replace wherever and whenever washed or blown away.
4. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
5. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
6. Reseed/replant during next planting season if scheduled end of maintenance period falls after September 15.
7. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.

B. Application Rates: Determined by soil analysis results.

C. Mix:

1. Nitrogen: 10.
2. Phosphoric Acid: 10.
3. Potash: 10.

D. Top Dress Type: As recommended by local authority.

2.02 SEED

A. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.

B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer’s instructions.

C. Seed Mix: As recommended by DOT or approved by Engineer.

2.03 SOD

A. Strongly rooted pads, capable of supporting own weight and retaining size and shape when suspended vertically from a firm grasp on upper 10 percent of pad.

1. Grass Height: Normal.
2. Strip Size: Supplier's standard.
3. Soil Thickness: Uniform; 1 inch plus or minus 1/4 inch at time of cutting.
4. Age: Not less than 10 months or more than 30 months.
5. Condition: Healthy, green, moist; free of diseases, nematodes and insects, and of undesirable grassy and broadleaf weeds. Yellow sod, or broken pads, or torn or uneven ends will not be accepted.

2.04 SPRIGS

A. Free of noxious weeds or other growth detrimental to economical maintenance, proper establishment, or appearance of completed lawn.

2.05 STRAW MULCH

A. Threshed straw of oats, wheat, barley, or rye, free from (i) seed of noxious weeds or (ii) clean salt hay.

2.06 HYDROSEEDING MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

2.07 NETTING

A. Jute:

1. Heavy-duty, twisted, weighing 1 pound per square yard.
2. Openings Between Strands: Approximately 1 inch square.

B. Plastic:

1. Extruded Polypropylene: 20 mils.
2. Opening Between Strands: 1 inch by 2 inch.

C. Matting:

1. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.
2. Manufacturers and Products:
   a. Akzo Industries, Ashville, NC; Curlex mat.
   b. North American Green, Evansville, IN; S150 blanket.

2.08 TACKIFIER

A. Derived from natural organic plant sources containing no growth or germination-inhibiting materials.

1. Capable of hydrating in water, and to readily blend with other slurry materials.
2. Wood Cellulose Fiber: Add as tracer, at rate of 150 pounds per acre.
3. Manufacturers and Products:
   a. Chevron Asphalt Co.; CSS 1.
   b. Terra; Tack AR.
   c. J Tack; Reclamare.

2.09 WEED BARRIER

A. 6 mils (0.006 inch) black polyethylene sheet.

2.10 DIVIDER

A. Cedar, Standard or Better Grade.

2.11 EDGING

A. Steel: 1/4 inch by 5 inches wide in 15-foot minimum lengths, manufacturer’s standard black, with 18-inch-long steel stakes and fastenings on curb.

B. Plastic: Polyethylene edging 1/8 inch by 4 inches wide, black, with integral design to provide a firm hold without staking.

PART 3 EXECUTION

3.01 PREPARATION

A. Grade areas to smooth, even surface with loose, uniformly fine texture.

1. Roll and rake, remove ridges, fill depressions to meet finish grades.
2. Limit such Work to areas to be planted within immediate future.
3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.

B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

B. Application Rate: 23 pounds per 1,000 square feet (1,000 pounds per acre).

3.03 SEEDING

A. Start within two days of preparation completion.

B. Hydroseed slopes steeper than 3H:1V. Flatter slopes may be mechanically seeded.

C. Mechanical: Broadcast seed in two different directions, compact seeded area with cultipacter or roller.

1. Sow seed at uniform rate of 23 pounds per 1,000 square feet.
2. Use Brillion type seeder.
3. Broadcasting will be allowed only in areas too small to use Brillion type seeder. Where seed is broadcast, increase seeding rate 20 percent.
4. Roll with ring roller to cover seed, and water with fine spray.

D. Hydroseeding:

1. Application Rate: As recommended by supplier for specific mulch type.
2. Apply on moist soil, only after free surface water has drained away.
3. Prevent drift and displacement of mixture into other areas.

4. Upon application, allow absorption and percolation of moisture into ground.
5. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.

E. Cover Crop Seeding: Apply seed at rate of 120 pounds per acre to areas that are bare or incomplete after September 15.

F. Mulching: Apply uniform cover of straw mulch at a rate of 2 tons per acre.

G. Netting: Immediately after mulching, place over mulched areas with slopes steeper than 3:1, in accordance with manufacturer's instructions. Locate strips parallel to slope and completely cover seeded areas.

H. Tackifier: Apply over mulched areas with slopes steeper than 4:1 at rate of 5 gallons per 1,000 square feet in accordance with the manufacturers recommended requirements.

I. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.

3.04 SODDING

A. Do not plant dormant sod, or when ground is frozen.

B. Lay sod to form solid mass with tightly fitted joints; butt ends and sides, do not overlap.

1. Stagger strips to offset joints in adjacent courses.
2. Work from boards to avoid damage to subgrade or sod.
3. Tamp or roll lightly to ensure contact with subgrade; work sifted soil into minor cracks between pieces of sod, remove excess to avoid smothering adjacent grass.
4. Complete sod surface true to finished grade, even, and firm.

C. Fasten sod on slopes to prevent slippage with wooden pins 6 inches long driven through sod into subgrade, until flush with top of sod. Install at sufficiently close intervals to securely hold sod.

D. Water sod with fine spray immediately after planting. During first week, water daily or more frequently to maintain moist soil to depth of 4 inches.

E. Apply top dress fertilizer at recommended rate.

3.05 SPRIGGING

A. Plant individual root clusters with roots and portions of stem buried in soil, but do not cover growing tips. Firm soil around sprigs after planting.

B. Furrows:

1. Dig at minimum of 12 inches on centers and open to depth of not less than 3 to 4 inches.
2. Open furrows at right angles to direction of slopes.

C. As soon as furrows are opened, place sprigs in continuous rows by hand.

D. Place sprigs at not more than 6 inches on centers, and stagger sprigs in alternate rows.

E. Cover sprigs with soil as soon as possible but no later than 30 minutes after placing in furrows.

F. Level and roll by mechanical or hand methods to even surface and to grade.

G. Water sprigs immediately after planting and keep moist by frequent watering until well rooted.

3.06 FIELD QUALITY CONTROL

A. Eight weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

END OF SECTION

SECTION 33 05 01.01
WELDED STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.9, Factory-Made Wrought Buttwelding Fittings.
   b. B36.10M, Welded and Seamless Wrought Steel Pipe.
   c. BPVC SEC VIII, Div. 1, Rules for Construction of Pressure Vessels.
   d. BPVC SEC IX, Welding and Brazing Qualifications.
2. American Society for Nondestructive Testing Inc. (ASNT): SNT-TC-1A, Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing.
3. American Water Works Association (AWWA):
   a. C200, Steel Water Pipe - 6 In. (150 mm) and Larger.
   b. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied.
   c. C206, Field Welding of Steel Water Pipe.
   d. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm.
   e. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
   f. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   g. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   h. M11, Steel Pipe - A Guide for Design and Installation.
4. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   b. A3.0M/A3.0, Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying.
   c. D1.1/D1.1M, Structural Welding Code - Steel.
   d. QC 1, Standard for AWS Certification of Welding Inspectors.
5. ASTM International (ASTM):
   a. A20/A20M, Standard Specification for General Requirements for Steel Plates for Pressure Vessels.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

c. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
d. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
e. A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
f. A435/A435M, Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates.
g. A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.
h. A770/A770M, Standard Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications.
i. A1018/A1018M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
j. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
k. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
l. E1255, Standard Practice for Radioscopy.

6. International Institute of Welding (IIW).
7. International Organization for Standardization (ISO): 9001:2000, Quality Management Systems - Requirements.
8. Lloyd’s Registry.
9. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
10. Steel Pipe Fabricators Association (SFPA).

1.02 DEFINITIONS

A. Fittings: Including, but not limited to fittings, closure pieces, bends, reducers, tees, wyes, bifurcations, crosses, outlets, manifolds, nozzles, wall sleeves, bulkheads, and other piping and appurtenances fabricated from steel plate, sheet, or coils as required to provide the Work, complete. Fittings shall include piping above ground or inside structures.

B. Acronyms:

1. CJP: Complete Joint Penetration.
2. CWI: Certified Welding Inspector.
3. MT: Magnetic Particle Testing.
4. NDE: Nondestructive Examination.

5. NDT: Nondestructive Testing.
6. PJP: Partial Joint Penetration.
7. PQR: Procedure Qualification Record.
8. PT: Liquid Penetrant Testing.
9. RT: Radiographic Testing.
10. UT: Ultrasonic Testing.
11. VT: Visual Testing.
12. WPQ: Welder/Welding Operator Performance Qualification.
13. WPS: Welding Procedure Specification.

1.03 DESIGN REQUIREMENTS

A. Fittings:

1. Design reinforcement, unless otherwise shown.
2. Design in accordance with AWWA M11, AWWA C200, and AWWA C208 as modified herein, and this Specification.

B. Pipe Layout: Design in accordance with AWWA M11:

1. General:
   a. Base stationing and elevation convention as shown on Drawings.
   b. Maximum Laying Lengths:
      1) Not limited, unless specifically shown on Drawings.
      2) Select lengths to accommodate installation operation.
2. Include, as minimum:
   a. Specific number, location, and direction of each pipe, joint, and fitting. Number each pipe in installation sequence.
   b. Station and centerline elevation at changes in grade or horizontal alignment.
   c. Station and centerline elevation to which spigot end of each pipe will be laid.
   d. Elements of curves and bends, both in horizontal and vertical alignment.
   e. Location of mitered pipe sections, beveled ends for alignment conformance, butt straps, and deep bell lap joints for temperature stress control.
   f. Location of closures, cutoff sections for length adjustment, temporary access manways, vents, and weld lead outlets for construction convenience.
      1) Provide for adjustment in pipe laying headings and to conform to indicated stationing.
      2) Changes in location or number will require Engineer approval.

g. Location of bulkheads, both those shown and as required, for hydrostatic testing of pipeline.
h. Details of specials with developed plan dimensions, wall thickness, reinforcing at openings, joint welding details, etc.

C. Welding Procedure Specification (WPS):

1. Qualified by testing in accordance with ASME BPVC SEC IX for shop welds and AWS D1.1/D1.1M for field welds.
2. PQRs conducted on unlisted base metal (most coil products are unlisted base metals) to be production welded as required in the referenced welding Code shall be traceable to heat lots.
3. Written WPS required for welds, both shop and field.
4. Notch-tough welding procedures that require heat input control shall be required:
   a. AWS D1.1/D1.1.M prequalified welding procedures are not allowed.
   b. WPS used to shop fabricate pipe shall be qualified in accordance with ASME BPVC SEC IX and shall include Supplementary Essential Variables.
   c. WPS used to field install pipe shall be qualified for heat input control in accordance with AWS D1.1/D1.1M.
   d. PQRs shall be qualified for notch tough welding with consideration for thickness of steel, test temperature, and Charpy V-notch CVN values. Refer to AWS D1.1/D1.1M, Table 4.6 PQR Supplementary Essential Variable Changes for CVN Testing Applications Requiring WPS Requalification for SMAW, SAW, GMAW, FCAW, and GTAW and Section 4, Part D Requirements for CVN Testing, Option A (three specimens). CVN test temperature and acceptance shall be same as pipe base metal specified herein.

D. Stulling (Strutting): Design for pipe and fittings such that over-deflection and damage is avoided during handling, storage, and installation, including backfill and compaction.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings showing pipe layout.
2. Material list and steel reinforcement schedules for materials specified.
3. Fabrication Information:
   a. Design calculations for fittings and specials including opening reinforcement details of collars, wrappers, and crotch plates.

b. Pipe and fitting details for temporary and permanent facilities indicating:
   1) Cylinder thickness.
   2) Manufacturing tolerances.
   3) Maximum angular deflection limitations of field joints.
   4) Closure sections and cutoffs for field length adjustment.
   5) Bulkheads, including details for removal of test bulkheads and repair of lining.
   6) Weld lead outlets and plugs.
   7) Stulling size, spacing, and layout.
c. Welded joint details including:
   1) Butt joints.
   2) Miter-cut ends for alignment conformance.
   3) Lap joints.
   4) Special thermal control joints required for control of temperature stresses.
   5) Butt strap joints.

4. Welding Data (Shop and Field Welding):
   a. Show on a weld map, complete information regarding base metal specification designation location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tail of welding symbol.
   b. Distinguish between shop and field welds.
   c. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for all welds.
   d. Welding and NDE symbols shall be in accordance with AWS A2.4.
   e. Welding terms and definitions shall be in accordance with AWS A3.0M/A3.0.
   f. Submit welding data together with Shop Drawings as a complete package.
   g. Fittings: Provide a joint weld beveling diagram. Refer to AWS D1.1/D1.1M, Annex P Local Dihedral Angle that can be used to calculate bevels for weld joint details of intersecting pipes.
5. Product data for the following:
   a. Welded Steel Pipe and Fittings:
      1) Material data.
      2) Chemical and physical test reports showing data consistent with specified requirements for each heat of steel proposed for use.
   b. Coatings and Linings:
      1) Technical data sheets itemizing technical and performance information that indicates compliance with this Specification.
      2) Color chart, if applicable.
      3) Manufacturer’s name, product number or name, and thickness.

B. Informational Submittals:

1. Certificates:
   a. Manufacturer's Certificate of Compliance that products furnished meet requirements of this Specification.
   b. Lining Materials: Certificate that lining system is currently approved for potable water contact in accordance with NSF 61 and satisfies current applicable governmental health and safety requirements for use in potable water.
2. Pipe Manufacturer's written Quality Assurance/Control Plan.
3. Statements of Qualification:
   a. Pipe manufacturer.
   b. Fittings fabricator.
   c. Field welding subcontractor qualifications.
   d. Welders (shop and field) or Welding Operators:
      1) Name of welder and certification stamp number.
      2) Welding procedures/positions for which welder is qualified.
      3) Certification date and current certification status.
   e. Contractor's Shop Inspector (CWI).
   f. Contractor's Field Inspector (CWI).
   g. NDT Quality Control Personnel.
4. Procedures:
   a. Shop and field welding information; at a minimum include complete welding code paper trail with linkage to Shop Drawings.
   b. Welder Qualifications and Welding Procedure Specifications in accordance with Section 05 05 23, Welding, and as specified below:
      1) Provide complete joint dimensions and details showing bevels, groove angles, root face, and root openings for all welds.
      2) Notch-tough welding procedures required. For shop welding, address supplementary essential variables in addition to essential variables as indicated in ASME Section IX, QW-251.2. For field welding, heat-input, control PQR essential variables as indicated in AWS D1.1/D1.1M, Table 4.6 shall be included. For shop and field welding, provide heat-input table on WPSs for welder guidance.
      3) PQRs for notch-tough welding shall document heat-input control by monitoring volts, amps, and travel speed or time-rate of change of weld metal volume as calculated by measuring change in electrode length over a period of time. Charpy V-notch tests shall be conducted on weld metal and heat affected zone. Test coupons shall be oriented transverse to final direction of rolling. Full size Charpy specimen test acceptance shall be same as base metal specified herein.

4) Written NDT procedures.
5) Written description of proposed sequencing of events or special techniques such as:
a) Controlling pipe wall temperature stress during installation.
b) Minimizing distortion of steel.
c) Shop-Applied Cement-Mortar Lining: Include description of machine to be used and list of similar projects where machine was used. Identify pipe size and total footage.
d) Monitoring pipeline temperatures during installation.

c. Written weld repair procedures for the Work.
d. Field coating application and repair.
e. Field lining application and repair.
f. Written consumable control procedure for welding materials demonstrating:
1) How consumables will be stored to comply with manufacturer's written instructions.
2) How consumables will be dried in ovens prior to use.
3) How consumables which become wet will be reconditioned.

5. Reports:
a. Source Quality Control Test Reports:
1) Hydrpstatoc testing.
2) Destructive weld testing.
3) Nondestructive weld testing.
4) Steel impact testing using Charpy V-notch method. Letter from independent testing agency certifying pipe furnished meets requirements of this Specification.
5) Coating and lining factory Site visit letter by qualified manufacturer's technical representative.
b. Field Quality Control Test Reports:
1) Weld tests, including re-examination of repaired welds, on each weld joint for the following tests, as applicable:
a) VT (visual testing).
b) RT (radigraphic testing).
c) UT (ultrasonic testing).
d) MT (mangnetic testing).
e) PT (liquid penetrant testing).
f) LT (leak testing).
c. Field coating and lining site visit letter by qualified techincal representative.
d. Cement-mortar lining compressive strength tests in accordance with AWWA C205.
e. Cement-mortar coating absorption tests in accordance with AWWA C205.

6. Field Testing Plan: Submit at least 15 days prior to testing and include following information at a minimum:
   a. Testing dates.
   b. Piping system and sections to be tested.
   c. Method of isolation.
   d. Method of conveying water from source to system being tested.
7. Calculation of maximum allowable leakage for piping sections to be tested. Design calculations prepared by a licensed professional engineer in the State of the Work for fittings, including opening reinforcement details of collars, wrappers, crotch plates; and harnessed joint assemblies.
8. Temperature Stress Control Plan: Submit at least 45 days prior to installing pipe and include at least the following information:
   a. Step by step installation procedures and sequencing to demonstrate compliance with temperature control requirements, including:
      1) Pipe installation.
      2) Joint welding of standard joints and temperature control joints.
      3) Pipe bedding and backfill.
   b. Methods to ensure compliance with procedures by installation personnel.
   c. Equipment to be used to monitor pipe wall temperature.
   d. Time of day, climatic, or seasonal installation limits to be used to achieve compliance with temperature control requirements.
9. Pipe manufacturer's design engineer's certification of training of Contractor's pipe installation crews.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Pipe Manufacturer:
   a. Experienced in fabricating pipe of similar diameters, lengths, and wall thickness required for the Work.
   b. Steel Pipe Fabricators Association (SPFA), Lloyd's Registry Certification, or ISO 9001:2000 Certification.
   c. Demonstrate current production capability for volume of work required for Project.
   d. Experience shall include successful fabrication to AWWA C200 standards of at least 5,000 linear feet of 42-inch diameter or larger pipe, with wall thickness of 1/2- inch or greater, in the Unites States within past 5-year period.
   e. Experience shall be applicable to fabrication plant facilities and personnel, not company or corporation that currently owns fabrication facility or employs personnel.

2. Fittings Fabricator:
   a. Experienced in fabricating fittings of similar diameters and wall thickness required for the Work.
   b. Steel Pipe Fabricators Association (SPFA), Lloyd's Registry Certification, or ISO 9001:2000 Certification.
   c. Demonstrate current production capability for volume of work required for this Project.
   d. Experience shall include successful fabrication to AWWA C200 and AWWA C208 standards of at least 25 fittings of 48-inch or larger pipe, with wall thickness 1/2 inch or greater, in the United States within past 5-year period.
   e. Experience shall be applicable to fabrication shop facilities and personnel, not company or corporation that currently owns fabrication facility or employs personnel.
3. Field Welding Subcontractor:
   a. Contractor shall perform all field welding through one welding subcontractor.
   b. Welding subcontractor shall show experience of successfully completing the butt-welding of over 2,000 feet of pipe (42-inch or larger) in the last 10 years. For each project referenced, submit client names, contact persons and phone number of each.
4. Welders and Welding Operators:
   a. Shop Welders: In accordance with ASME BPVC SEC IX.
5. Field Welders: In accordance with AWS D1.1/D1.1M.Contractor's Inspector for Shop and Field Welding:
   a. In accordance with AWS QC 1, with knowledge of welding code for the Work.
   b. After receiving CWI qualification, Shop CWI and Field CWI shall have 5 years' minimum professional experience related to welding inspection similar to the Work.
6. NDT Quality Control Personnel:
   a. In accordance with requirements of ASNT SNT-TC-1A, NDT Level II.
   b. After receiving NDT qualification, at least one NDT person shall have 5 years minimum professional experience related to NDT inspection similar to the Work. Other NDT personnel may work under the supervision of 5 year NDT, provided they have 1 year of related professional experience after receiving NDT qualification.
7. Field Lining Subcontractor: Minimum of 5 years of experience in proper preparation and field lining of steel pipelines or steel tanks with specified lining system.

B. Contractor's Shop Inspector:

1. In accordance with AWWA C200.
2. Responsibilities:
    a. Verify conformance to use of specified materials and their proper storage.
    b. Monitor conformance to approved WPS.
    c. Monitor conformance to approved NDT procedure specifications.
    d. Monitor conformance of WPQ.
    e. Provide 100 percent visual inspection before, during, and after shop welding.
    f. Coordinate NDT work and review test results.
    g. Maintain records and prepare report confirming results of inspection and testing.

C. Contractor's Field Inspector:

1. In accordance with AWWA C206 and AWS D1.1/D1.1M.
2. Responsibilities:
    a. Verify conformance to use of specified materials and their proper storage.
    b. Monitor conformance to approved WPS.
    c. Monitor conformance to approved NDT procedure specifications.
    d. Monitor conformance of WPQ.
    e. Provide 100 percent VT before, during, and after field welding.
    f. Coordinate NDT work and review test results.
    g. Maintain records and prepare report confirming results of inspection and testing.

D. Prefabrication Meeting: Hold prior to fabrication of pipe and fittings between representatives of Owner, Contractor, Engineer, and pipe fabricator to review following:

1. Project scope.
2. Submittal requirements.
3. Testing.
4. Inspection responsibilities.
5. Shop welding requirements.
6. Field welding requirements.
7. Shop and field coating and lining requirements.
8. Production and delivery schedule.

1.06 OTHER ISSUES PERTINENT TO THE WORK.DELIVERY, HANDLING, AND STORAGE

A. Pipe Marking:

1. Legibly mark installation sequence number on pipe and fittings in accordance with piping layout. Standard pipe sections do not need sequence number labeled provided wall thickness is clearly marked.
2. Fittings shall be marked at each end with notation “TOP FIELD CENTERLINE”.
3. The word “TOP” shall be painted or marked on outside top spigot of each fitting.
4. Mark “TOP MATCH POINT” for compound bends per AWWA C208 so end rotations can be easily oriented in field.

B. Delivery:

1. Securely bulkhead or otherwise seal ends of pipe and fittings prior to loading at manufacturing site.
2. Pipe ends shall remain sealed until installation.
3. Damage to pipe and fittings, including linings and coatings, found upon delivery to Site shall be repaired to Engineer’s satisfaction or removed from Site and replaced.

C. Storage:

1. Support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.
2. Support on sand or earth berms free of rock exceeding 3 inches in diameter.

1.07 SEQUENCING AND SCHEDULING

A. Notify Engineer in writing of the following:

1. Pipe Manufacturing: Not less than 14 days prior to starting.
2. Not less than 5 days prior to start of each of the following:
   a. Welding.
   b. Coating application.
   c. Lining application.
   d. Shop hydrostatic testing.

PART 2 PRODUCTS

2.01 GENERAL

A. Pipe Manufacturer:

1. Manufacturing of steel pipe and fittings shall be under direction of one pipe Supplier.
2. Responsibility shall include, at minimum, coordinating work of other suppliers for fittings.

B. Pipe Size:

1. Unless shown otherwise for pipe over 30 inches in diameter, the diameter shown shall be considered finished inside diameter after lining.
2. For pipe 30 inches in diameter and less, diameter shown shall be per ASME B36.10M.
   a. Pipe size shall be nominal outside diameter for 14-inch diameter pipe and larger.
   b. Pipe size shall be nominal inside diameter for 12-inch diameter pipe and smaller.

C. Steel pipe and fittings shall be manufactured, tested, inspected, and marked to comply with AWWA C200 and additional requirements of these Contract Documents.

D. In lieu of collar reinforcement, pipe or fittings with outlets may be fabricated in their entirety of steel plate having thickness equal to sum of pipe wall plus required reinforcement.

2.02 PIPE BARREL

A. Steel: Provide steel coils for spiral welded steel pipe or steel plate for straight seam welded steel pipe per AWWA C200 and as follows:

1. Specified Minimum Yield Strength: 36,000 psi.
2. Specified Minimum Tensile Strength: 53,000 psi.
3. Minimum Elongation in 2-inch Gauge Length: 21 percent.
4. Steel Quality as follows:
   a. Coils:
      1) Continuous cast process, fully-killed, fine grained practice conforming to physical, manufacturing and testing requirements of ASTM A1018/A1018M, SS Grade 36, Type 1.

2) Continuous cast process, fully-killed, fine grained practice conforming to physical, manufacturing and testing requirements of ASTM A1018/A1018M, HSLAS Grade 50, Class 2 (modified). Measured yield strength shall not exceed 85 percent of measured tensile strength.
3) AWWA A139 Gr C manufactured in accordance with AWWA C200 is acceptable.

b. Plate:
1) Fully-killed, conforming to ASTM A20/A20M, fine grained practice conforming to physical, manufacturing and testing requirements of ASTM A516/A516M, Grade 70.
2) Steel Chemistry: Conform to ASTM A516/A516M, Grade 70. Steel plates that are 3/4-inch thick or greater shall be normalized.]

c. Toughness:
1) Charpy V-notch Acceptance Criteria: Transverse specimen orientation, full size specimens, 25 foot-pounds energy at test temperature of 30 degrees F.
2) Frequency: See Paragraph Steel Toughness Testing for Thickness Equal to or Greater than 7/16 Inches.

5. Minimum nominal wall thickness as shown on Drawings. Maximum allowable thickness variation for plate, sheet, or coil shall be 0.010 inch less than ordered thickness.

2.03 FITTINGS

A. Fabrication:

1. Shop fabricate. No field fabrication will be allowed, unless approved by Engineer.
2. Fabricate from materials or straight pipe in conformance with specified requirements and dimensions of AWWA C208, unless otherwise indicated.

B. Wall Thickness:

1. General:
a. Refer to ASME B36.10M for definitions of wall thickness for standard weight pipe and nominal pipe size (NPS).
b. Reinforce to withstand either internal pressures, both circumferential and longitudinal, or external loading conditions, whichever is greater.

c. Minimum Plate Thickness: The greater of adjacent mainline pipe, thickness shown, thickness calculated as hereinafter specified, or as shown in Table 1.

Table 1		
Nominal Pipe Diameter (inches)	Pipe Manifolds Piping Above Ground Piping in Structures	Bends Reducers
24 and Under	Standard Weight	Standard Weight
Over 24	1/2 inch	1/2 inch

C. Bends, Unless Otherwise Indicated:

1. Minimum Radius: 1.0 times pipe diameter or as indicated on Drawings.
   a. For diameters 24-inches and smaller: use wrought or fabricated bend with radius of 1.0 times pipe diameter unless indicated otherwise.
   b. For diameters over 24-inches: radius =2.5 times pipe diameter unless indicated otherwise.
2. Minimum Bend Wall Thickness: Greater of Table 1 above or as calculated for straight pipe under internal pressure multiplied by following bend stress intensities (tabulated below or calculated with the following bend stress intensity formula where “n” is the bend radius multiplier and SI=bend stress intensity). For “n” greater than, or equal to, 2.5 the stress intensity factor may be ignored as indicated in AWWA M11.

$$SI = \frac{2 \cdot n - \frac{1}{3}}{2 \cdot n - 1}$$

Bend Radius Multiplier “n”	**AWWA M11 Bend Stress Intensity “SI”**
1.0	1.67
1.5	1.33
2.0	1.22

3. Maximum Miter Angle: 11-1/4 degrees on each section resulting in a maximum deflection angle of 22.5 degrees per miter weld as recommended in AWWA C208.
4. Bevels: Vary bevels on miters to provide a constant weld groove angle. For 11-1/4-degree miter, (22.5-degree miter weld) bevels must vary from 18.75 degrees on OD of bend to 41.25 degrees on ID of bend to provide a constant 60-degree groove angle for CJP welding.
5. Complete joint penetration (CJP) welds on miter welds.

D. Outlets:

1. 24 Inches and Smaller: Fabricate from ASTM A53/A53M, Type E or S, Grade B, standard weight steel pipe.
2. Larger than 24 Inches: Fabricate from ASTM A106/A106M, Grade B, standard weight pipe.
3. Fabricate collar or wrapper reinforcement using same steel as specified for main pipe barrel.

E. Steel Butt-Weld Fittings:

1. 24 Inches and Smaller: In accordance with ASME B16.9 conforming to ASTM A234/A234M.
2. Standard weight (unless thicker is called for in plans or specs).
3. Taper pipe wall at welds at 4:1 for connection to pipe of different wall thickness.
4. Coordinate difference in diameter convention between fittings and AWWA C200 and AWWA C208 pipe and fittings to provide complete piping system as shown.

2.04 JOINTS

A. Shop Welded:

1. Fabricate in accordance with AWWA C200 as modified herein.
2. Complete joint penetration (CJP) butt joints shall be used for longitudinal, girth, and spiral welds, unless otherwise indicated.
3. Lengths of pipe shall not be shop-joined using lap joints.

B. Field Welded Butt Joints:

1. All field joints on this project shall be butt joints with backer plates - except where a different field joint is required in the plans or specs.
2. For field butt joints, prepare spigot ends of steel pipe cylinders with the steel end finished perpendicular to the pipe and prepare bell ends with backer plates 3/8-inch thick by 3-inch wide centered on joint and tack welded tightly to pipe.
3. Miter steel wall of pipe at 45 degrees before attaching backer plate to create a groove for field welding. Submit welding details and welding code compliace per this specification and per Section 05 05 23, Welding.

C. Preparation of Joints for Field Welding:

1. Butt Joint Welded:
   a. Plain ends beveled as required by AWWA C200 and Contractor's field WPS.
   b. Provide protection for factory beveled pipe ends so ends are not damaged during transport.
   c. Shop weld all butt joints except where the plans specify field welded butt joints.
   d. Field welded butt joints with backer plate. In the shop, tack weld a curved backup plate on one of the two ends of the pipe joint being butt welded to allow for field fit-up flexibility (as shown in the details in the drawings).
   e. Field welded butt joints without backer. Tolerances on CJP butt joint beveled ends shall permit field assembly of pipe ends within workmanship assembly tolerances per AWS D1.1/D1.1M. According to this Code, for butt joints without backing or back-gouging the root opening tolerance is plus 1/16 inch minus 1/8 inch.
   f. Plain ends beveled as detailed in the drawings and required by AWWA C200 and Contractor's field WPS.
2. Lap Joint Welded:
   a. Double fillet and single fillet lap joints in preparation for field welding shall be in accordance with AWWA C200.
   b. For pipe 30 inches in diameter and larger, provide one of the following:
      1) Tack weld four metal tabs at equal intervals around inside circumference of bell ends to indicate location at which spigot end has reached maximum penetration into bell. Remove stops after welding of joint.
      2) Paint a 3/4-inch wide white stripe on outside circumference of spigot end of pipe. Side of stripe furthest from pipe end shall indicate location at which spigot end has reached maximum penetration into bell. Side of stripe closest to end of pipe will indicate limit of maximum joint pull.
   c. Double welded lap joints and butt-strap joints shall be tapped and drilled for testing in accordance with AWWA C206.

D. Miter-End Cuts:

1. Welded Lap Joints:
   a. As shown on Drawings.
   b. Moderate deflections and long radius curves may be made using miter-end cuts.

c. Use only with rubber gasket joints or lap welded joints, unless specifically approved in writing by Engineer.
d. Maximum Total Allowable Angle: 3 degrees per pipe joint.
e. Provide miter-cut that is cold expanded square with face of miter-cut on bell ends only.
f. Mitering of spigot ends will not be permitted.

2. Welded Butt Joints:
a. Maximum Total Allowable Angle: 2.5 degrees per pipe joint.
b. Minimum Pipe Wall Thickness: 1/2 inch.
c. Welded Butt joints shall be CJP.

2.05 FLANGES

A. In accordance with AWWA C207, Class D.

2.06 STULLING (STRUTTING)

A. Materials:

1. Shop-Lined Pipe: Wood stulls and wedges.
2. Unlined Pipe: Steel or wood.

B. Install stulling for pipe and fittings in accordance with approved submittal and as soon as practical after pipe is fabricated or, for shop-lined pipe, after lining has been applied.

C. Install stulling in manner that will not harm lining.

2.07 LININGS AND COATINGS

A. Interior of all Pipe: System 1 as detailed in Section 09 90 00, Painting and Coating.

1. All 42-inch and smaller diameter steel pipe covered by other Specifications within the Bid documents shall be high build epoxy lined for corrosive environment. System shall be NSF approved and system shall be applied in accordance with the manufacturer’s recommendations. Minimum thickness unless otherwise approved shall be 10 mils.

B. Exterior Buried Coating:

1. General
   a. Notify the Owner at least 3 Days prior to application of coating products.
   b. Holdback of and coating from field-welded joints as recommended by the manufacturer
2. Shop-applied:
   a. Polyurethane complying with the requirements of AWWA C222.
   b. Coating system for field joints along with the repair of any external coating during handling, shipping and installation shall be in accordance with the manufacturer's recommendations.
   c. Manufacturers/Products:
      1) Chemline, Chemthane 2265
      2) Carboline, Polyclad 777PL

C. Exterior Exposed: System 4 as detailed in Section 09 90 00, Painting and Coating. Shop-applied polyurethane complying with the requirements of AWWA C222 is also acceptable for the exterior coating on the buried steel piping and associated fittings.

D. Contractor shall provide protection for the pipe to prevent damage to coating system(s) from sun exposure and heating of the pipe due to sun exposure.

2.08 SOURCE QUALITY CONTROL

A. Steel Toughness Testing for Thickness Equal to or Greater than 7/16 Inches:

1. Include three impact specimens; conduct test in direction transverse to final direction of the coil rolling.
2. Coils:
   a. Conduct Charpy Testing per ASTM A370 on an initial coil of each heat to establish uniformity of steel.
   b. Take test coupons from an initial coil of each heat at locations of outer and inner wrap of coil.
   c. For each coil that fails to meet acceptance criteria, conduct Charpy Testing on next two coils in that heat.
   d. Do not use coils that do not qualify in production of pipe.
3. Plate:
   a. Conduct Charpy Tests on each plate in accordance with ASTM A20/A20M.
   b. Conduct on full-size (10 mm by 10 mm) specimens from each plate in accordance with ASTM A20/A20M.
   c. Do not use plates that do not qualify in production of pipe.

B. Shop Hydrostatic Pressure Test: In accordance with AWWA C200 Section 5.2, except as follows:

1. General: Unless specified otherwise, testing of pipe and fittings shall be performed before lining and coating is applied.
2. Pipe: Maintain test pressure for minimum of 5 minutes.
3. Fittings:
    a. Except as otherwise specified herein, no additional shop hydrostatic test will be required on fittings fabricated from successfully tested straight pipe.
    b. Test with crotch plates, regardless of whether or not straight pipe sections used were previously tested.
    c. Test each fitting to verify quality control.
    d. Test Pressure: Field test pressure.
    e. Maintain test pressure for a length of time as required to perform a visual inspection of welds.
    f. No leakage is allowed.

C. Joints, Lap-Welded:

1. Fit test minimum of 5 joints, selected by Engineer, of each pipe size used:
    a. Join pipe ends with proposed adjacent pipe end.
    b. Match-mark pipe ends.
    c. Record Actual Annular Space:
        1) Maximum space at a point.
        2) Minimum space at a point.
        3) Space at 90-degree intervals; top, bottom, and spring line on both sides.

D. Shop Nondestructive Testing:

1. Welds: 100 percent visually examined by Contractor’s Shop Inspector to criteria in ASME BPVC SEC VIII, Division 1.
2. CJP Welds: Spot radiographically or radioscopically examine pipe in accordance with ASME BPVC SEC VIII, Div. 1,
   Paragraph UW-52.100 percent radioscopic examine in accordance with ASTM E1255. Acceptance criteria per ASME BPV Code, Section VIII, Division 1, Paragraph UW-51. Welds that, in opinion of Engineer, cannot readily be radiographed, shall be ultrasonically examined in accordance with paragraph UW-53. UT will be an acceptable NDE inspection method in lieu of RT.
3. Fillet Welds: 100 percent examine using magnetic particle inspection method in accordance with ASME BPVC SEC VIII, Division 1, Appendix 6.

E. Air test collars and wrappers in accordance with AWWA C206. Inspection of Pipe Fabrication Procedure: Select and provide independent testing agency to observe pipe fabrication. Agency staff shall have experience in observation of steel pipe fabrication in accordance with ASTM E329. Representative of agency shall be present full time while pipe is being fabricated and while protective coatingand lining is applied. Provide a letter to Engineer certifying that pipe furnished meets requirements of this section.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Joints and related work for field assembly of fittings shall conform to requirements for straight pipe, unless otherwise shown.
2. Inspect pipe and fittings before installation. Clean ends thoroughly, remove foreign matter and dirt from inside.
3. For Field Lap Joints Make minor field adjustments by pulling standard joints.
    a. Maximum Allowable Angle: 75 percent of manufacturer's recommended or angle which results from 3/4-inch pull out from normal joint closure, whichever is less.
    b. Maximum Allowable Gap: 1/8 inch between bell and spigot at weld location.
4. Horizontal deflections or fabricated angles shall fall on alignment, as shown within tolerances below.
5. Vertical deflections shall fall on alignment, and pipe angle point locations shall match those indicated on Drawings within tolerances below.
6. For field-welded joints, pipe 30 Inches in Diameter and Larger:
    a. Ensure maximum penetration of spigot end into bell end is achieved through use of shop-welded tabs on inside circumference of bell end or by use of a paint stripe.
    b. If welded metal tabs are used, remove tabs prior to welding inside of joint.
7. Stulling:
    a. Maintain stulling in place until pipe is completely backfilled and compacted.
    b. Reinstall stulls that were temporarily removed to facilitate interior welding prior to backfilling.
8. Pipeline Alignment Tolerances:
    a. Plan: 1-inch.

3.02 WELDING

A. Comply with Section 05 05 23, Welding, and the following:

B. Perform welding only in presence of Contractor's Field Inspector.

C. Conform to AWS D1.1/D1.1M, AWWA C206, approved welding procedures, and referenced welding codes. In case of conflict AWS D1.1/D1.1M shall govern.

D. Preheat and Interpass temperature requirements for unlisted base metals shall be determined according to AWS D1.1/D1.1M, Annex XI Guideline on Alternative Methods for Determining Preheat.

E. Rejectable weld defects shall be repaired or redone, and retested until sound weld metal has been deposited in accordance with appropriate welding codes.

3.03 LININGS AND COATINGS

A. With the exception of the joints the lining and coating system shall be factory applied.

B. Field welded joints shall be coated in accordance with the recommendations of the system manufacturer.

3.04 FIELD QUALITY CONTROL

A. Field Welding:

1. All welds, 100 percent inspection, shall be VT inspected by Contractor's Field Inspector and marked to indicate acceptance or rejection.
2. Test butt-strap or double-welded lap joint welds by pressurizing connection between the two fillet welds in accordance with AWWA C206.
    a. Apply air or other Engineer-approved gas into connection between the two fillet welds.
    b. Paint welds with soap solution.
    c. Mark leaks indicated by escaping gas bubbles.
    d. Close threaded openings with flush pipe plugs or by welding them.
3. CJP Welds:
    a. Inspect 10 percent of butt joint welds with full circumference RT.
    b. Inspect 10 percent of other groove welds with UT.

4. Inspect 10 percent of lap joint welds with PT or MT.
5. Weld Acceptance:
    a. If, in the opinion of Engineer, inspections indicate inadequate quality of welds, percentage of welds inspected shall be increased.
    b. Welds to be inspected, if less than 100 percent rate, shall be selected at random by Engineer.
    c. VT: Perform VT per AWS D1.1/D1.1M Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.
    d. UT: Perform UT of CJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.13.1.
    e. RT: Perform RT of CJP butt joint welds in accordance with AWS D1.1/D1.1M, Paragraph 6.12.1.
    f. PT or MT:
        1) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.10.
        2) Acceptance shall be in accordance with VT standards specified above.
    g. Remove in manner that permits proper and complete repair by welding.
    h. Caulking or peening of defective welds is not permitted.
    i. Retest unsatisfactory welds.
6. Verification Acceptance: Engineer may conduct random nondestructive inspections of field-welded joints. Inspections will be of an appropriate type for weld being evaluated. Possible types of inspection include, but are not limited to, RT, UT, PT, and VT. Testing will be performed and evaluated per AWS D1.1/D1.1M. Provide Owner's Verification Inspector access to the Work.

B. Hydrostatic Testing:

1. Pipeline:
    a. General:
        1) Notify Engineer in writing 5 days prior to testing. Perform testing in presence of Engineer.
        2) Test newly installed pipelines. Using water as test medium, pipes shall successfully pass a leakage test prior to acceptance.
        3) Furnish testing equipment and perform tests in manner satisfactory to Engineer. Testing equipment shall provide observable and accurate measurements of make-up water under specified conditions.

4) Isolate new pipelines that are connected to existing pipelines.
5) Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Engineer, be done prior to placement of asphaltic concrete or roadway structural section.
6) Contractor may, if field conditions permit and as determined by Engineer, partially backfill trench and leave joints open for inspection and conduct an initial service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above.
7) Supply of temporary water shall be as stated in Section 01 50 00, Temporary Facilities and Controls.
8) Dispose of water used in testing in accordance with federal, state, and local requirements.

b. Procedure:
1) Maximum filling velocity shall not exceed 0.5 foot per secondcalculated based on the full area of pipe.
2) Expel air from pipe system during filling. Expel air through air release valve or through corporation stop installed at high points and other strategic points. Test Pressure:70 psi based on pressure as measured at highest pressure in pipeline.
3) Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4) Maintain hydrostatic test pressure continuously for 12 hours minimum, adding additional make-up water only as necessary to restore test pressure.

c. Leakage allowance is zero. Repair defective pipe section and repeat hydrostatic test as requried.

END OF SECTION

SECTION 33 05 16.13
PRECAST CONCRETE UTILITY STRUCTURE

PART 1 GENERAL

1.01 REFERENCES

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

1. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges, Division 1 Section 3, Division I Design-Loads (Part A, Part B, Part C).
2. ASTM International (ASTM):
   a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   d. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   e. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   f. C858, Standard Specification for Underground Precast Concrete Utility Structures.
   g. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
3. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910.27, Fixed Ladders.
   b. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detailed drawings showing complete information for fabrication including, but not limited to:
      1) Member dimensions and cross sections; location, size, and type of reinforcement, including additional reinforcement.
      2) Layout dimensions and identification of each precast unit.
      3) Welded connections indicated by AWS standard symbols.
      4) Details of connections, joints, accessories, and openings or inserts.

5) Watertight joint details.
6) Location and details of anchorage devices.
7) Access door details.
8) Details of ladder and pull-up extension.
9) If applying slope after precasting, submit proposed procedure prior to application.

b. Product Data:
1) Precast concrete items; show materials of construction by ASTM reference and grade.
2) Joint sealants.
3) Antislip coating.

B. Informational Submittals:

1. Manufacturer's data for lifting devices for handling and erection.
2. Manufacturer's certification that vault design and manufacture comply with referenced ASTMs (for example, ASTM C857 and ASTM C858).
3. Vault design calculation shall be signed by a civil or structural engineer registered in the State of Alabama.
4. Manufacturer's laboratory test reports.
5. Certified load test data for polypropylene steps.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store each unit in a manner that will prevent cracking, distortion, warping, straining and other physical damage, and in a manner to keep marking visible.

B. Lift and support each unit only at designated lifting points and supporting points as shown on Shop Drawings.

PART 2 PRODUCTS

2.01 VAULT MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Oldcastle Precast.
2. Jensen Precast.
3. Hanson Pipe and Precast.

2.02 PRECAST CONCRETE VAULTS

A. Design Requirements:

1. In the event of a conflict between or among standards, the more stringent standard shall govern.
2. Comply with ASTM C858, except as modified herein.
3. Reinforcing Steel:
   a. Deformed Bars: ASTM A615/A615M, Grade 60.
   b. Welded Wire Fabric: ASTM A497/A497M.
4. Nominal Dimensions: As shown on Drawings.
5. Construction: Rigid type and behave monolithically. Do not use panel-type vaults.
6. Design Loads: As determined by ASTM C857, and by using Site-specific values below.
   a. Unit Weight of Soil: As shown on Drawings.
   b. Active Earth Pressure Coefficient: As shown on Drawings.
   c. Groundwater Level: As shown on Drawings.
   d. Live Loads: AASHTO HS2044 truck loading plus impact.
   e. Designed to avoid flotation with a factor of safety equal to as shown on Drawings.
7. Design shall accommodate additional stresses or loads that may be imposed during factory precasting, transporting, erection, and placement.
8. Blockouts for penetrations shall be as shown on Drawings.
9. Sealant:
   a. Nonswelling preformed joint sealants to provide a lasting, watertight bond.
   b. Manufacturer and Product: Henry Company; RAM-NEK.
10. Mortar: Comply with ASTM C387/C387M, Type S or use Type I grout as specified in Section 03 62 00, Grouting.

B. Mark each member or element to indicate location in the structure, top surface, and date of fabrication.

C. Vault Floor:

1. Slope of vault floor shall be as shown on Drawings.
2. Slope may be applied after precasting, using mortar fill as specified in Section 03 30 00, Cast-in-Place Concrete, or Type I grout as specified in Section 03 62 00, Grouting.

2.03 LINING AND COATING

A. Interior lining and exterior coating shall conform to Section 09 90 00, Painting and Coating.

2.04 ACCESSORIES

A. Ladder:

1. Provide vault with galvanized steel ladder. Conform to requirements of Section 05 50 00, Metal Fabrications. Provide with pull-up extension.
2. Meet OSHA 29 CFR 1910.27 and OSHA 29 CFR 1926.502 requirements.

B. Polypropylene Steps:

1. Fabricate from minimum 1/2-inch, Grade 60, steel bar meeting ASTM A615/A615M.
2. Polypropylene Encasement: Conform to ASTM D4101.
3. Minimum Width: 13 inches, center-to-center of legs.
4. Embedment: 3-1/2 inches minimum and 4-1/2-inch minimum projection from face of concrete at point of embedment to center of step.
5. Cast in vault sections by manufacturer.
6. Load Test: Capable of withstanding ASTM C478 vertical and horizontal load tests.

C. Access Hatches: Manufacturer’s standard, HS20 load rated, spring-assisted, lockable, galvanized steel access door.

D. Pipe Connections to Vault: Modular mechanical seals conforming to requirements of Section 40 27 01, Process Piping Specialties.

PART 3 EXECUTION

3.01 GENERAL

A. Possible Settlement: If subgrade is encountered that may require removal to prevent structure settlement, notify Engineer. Engineer will determine depth of over excavation and means of stabilizing subgrade prior to structure installation.

B. Place 6-inch minimum thickness of imported crushed aggregate material on undisturbed earth or modified subgrade; thoroughly compact with a mechanical vibrating or power tamper. Meet requirements of Article Excavation and Backfill.

3.02 EXCAVATION AND BACKFILL

A. Remove and keep water clear from excavation during construction.

B. Excavation: As specified in Section 31 23 16, Excavation.

C. Backfill: As specified in Section 31 23 23, Fill and Backfill, and Section 31 23 23.15, Trench Backfill.

3.03 INSTALLATION

A. Concrete Base:

1. Place on prepared subgrade.
2. Properly locate, ensure firm bearing throughout, and plumb first section.

B. Sections:

1. Carefully inspect precast sections to be joined.
2. Thoroughly clean ends of sections to be joined.
3. Do not use sections with chips or cracks.

C. Joints:

1. Fill joints between precast sections per manufacturer’s recommendation.
2. Joints shall be watertight to prevent entrance of groundwater.
3. Joint Finish: Dry pack interior of joints to provide smooth finish.

D. Setting Precast Vault: Finish grade of structure top shall be even with surrounding finish grade surface, unless noted otherwise on Drawings.

E. Watertight construction below grade with no open cracks or spalls. Cracking and defective areas of concrete shall be repaired per requirements of Section 03 30 00, Cast-in-Place Concrete, and Section 03 64 23, Epoxy Resin Injection Grouting.

3.04 PIPE CONNECTION TO VAULT

A. Grout pipe connections flush with interior and exterior walls.

END OF SECTION

SECTION 33 12 17.01
SURGE CONTROL SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.5, Pipe Flanges and Flanged Fittings.
   b. B16.11, Forged Steel Fittings, Socket-Welding and Threaded.
2. National Electrical Manufacturers Association (NEMA): ICS 1, General Standards for Industrial Control and Systems.
3. Steel Structures Painting Council (SSPC):
   a. SP 6, Commercial Blast Cleaning.
   b. SP 10, Near-White Blast Cleaning.

1.02 SUBMITTALS

A. Action Submittals: Shop Drawings:

1. Complete dimensional fabrication drawings of surge tank, accessories, and piping.
2. Complete piping schematic drawings showing air and liquid piping, and flows directly associated with surge tank.
3. Fabrication drawings of surge control tank panel.
4. Complete electrical elementary diagrams and electrical interconnection diagrams for surge control tank. Diagrams in accordance with NEMA ICS 1.
5. Complete interior and exterior tank painting systems.
6. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Statements of Qualification: Tank welders.
3. Tank manufacturer’s written instructions.
4. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that tank is certified and stamped in accordance with ASME Section VIII, Division 1.

5. Test Reports:
    a. Date and time of testing.
    b. Description of method of testing, including pumping combinations and pressure records.
    c. Description of observed leaks and method and date of repair.
    d. Description of catastrophic failures.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.03 QUALIFICATIONS

A. Tank welders shall be ASME certified.

PART 2 PRODUCTS

2.01 SURGE TANK

A. Physical Data:

1. Net Volume: Not less than 2,500 gallons.
2. Configuration: Vertical cylindrical shape with elliptical heads.
3. Diameter: Approximately 72 inches.
4. Sidewall Length: Approximately 167 inches.
5. Design Pressure: Rated for 250 psig.
6. Design Temperature: 70 degrees F.
7. Connecting Line: 24 inches or larger with no check valve.
8. Steady-state air volume: 1,000 gallons.

B. Attachments:

1. Elliptical Manhole(s): One minimum, design and fabricate in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Article D10.
2. Nozzles:
    a. As shown and in accordance with ASME Code, Section VIII, Article D6.
    b. Sizes 2-1/2 Inches and Larger: 250 psi flanged, ASME B16.5.
    c. Sizes 2 Inches and Smaller: 250 psi screwed, ASME B16.11.
    d. Number and Type:
        1) One 24-inch inlet nozzle.
        2) One nozzle sized as required for level sensing probes.
        3) Two level gauge nozzles.
        4) Two try valve nozzles.

3. Pressure Relief (Safety) Valve:
   a. In accordance with Boiler and Pressure Vessel Code, Section VIII, General Requirements, UG-125 and 126.
   b. Set at 250 psig.
4. Level Gauges: One, length shall extend approximately 6 inches below and 6 inches above the designed operating range. .
5. Try Valves: Two.
6. Equipment Tag Number: 37-T-1-1.

C. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

D. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.

E. Air Compressor. The air compressor package shall be a Duplex (two air-cooled, two-stage, oil lubricated reciprocating type air compressors mounted on one air receiver). The air compressor package shall be the standard product of a manufacturer who is regularly engaged in the design and construction of fully automatic air compressor systems. The air compressor system shall include the following items.

1. A Totally Enclosed Fan Cooled (TEFC) motor shall drive the compressor and shall be adequate to drive the compressor continuously at full-rated output. Power supply shall be 230/460 volts, 3 phase and 60 hertz.
2. The Hydropneumatic Surge Control System supplier shall select the compressor volumetric capacity and discharge pressure. The capacity and discharge pressure selected shall be sufficient for the application to adjust the fluid level from the add air level to the add air reset in no more than 20 minutes.
3. Compressor unit shall include a totally enclosed crankcase of cast iron, separate detachable deep finned cylinders, matched balanced pistons, separately removable valve housing, low oil switch and a direct reading pressure gauge. The low oil switch shall shut down the compressor if the oil level is too low. The switch shall not reset without adding oil.
4. The air compressor controller shall be provided with a power on light, Hand-Off-Automatic (HOA) switch, run indication, motor overload alarm light and low oil level alarm light. It shall contain a magnetic motor starter and 120V power supply.

5. The air compressor shall start and stop based on pressure in the air receiver. Dry contacts shall be provided in the compressor controller for remote indication of running conditions for the compressor. The compressor shall be shutdown by motor overload, or low oil level. An alarm condition shall energize a local alarm light.
6. The compressor shall start automatically, provided its HOA switch is in the AUTO position. The compressor shall run continuously if its HOA switch is in the HAND position and shall shut down if its HOA switch is in the OFF position.
7. The air receiver shall be a minimum of 80-gallon capacity.
8. The air compressor package shall be coated with the standard factory coating.

F. Air Control Center Assembly:

1. The level control system including the local control panel and alarm indicators, air service valves, and air compressor (specify either a simplex or duplex) and air receiver, to be factory assembled (piped and wired) on a single base to provide ease of installation in the field. The air control center shall be PULSCO's model Aeolus, or equal.
2. An awning or cover is required to deflect direct rain or sunlight.
3. Material: Aluminum paneling on powder coated carbon steel frame.

G. Anchor Bolts: Galvanized, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

H. Controls: In accordance with general control requirements and component qualities specified in Section 40 99 90, Package Control Systems.

1. Provide a hardwired common alarm dry contact from the PLC.

2.02 FABRICATION

A. Fabricate tank in accordance with ASME Boiler and Pressure Vessel Code, Section VIII.

B. Fabricate of welded carbon steel.

C. Plate Thicknesses: Determine in accordance with allowable stresses listed in the Code for material, pressure, and temperature specified.

D. Heads: As specified in ASME Code, Section VIII, Division 1.

E. Shell and Head Thicknesses: Include minimum corrosion allowance of 0.125 inch.

F. Stamp and certify tank in accordance with ASME Code Section VIII, Division 1.

G. Interior (Submerged) Surface Treatment: Clean and paint in accordance with Section 09 90 00, Painting and Coating.

H. Exterior Surface Treatment: Clean and paint in accordance with Section 09 90 00, Painting and Coating.

2.03 SOURCE QUALITY CONTROL

A. Hydrostatically test tank in shop at 1.5 times design pressure for at least for 24 hours.

B. Repair leaks found during testing prior to painting.

2.04 MANUFACTURERS

A. Pulsco, 1813 E. Dyer Rd. #401, Santa Ana, CA 92705.

B. Or Engineered Approved Equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install tank in accordance with manufacturer’s written instructions.

B. Level tank and grout support legs as specified in before anchoring.

C. Assemble Accessories: Make process, control, and electrical connections.

D. Make piping connections such that misalignment stresses are not induced in tank nozzles.

3.02 FIELD QUALITY CONTROL

A. Field Static Test:

1. Hydrostatically test installed surge control tank for 4 hours minimum at 1.5 times design pressure, before dynamic testing.
2. Repair leaks detected during testing.

B. Functional Test:

1. Dynamic Test: Perform in response to flow startup and stoppage.
2. Testing with Multiple Pumps: Increase number of pumps, one at a time.
3. Record pressures for dynamic operation of each pump combination in startup and shutdown of flow.
4. Inspect and test components for alignment, operation, and connection, and performance.

END OF SECTION

SECTION 33 13 00
DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. B300, Hypochlorites.
   b. B301, Liquid Chlorine.
   c. C651, Disinfecting Water Mains.
   d. C652, Disinfection of Water Storage Facilities.
   e. C653, Disinfection of Water Treatment Plants.
   f. C655, Field Dechlorination.
2. Standard Methods for the Examination of Water and Wastewater, as published by American Public Health Association, American Water Works Association, and the Water Environment Federation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Plan describing and illustrating conformance to appropriate AWWA standards and this specification.
2. Procedure and plan for cleaning system.
3. Procedures and plans for disinfection and testing.
4. Proposed locations within system where Samples will be taken.
5. Type of disinfecting solution and method of preparation.
6. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.
7. Storage and handling considerations for disinfectant chemical.
8. Method of disposal for highly chlorinated disinfecting water.
9. Independent Testing Agency: Certification that testing agency is qualified to perform chlorine concentration testing and bacteriological testing in accordance with AWWA standards, agency requirements, and this specification.
10. Certified Bacteriological Test Results:
    a. Facility tested is free from coliform bacteria contamination.
    b. Forward results directly to Engineer.

1.03 QUALITY ASSURANCE

A. Independent Testing Agency: Certified in the State of Alabama, with 10 years' experience in field of water sampling and testing. Agency shall use calibrated testing instruments and equipment and documented standard procedures for performing specified testing.

1.04 SEQUENCING

A. Commence initial disinfection after completion of following:

1. Completion and acceptance of internal painting of system(s).
2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.
3. Disinfection of:
   a. Pumps and associated system piping.
   b. Treatment plant basins and processes used to supply water to system.

PART 2 PRODUCTS

2.01 WATER FOR DISINFECTION AND TESTING

A. Clean, uncontaminated, and potable.

B. Convey Owner-supplied potable water in disinfected pipelines or containers. Make arrangements for water supply and convey water in disinfected pipelines or containers.

2.02 DISINFECTANT

A. Provide disinfectant product conforming to AWWA standards.

PART 3 EXECUTION

3.01 GENERAL

A. Conform to AWWA C651 for pipes and pipelines, C652 for tanks and reservoirs, and C653 for water treatment plants and filters, except as modified in these Specifications.

B. Contractor's Equipment:

1. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.

2. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.

C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:

1. Pumps.
2. Tanks/Chlorine Contact Basin.
3. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
4. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and AWWA C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

D. Prior to application of disinfectants, clean pump, tank/chlorine contact basin, and pipelines of loose and suspended material.

E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 TURBIDITY

A. Cleaning of equipment and facilities shall include removal of materials that result in a turbidity exceeding limits stated in Article Testing.

3.03 PIPINGAND PIPELINES

A. Cleaning:

1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
2. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used, flush pipelines with potable water at a velocity as described in AWWA C651 until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.

3. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used, flush pipelines with potable water at the maximum expected flow rate as described in AWWA C651 until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
4. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
5. Flush pipe through flushing branches and remove branches after flushing is completed.
6. Clean the pipe by broom sweeping as described in AWWA C651.
7. Pipeline shall be cleaned by use of a pipe pig specifically designed for cleaning. Observe material removed by pig on each pass. Repeat process until pipe has been cleaned to the satisfaction of Engineer.

B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

C. Pipelines larger than 36 inches may be disinfected by spraying in accordance with AWWA C651.

3.04 PUMPS

A. Disinfecting Solutions: Minimum free chlorine concentration of 100 mg/L.

B. Application:

1. Inject disinfecting solution into pump and associated piping and circulate for a minimum 3-hour period of time. At end of circulation period, measure and record the free chlorine concentration in the circulated water.
2. Operate valves and pump appurtenances during disinfection to ensure disinfecting solution is dispersed into all parts of pump and lines.
3. If disinfecting solution contained in pump has a residual free chlorine concentration less than 50 mg/L after the 3-hour circulation period, reclean pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
4. After chlorination, flush water from pump until water through unit is chemically and bacteriologically equal to permanent source of supply.

3.05 TANKS AND RESERVOIRS

A. Cleaning:

1. Clean interior surfaces using water under pressure before sterilizing.
2. Isolate tank, reservoir or chlorine contact basin from system to prevent contaminating materials from entering distribution system.
3. Remove deposits of foreign nature.
4. Remove biological growths.
5. Clean slopes, walls, top, and bottom.
6. Avoid damage to structure.
7. Avoid pollution or oil deposits by workers and equipment.
8. Dispose of water used in cleaning in accordance with applicable regulations before adding disinfecting solution to tank chlorine contact basin and reservoir.

B. Disinfecting Procedure: In accordance with AWWA C652, unless herein modified. Parts of structures, such as ceilings or overflows that cannot be immersed, shall be spray or brush disinfected.

3.06 DISPOSAL OF CHLORINATED WATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.

B. Dechlorination Procedure: In accordance with AWWA C655, unless herein modified.

3.07 TESTING

A. Collection of Samples:

1. Coordinate activities to allow Samples to be taken in accordance with this specification.
2. Provide valves at sampling points.
3. Provide access to sampling points.

B. Test Equipment:

1. Clean containers and equipment used in sampling and make sure they are free of contamination.
2. Obtain sampling bottles with instructions for handling from Owner’s laboratory.

C. Chlorine Concentration Sampling and Analysis:

1. Collect and analyze Samples in accordance with AWWA 651 and 652.
2. Analysis to be performed by Owner's laboratory. Samples will be analyzed using amperometric titration method for free chlorine as described in latest edition of Standard Methods for Examination of Water and Wastewater.

D. After facilities or piping have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies.

1. Collect Samples in accordance with applicable AWWA Standard.
2. Analyze Samples for coliform concentrations in accordance with latest edition of Standard Methods for the Examination of Water and Wastewater.
3. Obtain and analyze a minimum of two Samples on each of 2 consecutive days from each separable structure and every 1,000 feet of pipeline by standard procedures outlined by state and local regulatory agencies.
4. Sampling points shall be representative and accepted by Engineer.

E. Turbidity Sampling and Analysis:

1. After facilities or piping have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to turbidity limitations for public drinking water supplies. Turbidity shall not exceed 0.3 NTU.
2. If turbidity is in excess of the limit, dispose of the water in accordance with this Specification and applicable regulations, take action to remove source of turbidity, refill system, and retest.

F. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

END OF SECTION

SECTION 33 41 01
STORM DRAIN SANITARY SEWER AND DRAINAGE PIPING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M36M, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
   b. M190M, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
   c. M196M, Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
2. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm Through 1200 mm) for Water and Other Liquids.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
3. ASTM International (ASTM):
   a. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
   b. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C150, Standard Specification for Portland Cement.
   e. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
   f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   g. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.

h. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
i. C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
j. C507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
k. C595, Standard Specification for Blended Hydraulic Cements.
l. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
m. C655, Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe.
n. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
o. C1012, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
p. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
q. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
r. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
s. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
t. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
u. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
v. F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
w. F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
x. F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

1.02 SUBMITTALS

A. **[A: Informational Submittals: Manufacturer's Certification of Compliance.]**

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. As specified in the Data Sheets following "End of Section."

2.02 SERVICE AND DRAIN CONNECTIONS

A. Pipe and fittings for individual service connection shall be of one type of material throughout.

B. **[A: Vitrified clay] [B: Nonreinforced concrete] [C: Ductile iron] [D: Polyvinyl chloride] [E: Cast iron soil]** pipe.

C. Residential Service: **[A: 4] [B: 6]** inches.

D. Commercial Service, Including Motel and Apartments: 6 inches, unless shown otherwise.

2.03 SERVICE CONNECTION MARKERS

A. New 2 by 4 lumber **[A: construction] [B: utility]** grade or better.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.
2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.
3. Pipe invert may deviate from line or grade up to **[A: 1/2] [B:]** inch for line and **[C: 1/4] [D:]** inch for grade, provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.
4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.
5. Prevent entry of foreign material into gasketed joints.
6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

B. Ductile Iron Pipe Corrosion Protection:

1. Remove foreign material from the exterior of the pipe.
2. Wrap pipe with polyethylene encasement tube 2 feet longer than the pipe section prior to laying pipe section.
3. After assembling the pipe joint, overlap encasement tube with adjacent tube and seal joints with securing tape.
4. Provide additional securing tape at 3-foot intervals along the pipe.
5. Repair rips, punctures, or other damage to the polyethylene with securing tape.
6. Fittings may be wrapped with a flat sheet or split tube provided all seams are securely taped.

C. Concrete Closure Collars: Only use concrete closure collars where shown or authorized by Engineer.

D. Service Connections:

1. Minimum Slope: **[A: 1/4 inch] [B:]** per foot.
2. Markers:
   a. Paint the top portion of the marker immediately after its installation with first-quality white, quick-drying enamel. **[C: After the paint has dried, use black, quick-drying enamel and neatly indicate the distance from the natural ground surface to the top of the service connection pipe in feet and inches.]**
   b. If marker is broken or knocked out of vertical alignment during backfilling operation, reopen trench and place marker in accordance with Sewer Service Connection Details shown on Drawings.
3. Disconnecting and Reconnecting Existing Service Connections:
   a. Locate the existing service connections prior to constructing the tee in the new sewerline.
   b. Disconnect existing service connections from existing sewers to be abandoned and reconnect them to the new sewers.

E. Square-End Underdrains: Cover top and sides of the joints with a strip of asphalt-saturated 30-pound roofing felt.

F. Perforated Underdrain: Lay with open joints and with perforations down.

3.02 PRESSURE TESTING

A. As specified in Section 40 80 01, Process Piping Leakage Testing.

3.03 REPAIR AND RETESTING

A. Sections of pipe not meeting the pressure test requirements shall **[A: be replaced] [B: or] [C: have individual joints tested and sealed]**.

B. Following repairs, sections shall be retested as specified.

3.04 SEWER CLEANING

A. Prior to final acceptance and final manhole-to-manhole inspection of the sewer system by Engineer, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.

B. Upon Engineer's final manhole-to-manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

3.05 SUPPLEMENTS

A. Data Sheets.

Number	Title
-.07	Polyethylene (PE) Profile Wall
-.08	Corrugated Polyethylene

END OF SECTION

TAG	QTY	COMP CODE	COMPONENT TITLE	OPTIONS	P&ID	INST. DETAIL
40LE-30-1 40LE-30-2	2	L007R	Level Element and Transmitter, Radar, Type R	Range: 0 - 12 Feet Span: 0 - 11 Feet Zero Reference: Bottom of Tank 6" Flange Mount	08-N-001	4091-252 4091-415BG
35FE/FIT-2-1	1	F4	Flow Element And Transmitter, Electromagnetic	Meter Size: 36 Inches Process: Finished Water Range: 0 - 30 MGD Span: 0.1 - 30 MGD	08-N-001	4091-219G 4091-420AG
35PIT-2-1	1	P9	Pressure Transmitter	Range: 0 - 120 PSI	08-N-001	4091-302 4091-304A 4091-415BG
35PSL-2-1A 35PSL-2-2A 35PSL-2-3A 35PSL-2-4A 35PSL-2-5A	5	P8	Pressure Switch, Fixed Dead Band	Setpoint: 20 PSI, Falling	08-N-001	4091-302 4091-304A 4091-415BG
35PI-2-1B 35PI-2-2B 35PI-2-3B 35PI-2-4B 35PI-2-5B	5	P4	Pressure Gauge	Range: 0 - 120 PSI	08-N-001	4091-302 4091-304A 4091-415BG
BSAH-35-20-1	1	M30A	Combination Horn And Strobe			

SECTION 33 41 01.08 CORRUGATED POLYETHYLENE (CPE)	
Item	**Description**
Pipe	**[A: AASHTO M252M (75 to 250-mm diameter).] [B: AASHTO M294M (300 to 900-mm diameter).] [C: AASHTO MP6 (1050 to 1200-mm diameter).]**
Pipe Stiffness (Minimum)	In accordance with specified AASHTO Specification.
Profile	**[A: Type C.] [B: Type S and D.]**
Joints	**[A: Bell and spigot, gasketed type.] [B: Bell and spigot, gasketed type and water-tight.] [C: Plain ends for culvert.]**
Gaskets	ASTM F477.
Fittings	Manufacturer's standard; same stiffness as adjacent pipe.
Source Quality Control	In accordance with specified AASHTO Specification.
Factory Testing	Pipe lengths used for deflection testing shall be destroyed after testing.

END OF SECTION

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
5. International Building Code (IBC).
6. International Mechanical Code (IMC).
7. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping 6 inches and larger and4 inches and smaller. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

2. Calculations for each type of pipe support, attachment and anchor.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Maintenance information on piping support system.
4. Calculations signed and sealed by a professional engineer registered in the State of Alabama.
5. Show Drawings signed and sealed by a professional engineer registered in the State of Alabama.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the state where the Work is to be installed.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
4. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.

2. Seismic loads in accordance with governing codes and as shown on Structural General Drawings.
3. Wind loads in accordance with governing codes and as shown on Structural General Drawings.
4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
    a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
    b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.
5. Electrical Conduit Support: Include in design of framing support system.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 HANGERS

A. Clevis: MSS SP 58, Type 1:

1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.

B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:

1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.

C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:

1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports: MSS SP 58, Type 44:

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.

B. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.

C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.

D. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches though 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP , Type 37 with U-bolt.
   a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
   b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.
3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
   a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
   b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer’s allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. B-Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).

2.06 FRP PIPE SUPPORTS SYSTEMS

A. General:

1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
2. Fire Retardant: ASTM E84.
3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer’s recommendations.
2. Identify and highlight nonFRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

2.08 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.

2.10 PIPE ALIGNMENT GUIDES

A. Type: Spider.

B. Manufacturers and Products:

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 SEISMIC RESTRAINTS

A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.

B. Manufacturers:

1. Mason Industries.
2. B-Line.
3. Anvil.

2.13 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.
2. Bolt Length (Extension Above Top of Nut):
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.
2. Manufacturer and Products:
   a. B-Line; B1999 Vibra Cushion.
   b. B-Line; Iso Pipe, Isolation Tape.

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers and Products:
   a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
   b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
   a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
   b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
5. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at 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 completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.

3. Horizontal Piping Supported from Floors:
    a. Saddle Supports:
        1) Pedestal Type, elbow and flange.
        2) Provide minimum 1-1/2-inch grout beneath baseplate.
    b. Floor Mounted Channel Supports:
        1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
        2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
        3) Attach pipe to channel with clips or pipe clamps.
    c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.
4. Insulated Pipe:
    a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
    b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
    c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
    a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
    b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
    a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
    b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.

3. Steel Beams: I-beam clamp or welded attachments.
4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENTS

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

1. Table 1: Nonchemical Areas.
2. Table 2: Chemical Areas.

END OF SECTION

Table 1
Nonchemical Areas

Exposure Conditions	Support Material
Office Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Shops and Warehouse Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Pipe Galleries	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Process Areas: High Humidity or Hydrogen sulfide	Stainless steel or FRP
Process Areas: Wetted or Submerged	Stainless steel or FRP
Pipes conveying chemicals listed in Table 2	Provide with corresponding support per Table 2.

Notes:

1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

Table 2
Chemical Areas

Exposure Conditions	Support for Direct Exposure	Support for Remote Exposure
Hydrofluorosilic Acid	FRP	Precoated steel
Sodium Hypochlorite	FRP	Precoated steel

Notes:

1. Direct exposure includes entire area within containment area; area within 20 feet horizontal and 10 feet vertical of chemical pumps or chemical mixing stations; or as specified.
2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
4. Stainless steel to be Type 304.
5. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
6. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

SECTION 40 05 33
PIPE HEAT TRACING

PART 1 GENERAL

1.01 REFERENCES

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

1. Factory Mutual.
2. Institute of Electrical and Electronics engineers, Inc (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
4. Underwriters Laboratories, Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's descriptive literature.
2. Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.
3. Pipe heat loss calculations for each pipe size to be heat traced.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN REQUIREMENTS

A. Design Heating Load:

1. Heating load to be calculated based upon a 50 degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 40 42 13, Process Piping Insulation, pipe as specified in Section 40 27 00, Process Piping—General, and shall include a 10 percent safety factor.
2. Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

2.02 ELECTRICAL HEATING TAPE

A. Cable: Self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.

B. UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.

C. Maximum Maintenance Temperature: 150 degrees F (65 degrees C).

D. Maximum Intermittent Temperature: 185 degrees F (85 degrees C).

E. Service Voltage: As indicated by branch circuits provided for heat tracing on the Drawings.

F. Manufacturers and Products:

1. Raychem; BTV-CR.
2. Thermon; BSX.
3. Nelson; CL1-J1 or L1-J1.

2.03 CONNECTION SYSTEM

A. Rating: NEMA 250, Type 4 and Factory Mutual approved.

B. Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.

C. Manufacturers and Products:

1. Power Connection Kit:
   a. Raychem; JBS-100.
   b. Thermon; PCA-1-SR or DP-L.
   c. Nelson; PLT-BC.
2. Splice Kit:
   a. Raychem; S-150.
   b. Thermon; PCS-1-SR.
   c. Nelson; PLT-BS.
3. Tee Kit:
   a. Raychem; T-100.
   b. Thermon; DS-S.
   c. Nelson; PLT-BY.
4. End Seal Kit:
   a. Raychem; E-150.
   b. Thermon; DE-S.
   c. Nelson; LT-ME.
5. Lighted End Seal Kit:
   a. Raychem; E-100-L.
   b. Thermon; DLS.
   c. Nelson; LT-L.

2.04 SECURING TAPE

A. Plastic Piping Systems:

1. Type: Aluminum foil coated adhesive tape.
2. Manufacturers and Products:
   a. Raychem; AT-180.
   b. Thermon; AL-20P.
   c. Nelson; AT-50.

B. Metallic Piping Systems:

1. Type: Glass or polyester cloth pressure sensitive tape.
2. Manufacturers and Products:
   a. Raychem; GS54 or GT66.
   b. Thermon; PF-1.
   c. Nelson; GT-6 or GT-60.

2.05 PIPE MOUNTED THERMOSTAT

A. Type: Fixed, nonadjustable, set at 40 degrees F.

B. Sensor: Fluid-filled with 3-foot capillary.

C. Enclosure: Glass-filled nylon, NEMA 250, Type 4X weatherproof with gasketed lid.

D. Switch: SP-ST, UL listed, rated 22 amps, 120 to 240V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-F5.
2. Thermon; E4X-1.
3. Raychem; DigiTrace Model E507S-LS for hazardous areas.
4. Thermon; E7-25325 for hazardous areas.

2.06 AMBIENT THERMOSTAT

A. Type: Adjustable setting (15 to 140 degrees F).

B. Sensor: Fluid-filled probe.

C. Enclosure: Epoxy-coated NEMA 250, Type 4X aluminum enclosure with exposed hardware of stainless steel.

D. Switch: SP-DT, UL or FM listed, rated 22 amps, 125 to 250V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-1A.
2. Thermon; B4X-15140.
3. Raychem; DigiTrace Model AMC-1H for hazardous areas.
4. Thermon; B7-15140 for hazardous areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install in accordance with the manufacturer's instructions and recommended practices.
2. Provide insulation as specified in Section 40 42 13, Process Piping Insulation, over all pipe heat tracing.
3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
5. Provide end of circuit pilot lights on heat tracing circuits for buried piping.

B. Electrical Heating Tape:

1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
2. Where design heating load exceeds heating tape capacity, install by spiraling.
3. Derate heating tape capacity when installed on plastic piping.

4. Install on services as follows:

Service	Piping Material	Enclosure Type	Notes
FL	See Specification 40 42 00 for Piping Schedule	NEMA 4X	Install on outdoors, exposed piping 4″ or smaller. Outdoor, corrosive, wet location

5. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min. feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

D. Thermostats:

1. Install in accordance with manufacturer’s instructions and as approved by Engineer.
2. For each group of heat traced circuit, install one ambient thermostat.

3.02 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.

1. Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION

SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
4. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
   e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   f. B16.9, Factory-Made Wrought Buttwelding Fittings.
   g. B16.11, Forged Fittings, Socket-Welding and Threaded.
   h. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
   i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
   l. B16.25, Buttwelding Ends.
   m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
   n. B31.1, Power Piping.
   o. B31.3, Process Piping.
   p. B31.9, Building Services Piping.
   q. B36.10M, Welded and Seamless Wrought Steel Pipe.

5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.
6. American Water Works Association (AWWA):
    a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
    b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
    c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
    d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
    e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
    f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
    g. C153/A21.53, Ductile-Iron Compact Fittings.
    h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
    i. C606, Grooved and Shouldered Joints.
7. American Welding Society (AWS):
    a. Brazing Handbook.
    b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
    c. D1.1/D1.1M, Structural Welding Code - Steel.
    d. QC1, Standard for AWS Certification of Welding Inspectors.
8. ASTM International (ASTM):
    a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
    b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
    d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
    e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
    f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
    g. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
    h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.

j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
n. A197/A197M, Standard Specification for Cupola Malleable Iron.
o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
q. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
r. A276, Standard Specification for Stainless Steel Bars and Shapes.
s. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
u. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
v. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
aa. A536, Standard Specification for Ductile Iron Castings.
bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
dd. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.

ee. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
hh. B32, Standard Specification for Solder Metal.
ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
jj. B61, Standard Specification for Steam or Valve Bronze Castings.
kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
ll. B75/B75M, Standard Specification for Seamless Copper Tube.
mm. B88, Standard Specification for Seamless Copper Water Tube.
nn. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
oo. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
pp. B464, Standard Specification for Welded UNS N08020 Alloy Pipe.
qq. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
rr. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
ss. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
tt. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
uu. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
vv. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
ww. D1330, Standard Specification for Rubber Sheet Gaskets.
xx. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

yy. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
zz. D2000, Standard Classification System for Rubber Products in Automotive Applications.
aaa. D2310, Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
bbb. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
ccc. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
ddd. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
eee. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
fff. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
ggg. D2996, Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
hhh. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
iii. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
jjj. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
kkk. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
lll. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
mmm. F423, Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
nnn. F436, Standard Specification for Hardened Steel Washers.
ooo. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
ppp. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
qqq. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
rrr. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
sss. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ttt. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

9. FM Global (FM).
10. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.
11. NSF International (NSF): 61 Drinking Water System Components—Health Effects.
12. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
13. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of: Liquid surface or within 1 foot above top of liquid surface.

1.03 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Building Service Piping: ASME B31.9, as applicable.
3. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code.
4. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
5. Thrust Restraints:
   a. Restrained pipe joints shall be used to accomplish thrust restraint.
   b. Thrust blocks shall be used only as indicated on design Drawings or by approval of Engineer.
   c. Design for test pressure shown in Piping Schedule.
   d. Allowable Soil Pressure: 1,000 pounds per square foot.
   e. Low Pressure Pipelines:
      1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
      2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
   a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
   b. Layout drawing showing location of each pipe section and each special length; number of otherwise designate laying sequence on each piece.
2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
6. Pipe Corrosion Protection: Product data.
7. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements:
   a. Pipe and fittings.
2. Anchorage and bracing calculations, as required by Section 01 88 15, Anchorage and Bracing.
3. Flanged Pipe and Fitting: Manufacturer’s product data sheets for gaskets including torquing requirements and bolt tightening procedures.
4. Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Pipe requirements:
   a. Information on pipe material.
   b. Solvent cement.
   c. Fitting information.
   d. Bolt information.
   e. Gasket information.
   f. Thread lubricant.

5. Qualifications:
   a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
   b. AWS QC1 Certified Welding Inspector: Submit evidence of current certification prior to commencement of welding activities.
   c. Welders:
      1) Continuity log for welders and welding operators.
      2) Welder qualification test records conducted by Contractor or manufacturer.
6. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
7. Nondestructive inspection and testing procedures.
8. Test logs.
9. Pipe coating applicator certification.
10. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
11. Torquing requirements and procedures, including torque values, for flanged piping assemblies.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
   b. Calibrated instruments and equipment and documented standard procedures for performing specified testing.
   c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
   d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
   e. Verification Welding Inspector: AWS QC1 Certified.
2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).
3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
4. Contractor's CWI: Certified in accordance with AWS QC1 and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.
5. Solvent Welder for Double Wall Containment Piping: Qualified in accordance with Chapter VII of the ASME B31.3 Code, Part 9, Paragraph A328.

B. Quality Assurance: Provide services of independent inspection and testing agency for welding operations.

1. The presence of Owner's Special Inspector or Verification CWI does not relieve Contractor from performing own quality control, including 100 percent visual inspection of welds.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

B. Piping materials and accessories designed for contact with public drinking water systems shall meet the requirements of NSF 61USEPA Safe Drinking Water Act.

2.02 PIPING

A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

B. Diameters Shown:

1. Standardized Products: Nominal size.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

2.03 JOINTS

A. Grooved End System:

1. Rigid type.
2. Use of flexible grooved joints allowed where shown on Drawings or with prior approval by Engineer.
3. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher-pressure rating than required for piping.

C. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

D. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than:
   a. 3 degrees for sizes through 12 inches.
   b. 2 degrees for sizes 14 inches through 16 inches.
   c. 1.5 degrees for sizes 18 inches through 24 inches.
   d. 1 degree for sizes 30 inches through 48 inches.
4. UL and FM approved.

E. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
   a. Fernco Joint Sealer Co.
   b. “Or-equal.”

F. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:

1. Polyethylene stub end thermally butt-fused to end of pipe.
2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.
4. Gaskets as specified on Data Sheet.

2.04 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.05 DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. System components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.06 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

B. Heat Shrink Wrap:

1. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.
2. Manufacturer and Product: Raychem; WPCT or TPS.

C. Insulating Flanges, Couplings, and Unions:

1. Materials:
   a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have ASME B31.9 working pressure rating equal to or higher than that of joint and pipeline.
   b. Galvanically compatible with piping.
   c. Resistant for intended exposure, operating temperatures, and products in pipeline.

2. Union Type, 2 Inches and Smaller:
   a. Screwed or solder-joint.
   b. O-ring sealed with molded and bonded insulation to body.
3. Flange Type, 2-1/2 Inches and Larger:
   a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
   b. Bolt insulating sleeves shall be provided full length between insulating washers.
   c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.
   d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
   e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.
4. Flange Insulating Kits:
   a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
   b. Insulating Sleeves: Full-length mylar.
   c. Insulating Washers: High-strength phenolic.
   d. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
      1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
      2) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.
5. Manufacturers and Products:
   a. Dielectric Flanges and Unions:
      1) PSI, Houston, TX.
      2) Advance Products and Systems, Lafayette, LA.
   b. Insulating Couplings:
      1) Dresser; STAB-39.
      2) Baker Coupling Company, Inc.; Series 216.

2.07 THRUST BLOCKS

A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.08 THRUST TIES

A. Steel Pipe: Fabricated lugs and rods in accordance with details shown on Drawings.

B. Buried Ductile Iron Pipe and Fittings: Unless restraint is otherwise specified or shown, conform to NFPA 24. Tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

2.09 VENT AND DRAIN VALVES

A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.

B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.10 FABRICATION

A. Mark each pipe length on outside with the following:

1. Size or diameter and class.
2. Manufacturer’s identification and pipe serial number.
3. Location number on laying drawing.
4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.11 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

B. Galvanizing:

1. Hot-dip applied, meeting requirements of ASTM A153/A153M.
2. Electroplated zinc or cadmium plating is unacceptable.
3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

A. See Piping Schedule and Section 09 90 00, Painting and Coating, for additional requirements.

B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

3.03 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.

B. Weld Identification: Keep paper record of which welder welded each joint.

C. Pipe End Preparation:

1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
3. Beveled Ends for Butt Welding: ASME B16.25.

D. Surfaces:

1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.

2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:

1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
2. Root Opening of Joint: As stated in qualified welding procedure.
3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.

F. Climatic Conditions:

1. Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
2. Stainless Steel and Alloy Piping: If ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Quality: Meet requirements of governing welding codes.

3.04 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer’s instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.

4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast-iron flange.
7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
8. Flange fillers are to be avoided, but, if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
10. or grooved joint flange adapter manufacturer.

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. 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. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

G. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

H. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

3.05 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

3. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

G. Provide stainless steel bird screen on open pipe ends connected to process piping (such as, vent piping), unless otherwise indicated on the Drawings. Attach bird screen with ring flange, threaded connection or other applicable pipe fitting.

3.06 INSTALLATION—BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes:
   a. Provide flexible mechanical compression joints for pressure pipe.
   b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown.
2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day’s work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.

9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    a. Shorter pipe lengths.
    b. Special mitered joints.
    c. Standard or special fabricated bends.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC or CPVC Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line, Except PVC or CPVC: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer’s recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on Drawings for encasement requirements.

B. Where concrete encased piping crosses structure expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 INSTALLATION—DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. Install according to manufacturer's instructions.

B. Valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to pipe.

C. Centering Devices for Double Wall Containment Piping:

1. Center and support carrier pipe within the containment pipe with centering devices. Locate not less than every 9 feet, or within 24 inches of the termination of containment pipe on fabricated pieces.
2. Install centering devices such that leak detection cable (if specified) will be unrestricted and such that system maintains free drainage.

D. Following Installation and Testing:

1. Flush clean carrier and containment piping system.
2. Purge annular space of moisture with clean, dry nitrogen gas.

3.09 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule.
2. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF 61 approved epoxy.

B. Carbon Steel Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.
2. Submerged or Embedded: Shop coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF 61 approved epoxy.

C. Copper Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.

D. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

E. Piping Accessories:

1. Exposed:
   a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
   b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
2. Buried:
   a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
   b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
   c. Flexible Couplings and Similar Items: Wrap with heat shrink wrap or coat with cement.
   d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
   e. Cement-Coated Pipelines: Cement coat appurtenances same as pipe.

F. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Dissimilar metal piping connections.
   b. Cathodically protected piping penetration to buildings and watertight structures.
   c. Submerged to unsubmerged metallic piping connections.
   d. Connections to existing metallic pipe.
   e. Where required for electrically insulated connection.
2. Pipe Installation:
   a. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
   b. Align and install insulating joints as shown on the Drawings and according to manufacturer’s recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.10 THRUST RESTRAINT

A. Location:

1. Buried Piping: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist because of hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.
3. Submerged Piping: At all joints in piping.

B. Thrust Ties:

1. Steel Pipe: Attach with lugs fabricated in accordance with details shown on Drawings.
2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

D. Thrust Blocking:

1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: 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 in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.11 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.12 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.13 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations.

3.14 INSULATION

A. See Section 40 42 13, Process Piping Insulation.

3.15 HEAT TRACING

A. See Section 40 05 33, Pipe Heat Tracing.

3.16 DISINFECTION

A. See Section 33 13 00, Disinfecting of Water Utility Distribution.

3.17 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.18 PIPE IDENTIFICATION

A. As specified in Section 09 90 00, Painting and Coating.

3.19 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

B. Minimum Duties of Welding Inspector:

1. Job material verification and storage.
2. Qualification of welders.
3. Certify conformance with approved welding procedures.
4. Maintenance of records and preparation of reports in a timely manner.
5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:

1. Perform examinations in accordance with Piping Code, ASME B31.3.
2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
3. Examine at least one of each type and position of weld made by each welder or welding operator.
4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

D. Test containment piping leak detection system in accordance with system manufacturer’s instructions and recommendations to verify proper operation.

3.20 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, to assist with unloading of the double wall containment piping system, system tests, containment pipe joint closure, installation and testing of leak detection system, and training of Owner’s personnel in operation and maintenance of leak detection system. Manufacturer’s representative shall complete a Manufacturer’s Certificate of Proper Installation. Inspection and examination practices shall be according to ASME B31.3 for Normal Fluid Service.

3.21 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 plant process air, and instrument air lines with compressed air at 4,000 fpm; do not flush with water.

C. Immediately after cleaning service piping, dry to minus 40 degrees F dew point with dry compressed instrument air or compressed commercial grade nitrogen.

D. 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.

E. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

F. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.22 SUPPLEMENTS

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

1. Piping Schedule.
2. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar-Lined Ductile Iron Pipe and Fittings
40 27 00.03	Carbon Steel Pipe and Fittings – General Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.11	Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings

END OF SECTION

PIPING SCHEDULE LEGEND

SERVICE

DR	Drain
FL	Hydrofluorosilicic Acid
FW	Finished Water
OF	Overflow
PD	Process Drain
RW	Raw Water
SD	Storm Drain
SPD	Sump Pump Discharge
V	Vents
W1	Water-Potable
W2	Water-Non-Potable
W3	Water-Plant

EXPOSURE

ALL	All
BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

MATERIAL

CELDI	Ceramic Epoxy-Lined Ductile Iron
CLDI	Cement-Lined Ductile Iron
CPVC	Chlorinated PVC
DI	Ductile Iron
WS	Fabricated Welded Carbon Steel

JOINT TYPE

FL	Flanged
GR	Grooved
HU	Hub and spigot
PRJ	Proprietary Restrained
RM	Restrained Mechanical
S	Screwed
W	Welded (including solvent and fusion)

PRESSURE TEST

G	Gravity Service: Test pressure is not shown on gravity services. Test to highest liquid level that pipe can be subject to.
H	Hydrostatic
I	In Service
P	Pneumatic
PC	Test per Uniform Plumbing Code
NA	Not Applicable

Service	Size(s) (In.)[1]	Exposure	Piping Material	Specification Section	Joint Type	Lining/ Coating[2]	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color and Label	Remarks
DR									Use Primary Service Information unless called out otherwise on Drawings.
DR	>=4	EXP	CLDI	40 27 00.01	FL	Cement Mortar/No. 4	150, H	N/A	
	>=4	BUR	CLDI	40 27 00.01	PRJ	Cement Mortar/No. 1	150, H	N/A	
	<4	ALL	PVC	40 27 00.10	FL, W	Bare/None	120, H	N/A	
FL	ALL	EXP	CPVC	40 27 00.11	FL, W	Bare/None	120, H	Fluoride/Light Blue with Red band	Install 4″ CPVC casing for all piping outside of containment areas
FW	>=24	EXP	CLDI	40 27 00.01	FL	Cement Mortar/No. 4	250, H	Dark Blue	
		BUR	CLDI		PRJ	Cement Mortar/No. 1			
	<24	EXP	WS	33 05 01.01	FL, W	Epoxy/No. 1	250, H	Dark Blue	30″ and 42″ Suction Piping upstream of vertical turbine pumps shall be welded steel
		BUR			RM, W				

Service	Size(s) (In.)[1]	Exposure	Piping Material	Specification Section	Joint Type	Lining/ Coating[2]	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color and Label	Remarks
HW	ALL	EXP	CPVC	40 27 00.11	W		150, H		See 22 07 00 for plumbing insulation requirements.
OF	>=4	EXP	CLDI	40 27 00.01	FL	Cement Mortar/No. 4	G	N/A	
	>=4	BUR	CLDI	40 27 00.01	PRJ	Cement Mortar/Remark 3	G	N/A	
	<4	BUR, EXP	CPVC	40 27 00.11	W	Bare/None	G	N/A	25% Hydrofluorosilicic Acid
PD	ALL	ALL	PVC-DWV	22 10 01.02	W	Bare/None	G	N/A	
RW	ALL	EXP	CLDI	40 27 00.01	FL	Cement Mortar/No. 4	150, H	Olive Green	
		BUR	CLDI		PRJ	Cement Mortar/No. 1		Olive Green	
SD	ALL	EXP	CLDI	40 27 00.01	FL	Cement Mortar/No. 4	150, H	N/A	
		BUR	CLDI		PRJ	Cement Mortar/No. 1		N/A	
SPD	ALL	ALL	PVC	40 27 00.10	W	Bare/None	150, H	N/A	

Service	Size(s) (In.)[1]	Exposure	Piping Material	Specification Section	Joint Type	Lining/ Coating[2]	Test Pressure and Type (psig-x), x = Type indicated in Legend	Pipe Color and Label	Remarks
TW	ALL	EXP	CPVC	40 27 00.11	W		150, H		See 22 07 00 for plumbing insulation requirements.
V	ALL	ALL	CPVC/PVC	40 27 00.11/ 40 27 00.10	W	Bare/None		N/A	Material shall match material of process chemical piping.
W1	ALL	EXP	PVC/CPVC	40 27 00.11/ 40 27 00.10	FL, W	Bare/None	150, H	Cold Water/ Dark Blue	Exposed plumbing piping (W1) to be CPVC, see 40 27 00.11 for specification. See 22 07 00 for plumbing insulation requirements.
		BUR			T, W				
W2	ALL	EXP	PVC	40 27 00.10	FL, W	Bare/None	150, H	Olive Green	
		BUR			T, W				
W3	>=4	EXP	CLDI	40 27 00.01	FL	Cement Mortar/No. 4	150, H	Olive Green	
	>=4	BUR	CLDI	40 27 00.01	PRJ	Cement Mortar/Remark 3	150, H		
	<4	BUR, EXP	PVC	40 27 00.10	FL, W	Bare/None	150, H		Insulate outdoors. See Section 40 05 33, Pipe Heat Tracing, and Section 40 42 13, Process Piping Insulation.

[1]">" Greater Than
"<" Less Than
"<=" Less Than or Equal To
">=" Greater Than or Equal To
"All" All Sizes
[2]Coating system number as specified in Section 09 90 00, Painting and Coating, and as specified in Article Pipe Corrosion Protection.
[3]Buried Ductile Iron Pipe shall be coated with Manufacturer Standard Asphaltic Coating

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).
Pipe	Buried Liquid Service Using Push-on, Mechanical, or Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron.
Lining	Cement-mortar: AWWA C104/A21.4.

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Fittings	Lined and coated same as pipe. Push-on: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron. Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face or ASME B16.1, Class 250 raised face. Gray cast iron will not be allowed.
Joints	Push-on: 250 psi minimum working pressure, AWWA C110/A21.10 and AWWA C111/A21.11. American Cast Iron Pipe Co., Fastite Joint; U.S. Pipe and Foundry, Tyton Joint. Mechanical: 250 psi minimum working pressure. Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Flange: Dimensions per AWWA C110/A21.10 flat face, or ASME B16.1 Class 250 raised face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.

SECTION 40 27 00.01 CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
	Branch connections 3 inches and smaller, except from glass-lined pipe, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.
Couplings	Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic. Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. Flanged: ASTM A307, Grade B carbon steel heavy hex head or stud bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M heavy hex head or stud bolts; ASTM A194/A194M, Grade 8M heavy hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.

SECTION 40 27 00.01
CEMENT-MORTAR AND CERAMIC-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS

Item	Description
Gaskets	General: Gaskets in contact with potable water shall be NSF ANSI 61 certified. Push-on, Mechanical, and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Push-on, Mechanical, and Proprietary Restrained Joints; Hot Air Service: EPDM or Viton, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Flanged, Water, Sewage and Hot Air Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000. Full face for flat-faced flanges, flat-ring type for raised-face flanges. Blind flanges shall be epoxy-lined in accordance with the system specified above. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint Lubricant	Manufacturer’s standard.

END OF SECTION

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 00.11
CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

Item	Size	Description
Pipe	All	Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441/F441M. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded nipples shall be Schedule 80.
Fittings	All	Schedule to Match Pipe Above: Conforming to the requirements of ASTM F439 for socket weld type and Schedule 80 ASTM F437 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.11
CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

Item	Size	Description
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	All socket type joints shall be made employing primer and solvent cements that meet or exceed the requirements of ASTM F493 and primers that meet or exceed the requirements of ASTM F656, resistant to the fluid service, and as recommended by the pipe and fitting manufacturer, except solvent weld cement for CPVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service, IPS Weld-On 724 or approved equal. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon tape.

END OF SECTION

SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   f. Manual M11, Steel Pipe—A Guide for Design and Installation.
3. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
5. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
2. Metal Bellows Field Finishing:
   a. Manufacturer’s recommended weld procedures for joining welded carbon steel piping to stainless steel bellows.

b. Welder qualifications for joining welded carbon steel piping to stainless steel bellows.
c. Product data for field-applied System No. 4, high temperature, epoxy lining and coating in accordance with Section 09 90 00, Painting and Coating.

3. Chemical Injectors:
   a. Type, size, quantity, materials, and model number of each.
   b. Sketch of each showing major parts, main pipe, and dimensions.
   c. Details and model number of each support system and component.
   d. Details and model of connects (for example, service saddle, weld-o-let).

B. Informational Submittals:

1. Coupling Harness:
   a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
   b. Weld procedure qualifications.
   c. Load proof-testing report of prototype restraint for any size coupling.
2. Basket Strainer:
   a. Manufacturer's written/printed installation instructions.
   b. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.03 EXTRA MATERIALS

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

Item	Quantity
Basket	One for each strainer
Disc seals	One for each strainer
Special tools required to maintain or dismantle	One complete set

PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 CONNECTORS

A. Teflon Bellows Connector:

1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 214.
   b. Resistoflex; No. R6904.
   c. Unisource Manufacturing, Inc.; Style 112.
   d. Proco Products, Inc.; Series 442.

B. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
2. Materials: Nitrile tube and wrap-applied neoprene cover.
3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.

4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
    a. Goodall Rubber Co.; Specification E-1462.
    b. Garlock; Style 204.
    c. Unisource Manufacturing, Inc.; Style 1501.
    d. Proco Products, Inc.; Series 220.

C. Metal Bellows Connector:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ANSI 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
6. Manufacturers and Products:
    a. U.S. Bellows, Inc.; Universal Tied Expansion Joint.
    b. Metraflex; Model MN.
    c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Flexible Metal Hose Connector:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Bronze.
3. End Connections: Female copper solder joint.
4. Minimum Burst Pressure: 500 psig at 70 degrees F.
5. Length: Minimum manufacturer recommendation for vibration isolation.
6. Manufacturers:
    a. U.S. Hose Corp.; Series 300.
    b. Anamet Industrial, Inc.
    c. Unisource Manufacturing, Inc.
    d. Proco Products, Inc.

E. Closure Collar Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

F. Quick Connect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.
3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.
5. Pressure Rating: 125 psi, minimum, at 70 degrees F.
6. Manufacturers and Products:
   a. OPW; Kamlock.
   b. Ryan Herco; 1300 Series.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flexible Sleeve Type Coupling:

1. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser Piping Specialties; Style 38.
      2) Smith-Blair, Inc.; Style 411.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 253.
      2) Smith-Blair, Inc.; Style 441.

C. Transition Coupling for Steel Pipe:

1. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 62.
   b. Smith-Blair, Inc.; Style 413.

D. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.
2. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 913.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 912.

E. Restrained Flange Adapter:

1. Pressure Rating:
   a. Minimum Working Pressure Rating: Not less than 150 psi.
   b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer’s proof testing.
2. Thrust Restraint:
   a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
   b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.

F. Restrained Dismantling Joints:

1. Pressure Rating:
   a. Minimum working pressure rating shall not be less than rating of the connecting flange.
   b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
2. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 131.
   b. Smith Blair, Inc.; Model 975.

G. Exposed Metallic Piping Plain End Couplings:

1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, or equal.

2.04 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced molded wide arch.
2. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.
3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: 250 degrees F.
7. Rated Deflection and Pressure:
   a. Lateral Deflection: 3/4 inch, minimum.
   b. Burst Pressure: Four times the working pressure.
   c. Compression deflection and minimum working pressure as follows:

Size (inch)	**Deflection (inch)**	**Pressure (psig)**
2-1/2 to 12	1.06	150
14	1.65	130
16 to 20	1.65	110

8. Manufacturers and Products:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.
   c. Goodall Rubber Co.; Specification E-711.
   d. Unisource Manufacturing, Inc.; Series 1500.
   e. Proco Products, Inc.; Series 251.

B. Teflon Bellows:

1. Type: Three convolutions, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 100 psig, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 215.
   b. Resistoflex; No. R6905.
   c. Unisource Manufacturing, Inc.; Style 113.
   d. Proco Products, Inc.; Series 443.

C. Metal Bellows:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ASME 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of eight convolutions and minimum axial compression of 3/4 inches.
6. Manufacturers and Products:
   a. U.S. Bellows, Inc.; Universal Tied expansion joint.
   b. Metraflex, Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Copper Pipe Expansion Compensator:

1. Material: Stainless steel bellows with female copper solder joint ends.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
   a. Senior Flexonics; Model HB.
   b. Hyspan; Model 8510.
   c. Unisource Manufacturing, Inc.; Style EC-FFS.

E. Galvanized and Black Steel Pipe Expansion Compensator:

1. Material: Carbon steel with stainless steel bellows.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
   a. Senior Flexonics; Model H.
   b. Hyspan; Model 8503.
   c. Unisource Manufacturing, Inc.; Style EC-MMT.

F. Flexible Metal Hose:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Stainless steel, ASTM A276, Type 321.
3. End Connections:
   a. 3 Inches and Larger: Shop fabricated flanged ends to match mating flanges.
   b. 2-1/2 Inches and Smaller: Screwed ends with one union end.
4. Minimum Burst Pressure: 600 psig at 70 degrees F for 12 inches and smaller.
5. Length: Provide hose live-length equal to lengths shown on Drawings.
6. Manufacturer:
   a. U.S. Hose Corp.; Series 401M.
   b. Anamet Industrial, Inc.; BWC21-1.

2.05 FLEXIBLE EXPANSION JOINTS

A. Design:

1. Ball and socket type for earth settlement compensation.
2. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping.
3. Assembly shall accommodate up to 4 inches of expansion in length.
4. Ductile iron conforming to AWWA C153/A21.53.
5. Rated for 350 psi.
6. Components shall be lined and coated by manufacturer with fusion-bonded epoxy on all surfaces not bearing gaskets.
7. End Connections: Flanged or mechanical joint as shown and as required by connecting pipe and fittings.
8. Joint connecting to mechanical joint shall be thrust restrained.
9. Bonding:
   a. Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint.
   b. Provide 24-inch bond wires for field bonds to adjacent metallic piping.
   c. Bond wires shall be 2 AWG with two 12-inch-long THHN insulated 12 AWG wire pigtails.

B. Manufacturer and Product: EBAA Iron Sales Co.; Flex-Tend.

2.06 SEAL WATER HOSE

A. Product as specified for water hose, except 3/8 inch with male NPT ends, in 2-foot lengths.

2.07 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
   a. Body: Malleable or ductile iron.
   b. Straps: Galvanized steel.
   c. Hex Nuts and Washers: Steel.
   d. Seal: Rubber.
5. Manufacturers and Products:
   a. Smith-Blair; Series 313 or 366.
   b. Dresser; Style 91.

B. Nylon-Coated Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Materials:
   a. Body: Nylon-coated iron.
   b. Seal: Buna-N.
   c. Clamps and Nuts: Stainless steel.
4. Manufacturer: Smith-Blair; Style 315 or 317.

2.08 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: AWWA C110/A21.10 flange.

C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

2.09 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16 inch.
2. Seep Ring:
   a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
   b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
   c. Continuously fillet weld on each side all around.
3. Factory Finish:
   a. Galvanizing:
      1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
      2) Electroplated zinc or cadmium plating is unacceptable.
   b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Molded Polyethylene Pipe Sleeve:

1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
2. Provided with end caps for support during concrete placement.
3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

C. Insulated and Encased Pipe Sleeve:

1. Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

D. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
   a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
   b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer’s instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
2. Thickness: Equal to or greater than remainder of pipe in line.
3. Fittings: In accordance with applicable Pipe Data Sheet.
4. Thrust Collars:
    a. Rated for thrust load developed at 250 psi.
    b. Safety Factor: 2, minimum.
    c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
    a. American Cast Iron Pipe Co.
    b. U.S. Pipe and Foundry Co.

B. Steel or Stainless Steel Wall Pipe:

1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.
3. Thrust Collar:
    a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
    b. Continuously fillet welded on each side all around.

2.11 CHEMICAL INJECTOR SYSTEM

A. Chemical Injectors:

1. Type, size, quantity, and materials as shown on Drawings and Standard Details.
2. Manufacturer: SAF-T-FLO.

B. Support System:

1. Stainless steel Unistrut or FRP Aickenstrut.
2. Materials compatible with chemical service and subject to Engineer approval.

C. Connectors: Stainless steel service saddle or weld-o-let, as shown on Drawings.

2.12 MISCELLANEOUS SPECIALTIES

A. Strainers, Water Service, 2 Inches and Smaller:

1. Type: Bronze body, Y-pattern, 200 psi nonshock rated, with screwed gasketed bronze cap.
2. Screen: Heavy-gauge Type 304 stainless steel or monel, 20-mesh.
3. Manufacturers and Products:
   a. Armstrong International; Inc.; Model F.
   b. Mueller Steam Specialty; Model 351M.

B. Strainers, Water Service, 2-1/2 Inches and Larger:

1. Type: Cast iron or ductile iron body, Y-pattern, 175 psi nonshock rated, with flanged gasketed iron cap.
2. Screen: Heavy-gauge Type 316 stainless steel, 0.045-inch perforations.
3. Manufacturer and Product: Armstrong International, Inc.; Model A7FL 125.

C. Strainers, Plastic Piping Systems, 4 Inches and Smaller:

1. Type: Y-pattern PVC body, 150 psi nonshock rated, with screwed PVC cap and Viton seals.
2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward.

D. Pump Seal Water Sight Flow Indicators:

1. Bronze body, 3/8-inch, horizontal, ball action with tempered glass.
2. Rated 125 psi with NPT screwed ends.
3. Operate with a minimum flow of 0.25 gpm.
4. Manufacturers and Products:
   a. Eugene Ernst Co.; Series E-57-4.
   b. Jacoby Tarbox Co.

PART 3 EXECUTION

3.01 GENERAL

A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures:

1. Install 18 inches or less from face of structures; joint may be flush with face.
2. Install a second flexible joint, whether or not shown.
   a. Pipe Diameter 18 Inches and Smaller: Within 18 inches of first joint.
   b. Pipe Diameter Larger than 18 Inches: Within two to three pipe diameter of first joint.

D. Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes. Wrap complete joint assembly in a double layer of polyethylene encasement, as specified in Section 40 27 00, Process Piping—General.

3.03 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown 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 pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
   a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
   b. Clean pipe surface before placing closure collars.
   c. Wet nonmetallic pipe thoroughly prior to pouring collars.
   d. Prevent concrete from entering pipe.
   e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
   f. Make entire collar in one placement.
   g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.04 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
2. Nonmetallic Pipe: Teflon bellows expansion joint.
3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
5. Pipe Run Offset: Flexible metal hose.

C. Weld-End Metal Bellows Installation:

1. Field Weld: Stainless steel bellows beveled ends joined to ALP carbon steel piping in accordance with approved welding procedures.

2. Lining:
   a. System No. 4, high-temperature epoxy, in accordance with Section 09 90 00, Painting and Coating.
   b. Field apply lining to protect bellows and piping from rust at welded joint.
   c. Line both ends inside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot inside length of the carbon steel pipe.
3. Coating:
   a. System No. 4, high-temperature epoxy, in accordance with Section 09 90 00, Painting and Coating.
   b. Field apply coating to protect bellows and piping from weather and rust at welded joint.
   c. Coat both ends outside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot outside length of the carbon steel pipe.

D. Anchors and Anchor Walls: Install as specified in Section 40 05 15, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.05 SERVICE SADDLES

A. Ferrous Metal Piping (except stainless steel): Double-strap iron.

B. Plastic Piping: Nylon-coated iron.

3.06 OUTLET/TAPPING SADDLE

A. Install in accordance with manufacturer’s written instructions.

3.07 COUPLINGS

A. General:

1. Install in accordance with manufacturer’s written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Remove pipe coating if necessary to present smooth surface.
4. Application:
   a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
   b. Concrete Encased Couplings: Flexible coupling.

3.08 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

B. Product Applications Unless Shown Otherwise:

1. Nonmetallic Piping: Teflon bellows connector.
2. Copper Piping: Flexible metal hose connector.
3. Compressor and Blower Discharge: Metal bellows connector.
4. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.09 PIPE SLEEVES

A. Application:

1. As specified in Section 40 27 00, Process Piping—General.
2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.

B. Installation:

1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations:
   a. Wall pipes with thrust collars.
   b. Provide taps for stud bolts in flanges to be set flush with wall face.
2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
3. Existing Walls: Rotary drilled holes.
4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, Painting and Coating.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.11 CHEMICAL INJECTOR SYSTEM

A. Install in accordance with manufacturer's instructions.

3.12 MISCELLANEOUS SPECIALTIES

A. Basket Strainers:

1. Install in accordance with manufacturer's instructions.
2. Field Quality Control:
   a. Conduct test on each basket strainer.
   b. Test valves shall be tested for proper seating, travel, and operation.
3. Manufacturer's Services: Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
2. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
3. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
5. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
   d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
   e. C509, Resilient-Seated Gate Valves for Water Supply Service.
   f. C510, Double Check Valve Backflow Prevention Assembly.
   g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   k. C542, Electric Motor Actuators for Valves and Slide Gates.
   l. C550, Protective Interior Coatings for Valves and Hydrants.
   m. C606, Grooved and Shouldered Joints.
   n. C800, Underground Service Line Valves and Fittings.

6. ASTM International (ASTM):
    a. A276, Standard Specification for Stainless Steel Bars and Shapes.
    b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
    c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
    d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
    e. B61, Standard Specification for Steam or Valve Bronze Castings.
    f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
    g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
    h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
    i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
    j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
    k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
    l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
    m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
    n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
7. Canadian Standards Association, Inc. (CSA): 9.1, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
8. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
9. FM Global (FM).
10. Food and Drug Administration (FDA).
11. International Association of Plumbing and Mechanical Officials (IAPMO).
12. Manufacturers Standardization Society (MSS):
    a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
    b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
    c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
    d. SP-88, Diaphragm Valves.
    e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. Underwriters Laboratories (UL).
16. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
    b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
    c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
    d. Sizing calculations for open-close/throttle and modulating valves.
    e. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
    a. Electric actuators; full compliance with AWWA C542.
    b. Butterfly valves; full compliance with AWWA C504.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
4. Tests and inspection data.
5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.

D. Valve ends to suit adjacent piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for full range of pressures and velocities.

G. Valve to open by turning counterclockwise, unless otherwise specified.

H. Factory mount operator, actuator, and accessories.

I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SCHEDULE

A. Additional requirements relative to this section are shown on Valve Schedule located at the end of this section.

2.03 MATERIALS

A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
2. Stainless steel Alloy 18-8 may be substituted for bronze.

B. Valve materials in contact with or intended for drinking water service to meet the following requirements:

1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.
3. Supply certification product is certified as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61. Provide certification for each valve type used for drinking water service.

2.04 FACTORY FINISHING

A. General:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
3. Material in contact with potable water shall conform to NSF/ANSI 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”

B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.
2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.05 VALVES

A. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
      3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
      4) Mark AWWA gate valves with manufacturer's name or mark, year of valve casting, valve size, and working water pressure.
      5) Repaired AWWA gate valves shall not be submitted or supplied.
      6) Supply AWWA gate valves with stainless steel bolting.
      7) AWWA C509 and AWWA C515 valves may be substituted for each other.
2. Type V135 Resilient Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
   a. Ductile iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C515, minimum design working water pressure 250 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
   b. Manufacturers and Products:
      1) American Flow Control; Series 2500.
      2) M&H; Style 7000 and C515 Large RW Valves.

B. Ball Valves:

1. Type V330 PVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.
      3) Spears; True Union.

2. Type V331 PVC Ball Valve 3 Inches and 4 Inches:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1. Provide pressure relief hole drilled on low pressure side of ball.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.

C. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
      3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
      4) No travel stops for disc on interior of body.
      5) Self-adjusting V-type or O-ring shaft seals.
      6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
      7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
      8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
      9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
      10) Valves to be in full compliance with NSF/ANSI 61. Provide NSF/ANSI 61 certificate for each valve.
   b. Non-AWWA butterfly valves to meet the following actuator requirements:
      1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.

2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
   a. AWWA C504, Class 150B.
   b. Short body type, flanged ends.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N EPDM rubber seat bonded or molded in body only, and stainless steel seating surface.
   d. Provide epoxy lining and coating in compliance with AWWA C550.
   e. Manufacturers and Products:
      1) Pratt; Model 2FII or Triton XR-70.
      2) DeZurik; AWWA Valve.

D. Check and Flap Valves:

1. Type V615 Slanting Disc Check Valve 2 Inches to 60 Inches:
   a. Slanting or tilting disc design, off-center pivot, body ductile iron two-piece design, bronze seat on 55 degree angle, disc bronze or ductile iron, pivot pin and bushing Type 304 stainless steel, Class 250, 300 psi rating, Class 250 flange drilling, flat face, bottom mounted buffer cylinder for cushion closing valve disc position indicator.
   b. Manufacturers and Products:
      1) APCO; Series 800.
      2) Val-Matic; Series 9700.

E. Self-Regulated Automatic Valves:

1. Type V742 Air and Vacuum Valve 1/2 Inch to 16 Inches for Vertical Turbine Service:
   a. Equip 1/2 inch through 3 inches with stainless steel diffuser screen to break up solid water column before coming in contact with float, manufacturer’s standard double acting throttling device in outlet for throttling, NPT threaded inlet and outlet.
   b. Equip 4 inches and larger with anti-slam device to throttle flow of water into air valve. Design anti-slam device to permit full, unrestricted flow of air into and out of air valve, but reduce flow area for water to approximately 10 percent. ASME B16.1 Class 250 flanged inlet and NPT threaded outlet.
   c. Rated 300 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
   d. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 141DAT to 146DAT or Series 1904 to 1916.
      2) Val-Matic Valve; Series 100WS to 116WS.

2. Type V744 Air Release Valve 1/2 Inch to 2 Inches:
   a. Suitable for water service, automatically exhaust small amounts of entrained air that accumulates in a system. In CLOSED position, seat against resilient seat to prevent water leakage.
   b. Rated 300 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, NPT threaded inlet and outlet, built and tested to AWWA C512. Operating pressure is 210 psi. Minimum orifice size of 0.156 inches.
   c. Manufacturers and Products:
      1) APCO Valve and Primer Corp.; Series 50, 200, and 200A.
      2) Val-Matic Valve; Series 15A to 45.6.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
   a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
   b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
   c. Operator self-locking type or equipped with self-locking device.
   d. Position indicator on quarter-turn valves.
   e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator’s threaded steel reach rod with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
   a. Galvanized and painted handwheel.
   b. Cranks on gear type operator.
   c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
   d. Valve handles to take a padlock, and wheels a chain and padlock.
3. Buried Operator:
   a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.

b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
c. Buried valves shall have extension stems, bonnets, and valve boxes.

2.07 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve operator, bearing valve tag number shown on Valve Schedule and Drawings.

B. T-Handled Operating Wrench:

1. One each galvanized operating wrenches, 4 feet long.
2. Manufacturers and Products:
   a. Mueller; No. A-24610.
   b. Clow No.; F-2520.
3. One each galvanized operating keys for cross handled valves.

C. Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.

1. Manufacturers and Products:
   a. Pratt.
   b. DeZurik.

D. Floor Stand:

1. Nonrising, heavy pattern, indicating type.
2. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment. Stem length as required to connect valve operating nut and floor stand.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
4. Anchor Bolts: Type 304 stainless steel.
5. Manufacturers and Products:
   a. Clow; Figure F-5515.
   b. Mueller, Figure A-26426.

E. Floor Box:

1. Plain type, for support of nonrising type stem.
2. Complete with solid extension stem, operating nut, and stem guide brackets. Stem length as required to extend valve operating nut to within 3 inches of finish floor.
3. Stem Guide: Space such that stem L/R ratio does not exceed 200.

4. Anchor Bolts: Type 304 stainless steel.
5. Manufacturers and Products:
    a. Neenah Foundry; R 7506.
    b. Clow; No. F5690.

F. Chain Wheel and Guide:

1. Handwheel direct-mount type.
2. Complete with chain.
3. Galvanized or cadmium-plated.
4. Manufacturers and Products:
    a. Clow Corp.; Figure F-5680.
    b. Walworth Co.; Figure 804.
    c. DeZurik Corp.; Series W or LWG.

G. Cast-Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 5-1/4-inch ID shaft.

1. Box: Cast iron with minimum depth of 9 inches.
2. Lid: Cast iron, minimum depth 3 inches, nonlocking type, marked WATER.
3. Extensions: Cast iron.
4. Two-piece box and lid for valves 4 inches through 12 inches, three-piece box and lid for valves larger than 12 inches with base sized for valve.
5. Valve extension stem for valves with operating nuts 3 feet or greater below finish grade.
6. Manufacturers and Products:
    a. East Jordan Iron Works; Cast-Iron Valve Boxes.
    b. Bingham & Taylor; Cast-Iron Valve Boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

D. Valve Installation and Orientation:

1. General:
   a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance.
   c. Install valves per manufacturer's recommendations.
2. Gate, Globe, and Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
   b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.
3. Butterfly Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
   b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
   c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
   d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
   e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.
4. Check Valves:
   a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
   b. Install valve in vertical flow (up) piping only for gas services.
   c. Install swing check valve with shaft in horizontal position.
   d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.

E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

F. Install safety isolation valves on compressed air.

G. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

H. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

I. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

J. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

K. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate “L” type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer’s data.

E. Set, verify, and record set pressures for relief and regulating valves.

F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:

1. 1/2 person-day for installation assistance and inspection.
2. 1/2 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 SUPPLEMENTS

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

1. Valve Schedule.

END OF SECTION

Valve Schedule								
Tag Number	**Valve Type**	**Location**	**Valve Size (inches)**	**Process Fluid**	**Maximum Operating Flow (gpm)**	**Maximum Pressure (psi)**	**Manual Valve Operator**	**Comments**
GV-35-1-1	V135	Return Suction Line	36″	FW	19600	210	Nut	Vertical Mount Gear Operator
GV-35-1-2	V135	Return Suction Line	36″	FW	19600	210	Nut	Vertical Mount Gear Operator
ARV-35-1-1	V744	FWPS Discharge	2″	FW	5500	210	N/A	
GV-35-2-1A	V135	FWPS Suction	30″	FW	5500	210	Nut	Vertical Mount Gear Operator
GV-35-2-2A	V135	FWPS Suction	30″	FW	5500	210	Nut	Vertical Mount Gear Operator
GV-35-2-3A	V135	FWPS Suction	30″	FW	5500	210	Nut	Vertical Mount Gear Operator
GV-35-2-4A	V135	FWPS Suction	30″	FW	5500	210	Nut	Vertical Mount Gear Operator
GV-35-2-5A	V135	FWPS Suction	30″	FW	5500	210	Nut	Vertical Mount Gear Operator
GV-35-2-6A	V135	FWPS Suction	30″	FW	5500	210	Nut	Vertical Mount Gear Operator
GV-35-2-7A	V135	FWPS Suction	30″	FW	5500	210	Nut	Vertical Mount Gear Operator
GV-35-2-1B	V135	FWPS Discharge	20″	FW	5500	210	Handwheel	Vertical Mount Gear Operator
CV-35-2-1B	V615	FWPS Discharge	20″	FW	5500	210	Nut	
ARV-35-2-1A	V742	FWPS Discharge	2″	FW	5500	210	N/A	
ARV-35-2-1B	V744	FWPS Discharge	2″	FW	5500	210	N/A	
GV-35-2-2B	V135	FWPS Discharge	20″	FW	5500	210	Handwheel	Vertical Mount Gear Operator
CV-35-2-2B	V615	FWPS Discharge	20″	FW	5500	210	Nut	
ARV-35-2-2A	V742	FWPS Discharge	2″	FW	5500	210	N/A	

Valve Schedule								
Tag Number	**Valve Type**	**Location**	**Valve Size (inches)**	**Process Fluid**	**Maximum Operating Flow (gpm)**	**Maximum Pressure (psi)**	**Manual Valve Operator**	**Comments**
ARV-35-2-2B	V744	FWPS Discharge	2″	FW	5500	210	N/A	
GV-35-2-3B	V135	FWPS Discharge	20″	FW	5500	210	Handwheel	Vertical Mount Gear Operator
CV-35-2-3B	V615	FWPS Discharge	20″	FW	5500	210	Nut	
ARV-35-2-3A	V742	FWPS Discharge	2″	FW	5500	210	N/A	
ARV-35-2-3B	V744	FWPS Discharge	2″	FW	5500	210	N/A	
GV-35-2-4B	V135	FWPS Discharge	20″	FW	5500	210	Handwheel	Vertical Mount Gear Operator
CV-35-2-4B	V615	FWPS Discharge	20″	FW	5500	210	Nut	
ARV-35-2-4A	V742	FWPS Discharge	2″	FW	5500	210	N/A	
ARV-35-2-4B	V744	FWPS Discharge	2″	FW	5500	210	N/A	
GV-35-2-5B	V135	FWPS Discharge	20″	FW	5500	210	Handwheel	Vertical Mount Gear Operator
CV-35-2-5B	V615	FWPS Discharge	20″	FW	5500	210	Nut	
ARV-35-2-5A	V742	FWPS Discharge	2″	FW	5500	210	N/A	
ARV-35-2-5B	V744	FWPS Discharge	2″	FW	5500	210	N/A	
ARV-35-3-1	V744	FWPS Discharge	2″	FW	5500	210	N/A	
GV-35-3-1	V135	Discharge Line	36″	FW	19600	210	Nut	Side Mount Gear Operator, Position D
GV-35-3-2	V135	Discharge Line	36″	FW	19600	210	Nut	Side Mount Gear Operator, Position D
GV-35-3-3	V135	Discharge Line	36″	FW	19600	210	Nut	Side Mount Gear Operator, Position B

Valve Schedule

Tag Number	Valve Type	Location	Valve Size (inches)	Process Fluid	Maximum Operating Flow (gpm)	Maximum Pressure (psi)	Manual Valve Operator	Comments
GV-35-3-4	V135	Discharge Line	36″	FW	19600	210	Nut	Side Mount Gear Operator, Position B
GV-35-3-5	V135	Discharge Line	36″	FW	19600	210	Nut	Side Mount Gear Operator, Position D
GV-35-3-6	V135	Discharge Line	36″	FW	19600	210	Nut	Side Mount Gear Operator, Position D
GV-35-3-7	V135	Discharge Line	36″	FW	19600	210	Nut	Side Mount Gear Operator, Position D
BFV-25-1-7	V500	Air Stripping Tower	14″	RW	2750	150	Handwheel	
BFV-25-2-7	V500	Air Stripping Tower	16″	RW	2750	150	Handwheel	
BV-40-30-2	V330	Fluoride Tank	2″	F	30	150	Lever	
BV-40-30-3	V330	Fluoride Tank	2″	F	30	150	Lever	
GV-35-3-8	V135	6” Piping to Hydrant	6″	FW	1500	210	Nut	Side Mount Gear Operator, Position B
GV-35-3-9	V135	6” Piping to Hydrant	6″	FW	1500	210	Nut	Side Mount Gear Operator, Position B

Note: This valve schedule includes the major valves for this Project. Additional valves could be required for the Project and this should be used in conjunction with the Drawings.

Side Mount Gear Operator Orientation Relative to Forward Flow:

A = Gear Operator at 0 degrees

B = Gear Operator at 90 degrees

C = Gear Operator at 180 degrees

D = Gear Operator at 270 degrees

SECTION 40 42 13
PROCESS PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
   c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
   g. C552, Standard Specification for Cellular Glass Thermal Insulation.
   h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
   i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer's descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 1—Elastomeric:

1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
3. Nominal Density: 3 pcf to 6 pcf.
4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
6. Joints: Manufacturer's adhesive.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Smoke Developed Index: Less than 50 per ASTM E84.
9. Manufacturers and Products:
   a. Nomaco; K-Flex.
   b. Armacell; AP Armaflex.

B. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.

6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.
8. Manufacturers and Products:
   a. Owens Corning Fiberglass; ASJ/SSL-11.
   b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer’s recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

2.02 ROOF DRAIN AND OVERFLOW DRAIN SUMP INSULATION

A. Type 1: 1 inch thick.

2.03 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.04 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
3. Flame Spread Rating: 25 per ASTM E84.
4. Smoke Developed Index: 50 per ASTM E84.
5. Manufacturers and Products:
    a. Knauf Insulation; Proto 1000.
    b. Johns Manville; Zeston 2000 or 300.
    c. Speedline; 25/50 Smoke-Safe.

B. Type F2—Paint:

1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
    a. Manufacturer and Product: Armacell; WB Armaflex finish.
2. Type 2 Insulation: In accordance with Section 09 90 00, Painting and Coating.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.
2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturers:
    a. RPR Products; Insul-Mate.
    b. ITW, Pabco-Childers.

D. Type F4—Foamglass Jacketing:

1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS.
2. Type 3 Insulation—Greater that 1 Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30.

PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in Section 40 27 00, Process Piping—General.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer’s instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

E. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.

F. Roof Drains: Insulate vertical drops from roof drains to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.

G. Roof Drains and Overflow Drains: Insulate entire pipe runs. Where roof and overflow drains exist through an exterior wall ensure annular space between pipes and walls are properly sealed prior to insulating.

H. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.

I. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

J. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):

1. Aluminum or color coded PVC jacketing does not require painting.
2. If insulated piping system is indicated to be painted in Section 40 27 00, Process Piping—General, piping shall receive the following:
   a. Prime coat in accordance with Section 09 90 00, Painting and Coating.
   b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, Painting and Coating.

3.04 SUPPLEMENTS

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

1. Service and Insulation Thickness Table.

END OF SECTION

Service and Insulation Thickness								
					Finish Systems			
Service Type	**Pipe Legend**	**Thickness**	**Fluid Temperature (degrees F)***	**Insulation**	**Concealed from View**	**Indoors Exposed**	**Outdoors**	**Buried**
HG–Heating Systems (steam, condensate, and hot water)	HWR HWS	ASHRAE 90.1 or IECC whichever results in thickest insulation.	201 to 250	Type 2	None	F3 below 8'	F3	NA
DW–Domestic and Service Hot Water Systems.	HW	ASHRAE 90.1 or IECC whichever results in thickest insulation.	105 to 140	Type 1 (6" or less)	None	F3 below 8'	F3	NA
CS–Cooling Systems (Condensate control, chilled water, and refrigerant)	RD W1, W2	ASHRAE 90.1 or IECC whichever results in the thickest insulation.	40 to 60	Type 1 (6" or less)	None	F3 below 8'	F3	NA
HT–Piping requiring heat tracing.		Pipe Size: Insulation Thickness Inches:* 1/4-3: 1 3.5-10: 1.5 12-16: 2 18-24: 2.5		Type 2 Insulate and heat trace outside lines 1' above grade. Use Type 3 insulation from 1' above grade to frost depth.	None	F3 below 8'	F3	F4 on Type 3

Service and Insulation Thickness								
					Finish Systems			
Service Type	**Pipe Legend**	**Thickness**	**Fluid Temperature (degrees F)***	**Insulation**	**Concealed from View**	**Indoors Exposed**	**Outdoors**	**Buried**
PE–Personnel Exposure		ASHRAE 90.1 or IECC whichever results in the thickest insulation	>140	Type 2 Minimum 1.5" thick	No insulation or finish	F3 below 8'	F3	NA

*Use these fluid temperatures unless otherwise noted in the Piping Schedule.
Inches*: Based upon insulation with glass fiber per ASTM C547, outdoors with 20 mph wind with 10 percent safety and no value assigned to cladding or air space at cladding. Matches the watts per foot in Section 40 05 33, Pipe Heat Tracing. 2012 IECC requires 1-inch minimum thickness.

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
   a. Submit prior to testing and include at least the information that follows.
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Test type.
      4) Method of isolation.
      5) Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. Chlorine Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.

5. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
   b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
6. Items that do not require testing include: Equipment seal drains, tank overflows to atmospheric vented drains, tank atmospheric vents.
7. Test Pressure: As indicated on Piping Schedule, or as specified by equipment manufacturer, whichever is higher.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.
3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage: Zero.
7. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallon per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:

1. Hydrostatic Head:
    a. At least 6 feet above maximum estimated groundwater level in section being tested.
    b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace, and retest as specified.

3.05 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges with standardized test gauge provided by Engineer at start of each testing day. Engineer will witness calibration.
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 reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will 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 using values from following table:

Table 1*

A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1,114	0.10
6	0.40	424	2:50	743	0.23
8	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-inch diameter pipe:
For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15
For 250 feet, T = 7:05 (Col D)
For 500 feet, 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 will be considered defective even if pipe previously passed a pressure test.

E. Defective Piping Sections: Replace, and retest as specified.

3.06 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 40 90 00
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:

1. Section 40 91 00, Instrumentation and Control Components.

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.

1. Provide, install, and calibrate new Fluoride Storage Tank (2) level transmitter, Finished Water Discharge Pressure Transmitter, and Finished Water Magnetic Flowmeter. Include all related PLC and Data Flow Systems HMI programming.
2. Provide and commission new Fluoride Level Monitoring Panel (LCP-40-30) for use at the Fluoride Storage Tanks. This panel consists of level indicators, analog surge protectors, analog signal isolators, sunshield, and AC surge protection.
3. Provide and commission new Finished Water Pump Station Panel (SCADA PLC-FW) for use at the Finished Water Pump Station. This panel consists of a PLC, UPS, analog surge protectors, and AC surge protection. The PLC will be connected to the Ethernet Switch in the Control Room for monitoring on the Data Flow Systems HMI.
4. Provide the following HMI signals:
    a. Fluoride Tank 1 Level.
    b. Fluoride Tank 2 Level.
    c. Fluoride Tanks High Level.
    d. Finished Water Flow.
    e. Finished Water Pump X Run Status (X=1 to 5).
    f. Finished Water Pump X Run Command (X=1 to 5).
    g. Finished Water Pump X Fault Alarm (X=1 to 5).
    h. Finished Water Pump X In Remote Status (X=1 to 5).
    i. Finished Water Pump X Amps (X=1 to 5).
    j. Finished Water Pump X High Temperature (X=1 to 5).
    k. Finished Water Pump X High Discharge Pressure (X=1 to 5).
    l. Finished Water Pump X Low Suction Pressure (X=1 to 5).

m. Finished Water Pump X Low PSI – Pumps Disabled (X=1 to 5).
n. Finished Water Discharge Pressure.
o. Finished Water Flow.
p. Generator X Minor Alarm (X=1 to 2).
q. Generator X Major Alarm (X=1 to 2).
r. Generator X Run Status (X=1 to 2).
s. Generator X Low Fuel Level (X=1 to 2).
t. Surge Tank System Common Alarm.
u. Switchgear Power Monitors (2 devices, 11 values each, Modbus TCP). Refer to Drawing 08-N-001 for complete list.
v. Motor Monitoring signals (5 pumps with 2 vibration sensors and 8 RTD sensors per pump, Modbus TCP).
w. Finished Water Electrical Room HVAC Smoke Alarm 1 and 2 as a common alarm.
x. Circuit Breaker Monitoring signals (up to 30 signals to be determined, Modbus TCP).
y. Provide Panel space in PLC-FW for Media Converter and Patch Panel as shown on Drawings that will be provided by others.

5. Re-Terminate and test Transfer Pump 2 and 4 Run Status signals to HMI. Motor controls are moving from MCC-A (renamed MCC-A1) to MCC-A2.
6. Additive Alternate 2: Provide required hardware in SCADA PLC-AS, PLC programming and HMI graphics to add one new Air Stripper Tower. Provide Blower Run Command and Run Status signals to HMI.
7. Additive Alternate 3: Provide new Main PLC (Master), UPS, and control panel with 50 percent more I/O capacity than the existing unit.

1.02 REFERENCES

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

1. American National Standards Institute (ANSI).
2. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
4. International Society of Automation (ISA):
   a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.

b. S5.1, Instrumentation Symbols and Identification.
c. S5.4, Instrument Loop Diagrams.
d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.

5. International Conference on Energy Conversion and Application (ICECA).
6. National Electrical Code (NEC).
7. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, Industrial Control and Systems General Requirements.
8. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
9. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. AFD: Adjustable Frequency Drive.
2. FDT: Factory Demonstration Test.
3. HMI: Human-Machine Interface.
4. I&C: Instrumentation and Control.
5. I/O: Input and Output.
6. O&M: Operation and Maintenance.
7. OIT: Operator Interface Terminal (PanelView).
8. P&ID: Process and Instrument Diagram.
9. PC: Personal Computer.
10. PIC: Process Instrumentation and Control.
11. PLC: Programmable Logic Controller.
12. RVSS: Reduced Voltage Soft Starter.
13. SCADA: Supervisory Control and Data Acquisition.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Two hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.
3. Controller Programming Software: Software packages for the configuring of PLCs.

E. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:

1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.
2. Programming in any programming or scripting language.

F. Rising/Falling: Define action of discrete devices about their setpoint.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

G. Signal Types:

1. Analog Signal, Current Type:
   a. 4 to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.

2. Analog Signal, Voltage Type: 1 to 5 volts dc within panel where common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches.
   c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Complete detailed design of PIC components and PIC Drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
3. PIC design as shown and specified includes:
   a. Functional requirements, performance requirements, and component specifications.
   b. P&IDs and block diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

B. Data Flow Systems out of Melbourne, FL has been selected as the PIC System Integrator and shall be used for at least the following Work:

1. For PIC Equipment and Ancillaries:
   a. Completing detail design.
   b. Submittals.
   c. Equipment, enclosures, and ancillaries.
   d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
   e. Verify readiness for operation.
   f. Verify correctness of final power and signal connections (lugging and connecting).
   g. Adjusting and calibrating.
   h. Starting up and loop tuning.
   i. Testing and coordination of testing.
   j. Training.

2. Verify following Work not by PIC System Integrator is provided:
   a. Field instruments and related accessories.
   b. Correct type, size, and number of signal wires with their raceways.
   c. Correct electrical power circuits and raceways.
   d. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
   e. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. NonPIC Equipment Directly Connected to PIC Equipment:
   a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with PIC.
   c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
   d. Test to demonstrate required interface and operation with PIC.
   e. Examples of items in this category, but not limited to the following:
      1) Valve operators, position switches, and controls.
      2) Motor control centers.
      3) Adjustable speed and adjustable frequency drive systems.
   f. Examples of items not in this category:
      1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
      2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General:

1. Partial Submittals not in accordance with Project Schedule will not be accepted.
2. Submittal Format:
   a. Hard Copy: If required by Contract.
   b. Electronic Copies: Required, unless otherwise noted for specific items.
      1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
      2) Documents created specifically for Project:
         a) Text and Graphics: Microsoft Word.
         b) Lists: Microsoft Excel, unless otherwise noted for specific items.
         c) Drawings: MicroStation.

3. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
4. Legends and Abbreviation Lists:
   a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
   b. Use identical abbreviations in PIC subsections.
   c. Submit updated versions as they occur.
5. Activity Completion:
   a. Action Submittals: Completed when reviewed and approved.
   b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

1. Bill of Materials: List of required equipment.
   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) PIC Components: By component identification code.
      2) Other Equipment: By equipment type.
   b. Data Included:
      1) Equipment tag number.
      2) Description.
      3) Manufacturer, complete model number and all options not defined by model number.
      4) Quantity supplied.
      5) Component identification code where applicable.
      6) For panels, include panel reference number and name plate inscription.
   c. Formats: Hard copy and Microsoft Excel.
2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
   a. Catalog information, marked to identify proposed items and options.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.

3. Instrument List:
   a. Engineer will provide an initial Instrument List in Microsoft Excel. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.
   b. Applicable fields to be completed include, but are not limited to:

Instrument List Characteristics	
Item	**Initially Completed By**
Tag Number	Engineer
Description	Engineer
Manufacturer and complete model number	Contractor
Size and scale range	Engineer
Setpoints	Engineer
Reference P&IDs	Engineer
Instrument detail number	Engineer

   c. Submit updated version of Instrument List.
   d. Electronic Copies: Microsoft Excel.
4. Component Data Sheets: Data sheets for I&C components.
   a. Format:
      1) Similar to ISA TR20.00.01.
      2) Microsoft Excel, one component per data sheet.
      3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
   b. Content: Specific features and configuration data for each component, including but not limited to:
      1) Tag Number.
      2) Component type identification code and description.
      3) Location or service.
      4) Service conditions.
      5) Manufacturer and complete model number.
      6) Size and scale range.
      7) Setpoints.
      8) Materials of construction.
      9) Options included.
      10) Power requirements.
      11) Signal interfaces.
      12) Name, address, and telephone number of manufacturer’s local office, representative, distributor, or service facility.
   c. Electronic Copies: Microsoft Excel.

5. Sizing and Selection Calculations:
   a. Primary Elements:
      1) Complete calculations plus process data used. Example for Flow Elements: Minimum and maximum values, permanent head loss, and assumptions made.
   b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
   c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
6. Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and location of front of panel devices.
   b. Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Submit electronic copies of Drawings.
7. Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
   b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
   d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
   e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
   f. For existing panels that are being modified, prepare detailed panel construction drawings that clearly define the modifications being made.
   g. Submit electronic copies of Drawings.
8. Panel Wiring Diagrams:
   a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
   b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.

c. Diagram Type:
   1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
   2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.

d. Item Identification: Identify each item with attributes listed.
   1) Wires: Wire number and color. Cable number if part of multiconductor cable.
   2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
   3) Components:
      a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
      b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
   4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
   5) Relay Coils:
      a) Tag number and its function.
      b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
   6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
   7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.

e. Show each circuit individually. No "typical" diagrams or "typical" wire lists will be allowed.

f. Ground wires, surge protectors, and connections.

g. Wire and Cable Names: Show names and wire color for circuits entering and leaving a panel. Refer to Division 26, Electrical.

h. For existing panels that are being modified, prepare detailed panel construction drawings that clearly define the modifications being made.

9. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
    a. Conform to the minimum requirements of ISA S5.4.
    b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
    c. Show loop components within a panel and identify each component, component terminals, and panel terminals.
    d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
        1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
        2) Identify the component by tag and description.
        3) Identify panel and component terminal numbers.
    e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
    f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.
    g. One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.
    h. Show:
        1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
        2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
        3) Tabular summary on each analog loop diagram:
            a) Transmitting Instruments: Output capability.
            b) Receiving Instruments: Input impedance.
            c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
            d) Total loop impedance.
            e) Reserve output capacity.
        4) Circuit and raceway schedule names.
10. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
    a. Required voltages, currents, and phases(s).
    b. Maximum heat dissipations Btu per hour.
    c. Calculations.
    d. Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 100 degrees F.

11. Installation Details: Include modifications or further details required and define installation of I&C components.
12. Spares, expendables, and test equipment.
13. Shop Drawings for Changes Impacting PLC Programming:
    a. Submit details of changes required to PLC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.
    b. Submit changes at 30-day intervals.
14. Applications Software Documentation: For equipment for which Contractor provides applications software provide:
    a. Complete configuration documentation for microprocessor based programmable devices.
    b. For each device, include program listings and function block diagrams, as appropriate, showing:
        1) Functional blocks or modules used.
        2) Configuration, calibration, and tuning parameters.
        3) Descriptive annotations.
    c. Refer to PIC subsections for additional requirements.

C. Informational Submittals:

1. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
    a. General:
        1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
        2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
    b. Final versions of Legend and Abbreviation Lists.
    c. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
    d. Provide the following items as defined under heading Action Submittals:
        1) Bill of materials.
        2) Catalog cuts.
        3) Instrument list.
        4) Component data sheets.
        5) Detailed Wiring Diagrams: As-built drawings.
            a) Panel wiring diagrams.
            b) Loop diagrams.
            c) Interconnecting wiring diagrams.
        6) Applications software documentation.

e. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
   1) Content for Each O&M Manual:
      a) Table of Contents.
      b) Operations procedures.
      c) Installation requirements and procedures.
      d) Maintenance requirements and procedures.
      e) Troubleshooting procedures.
      f) Calibration procedures.
      g) Internal schematic and wiring diagrams.
      h) Component and I/O Module Calibration Sheets from field quality control calibrations.
   2) Provide PDF file with linked index to all manuals.
f. List of spares, expendables, test equipment and tools provided.

2. Provide Manufacturer's Certificate of Proper Installation where specified.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator: Data Flow Systems of Melbourne, FL is the selected PICS supplier.

   Eric Stord, Director of Technical Sales
   (321) 259-5009
   erics@dataflowsys.com
   605 N John Rodes Blvd, Melbourne, FL 32934

B. PIC Coordination Meetings and Workshops:

1. General: Refer to Section 01 31 19, Project Meetings, for PIC coordination meetings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements.

B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

A. Refer to Section 01 31 13, Project Coordination, for Contractor's scheduling requirements for applications software testing.

B. Prerequisite Activities and Lead Times: Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:

1. Shop Drawing Reviews by Engineer:
   a. Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
   b. Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.
2. Test Prerequisite: Associated test procedures Submittals completed.
3. PLC and HMI Shipment to Site:
   a. General Prerequisites:
      1) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
      2) Unwitnessed FDT completed.
4. PLC and HMI Installation Prerequisite: Equipment received at Site.
5. Functional Test Prerequisite: PLC and HMI installation complete.
6. Performance Test Prerequisite: Functional Test completed and facility started up.

1.09 EXTRA MATERIALS

A. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

B. Spare Parts:

Description	Percent of Each Type and Size Used	No Less Than
dc power supplies	20	1
Fuses	20	5
Relays	20	5
Surge Suppressors	10	1
Signal Isolators	10	1

C. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Corrosion-inhibiting vapor capsules.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software, whether indicated or not, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 6.05 Substitutes and "Or-Equals".
2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Components for Each Loop: Major components for each loop are listed in Loop Specification referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.

C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. PLC model to be selected by Data Flow Systems for compatibility with existing system and capacity for signals and control functions identified by this Project.

2.04 SERVICE CONDITIONS

A. Standard Service Conditions: The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:

1. Outside:
    a. Temperature: Minus 20 degrees F to 104 degrees F.
    b. Relative Humidity: 10 percent to 100 percent noncondensing, rain.
    c. NEC Classification: Nonhazardous.

B. Standard Service Conditions for Panels and Consoles: Unless otherwise noted, in Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:

1. Smaller Panels and Assemblies (that are not freestanding):
    a. Inside, Air Conditioned: NEMA 12.
    b. All Other Locations: NEMA 4X.
2. Field Elements: Outside.

2.05 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Location and Inscription: As shown on Drawings.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2-inch-high, white on black background, unless otherwise noted.

B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription:
   a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
   b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
   c. Refer to P&IDs on Drawings.
2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch-high, imposed.
4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.06 MECHANICAL SYSTEM COMPONENTS

A. Reference Section 40 91 00, Instrumentation and Control Components.

2.07 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

A. Shown on Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.

B. Supplemented by Loop Specifications that describe requirements not obvious on P&IDs.

2.08 LOOP SPECIFICATIONS

A. See Article Supplements located at End of Section.

B. Organization: By unit process and loop number.

C. Loop Subheadings:

1. Global Functions: Defines functions common to all similar loop types.
2. Modular Functions: Defines basic requirements of each loop type.
3. Unit Process: Defines requires specific to each unit process.

2.09 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceways.

B. Wiring External to PIC Equipment:

1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
2. Other Wiring and Cable: As specified in Section 26 05 19, Power Conductors and Cables 51V-600V.

C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

D. Wires within Enclosures:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than No. 18 AWG.
2. Analog Signal Circuits:
   a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.

b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Beldon No. 1121A.
c. Size: No. 18 AWG, minimum.

3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than No. 18 AWG.
4. Special Signal Circuits: Use manufacturer's standard cables.
5. Wire Identification: Numbered and tagged at each termination.

E. Terminate and identify wires entering or leaving enclosures as follows:

1. Special signals terminated using manufacturer's standard connectors.
2. Identify wiring in accordance with requirements in Section 26 05 19, Power Conductors and Cables 51V-600V.

F. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare PLC I/O points to terminal blocks.
   c. One wire per terminal for field wires entering enclosures.
   d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
   e. Spare Terminals: 20 percent of connected terminals, but not less than 10 per terminal block, unless otherwise shown on Drawings.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
   a. Locate signal ground at dc power supply for loop.
   b. Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

I. Electrical Transient Protection:

1. General:
   a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
   b. Surge suppressors may not be shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details in Drawings.
   c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
      1) Connection of ac power to PIC equipment including panels, consoles assemblies, and field-mounted analog transmitters and receivers.
      2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Surge Suppressors.
3. Installation and Grounding of Suppressors:
   a. As shown. See Surge Suppressor Installation Details.
   b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.10 PANEL FABRICATION

A. General:

1. Nominal Panel Dimensions: Refer to Control Panel Schedule in Article Supplements for minimum external dimensions allowed for individual control panels.
2. Instrument Arrangements: Contractor to submit for approval prior to construction.
3. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
4. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator’s facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.

5. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.
6. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.
2. Space Heaters:
   a. Controlled by hygrostat to maintain internal panel temperatures above dewpoint.
      1) Use Hoffman AMHUM.
   b. Refer to Control Panel Schedule in Article Supplements.

C. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
   a. Panels listed as inside, air conditioned:
      1) Enclosure Type: NEMA 12.
      2) Materials: Steel.
   b. Other Panels:
      1) Enclosure Type: NEMA 4X.
      2) Materials: Type painted steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Lockable.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. H. F. Cox.

D. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels:

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

E. Control Panel Electrical:

1. Power Distribution within Panels:
   a. Feeder Circuits:
      1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.

2) Make provisions for feeder circuit conduit entry.
3) Furnish terminal block for termination of wires.

b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
1) Locate to provide clear view of and access to breakers when door is open.
2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
a) Branch Circuit Breakers: 15 amps at 250V ac.
3) Breaker Manufacturers and Products: Refer to Division 26, Electrical.

c. Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
1) Devices on Single Circuit: 20, maximum.
2) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
3) Branch Circuit Loading: 12 amperes continuous, maximum.
4) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
5) Provide 120V ac plugmold for panel components with line cords.

2. Signal Distribution:
a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
b. Within Panels: 4 to 20 mA dc signals may be distributed as 1V dc to 5V dc.
c. Outside Panels: Isolated 4 to 20 mA dc only.
d. Signal Wiring: Twisted shielded pairs.
e. RTD and Thermocouple Extension Cable:
1) Continuous field to panel with no intermediate junction boxes or terminations.
2) RTDs in motor windings are considered a 600-volt circuit.
3) Terminate thermocouple extension wire directly to loop instrument.

3. Signal Switching:
a. Use dry circuit type relays or switches.
b. No interruption of 4 to 20 mA loops during switching.
c. Switching Transients in Associated Signal Circuit:
1) 4 to 20 mA dc Signals: 0.2 mA, maximum.
2) 1V dc to 5V dc Signals: 0.05V, maximum.

4. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
5. Internal Panel Lights for Freestanding Panels:
   a. Not required.
6. Service Outlets for Freestanding Panels:
   a. Type: Three-wire, 120-volt, 15-ampere, GFCI GFCI duplex receptacles.
   b. Quantity:
      1) One.
   c. Mounting: Along back-of-panel area.
7. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted in individual Loop Specifications.

Tag Function	Inscription(s)	Color
OO	ON OFF	Green Red
OC	OPEN CLOSE	Green Red
OCR	OPEN CLOSE REMOTE	Green Red Black
OOR	ON OFF REMOTE	Green Red Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Green Red
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

   b. Lettering Color:
      1) Black on white and yellow buttons.
      2) White on black, red, and green buttons.

8. Standard Light Colors and Inscriptions:
   a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted in individual Loop Specifications.

Tag Function	Inscription(s)	Color
ON	ON	Green
OFF	OFF	Red
OPEN	OPEN	Green
CLOSED	CLOSED	Red
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Blue

   b. Lettering Color:
      1) Black on white and amber lenses.
      2) White on red and green lenses.

F. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw Type and Compression Clamp Type Terminals:
   a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
   b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.

6. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
7. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
8. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
9. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
10. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
11. Conductors Carrying Foreign Voltages within a Panel:
    a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
    b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
12. Harness Wiring:
    a. 120V ac: No. 14 AWG, MTW.
    b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
13. Panelwork:
    a. No exposed connections.
    b. Allow adjustments to equipment to be made without exposing these terminals.
    c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
14. Plastic Wire Ducts Color:
    a. 120V ac: White.
    b. 24V dc: Gray.
    c. Communications Cables and Fiber Optic Jumpers: Orange.
15. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
16. Make plastic wire ducts the same depth.
17. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

G. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.

H. Factory Finishing:

1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.

2.11 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
   a. Northern Instruments; Model Zerust VC.
   b. Hoffmann Engineering; Model A-HCI.

2.12 TEST EQUIPMENT AND TOOLS

A. None required.

2.13 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer's decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
   a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
   b. Describe each test item to be performed.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.

5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
6. Conducting Tests:
    a. Provide special testing materials and equipment.
    b. Wherever possible, perform tests using actual process variables, equipment, and data.
    c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
    d. Define simulation techniques in test procedures.
    e. Test Format: Cause and effect.
        1) Person conducting test initiates an input (cause).
        2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator's facility.
3. Integrated Test:
    a. Interconnect and test PIC, except for primary elements and smaller panels.
    b. Exercise and test functions.
    c. Provide stand-alone testing of smaller panels.
    d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Witnessed Factory Demonstration Tests (FDT): Not required.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:

1. Proper installation.
2. Correct control action.
3. Input and output signals.

3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 19, Power Conductors and Cables 51V-600V.

C. Electrical Raceways: As specified in Section 26 05 33, Raceways.

D. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate PIC testing with Owner and affected Subcontractors.
2. Notify Engineer of Performance Test schedule four weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.
2. Preparation for Testing: Performed by PIC System Integrator to test and document PIC is ready for operation.
    a. Loop/Component Inspections and Tests:
        1) These inspections and tests will be spot checked by Engineer.
        2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.

b. FDT-Repeat:
   1) Repeat FDT onsite with installed PIC equipment and software.
   2) Use FDT test procedures as basis for this test.
   3) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.

3. Functional Test:
   a. Scope: Confirm PIC, including applications software, is ready for operation.
   b. Refer to PIC subsections for additional requirements.
   c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.
4. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

D. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform a witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and nonloop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Follow daily schedule required for FDT.
8. Determination of Ready for Operation: When Functional Test has been completed.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: As required by each PIC subsection.

3.05 TRAINING

A. General:

1. Perform training to meet specific needs of Owner's personnel.
2. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
3. Provide instruction on one working shift(s) as needed to accommodate the Owner's personnel schedule.

B. Operations and Maintenance Training:

1. General:
   a. Refer to specific requirements specified in PIC Subsections.
   b. Include review of O&M data and survey of spares and expendables.
   c. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations and Maintenance Training: For Owner's operations personnel on operation of I&C components.
   a. Training Session Duration: 1 instructor hour.
   b. Number of Training Sessions: One.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
   e. Content: Conduct training on loop-by-loop basis.
      1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
      2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
      3) Interfaces with PIC subsystems.

3.06 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.08 SUPPLEMENTS

A. Supplements listed below, follows "End of Section," are part of this Specification.

1. Loop Specifications.
2. Instrument List.
3. PLC Input/Output List.
4. Control Panel Schedule.

END OF SECTION

LOOP SPECIFICATIONS

FORMAT

The loop specifications are divided into the following sections:

Process Monitoring and Control Systems (PMCS) Overview: This section together with the Block Diagram Drawings describes the PMCS.

Function Definitions: This section defines various functions used in subsequent sections.

Required Global Functions: These functions are required for all identified variables, and thus are not included in the subsequent Unit Process Loop Specifications.

Modular Functions: For functions used repetitively, modular functions have been developed and are used in the specific Unit Process Descriptions.

Unit Processes: Loop specifications for each specific Unit Process are described. These descriptions include extensive use of referenced Modular Functions.

PMCS OVERVIEW

The PMCS consists of an Ethernet Network whose nodes include PLCs, Servers and Workstations.

FUNCTION DEFINITIONS

Pump Run Fail: A pump is commanded-to-run from the PMCS, but is not confirmed running within a preset time. Unless otherwise noted, running is confirmed by receiving an ON status M-contact from the pump's starter or adjustable speed drive.

Start: Issue a maintained Run command. Controlled device shall run as long as the Run command signal is present. On absence of Run command, immediately ceases operation.

Stop: Cease the maintained Run command.

REQUIRED GLOBAL FUNCTIONS

1. Trend each process variable which has a PLC analog input.
2. If shown under PMCS discrete displays, derive HIGH HIGH and LOW LOW alarms from the associated process variable.

MODULAR FUNCTIONS (Implement if noted in the specific unit process loop specifications)

Modular Function: Level

PMCS Discrete Displays

High Level Alarm

Low Level Alarm

PMCS Value Displays

Level

PMCS Trends

See Global Functions

Modular Function: ON Status

PMCS Discrete Displays

ON Status

PMCS Value Display

Elapsed Run Time; display last 24 hours; see Global Functions

Cycle Counter; display last 24 hours; see Global Functions

Modular Function: RUN Command

PMCS Discrete Display

ON Status

Pump Run Fail

Pump under PMCS Control (Field Hand Switch in Remote)

PMCS Value Display

Elapsed Run Time; display last 24 hours; see Global Functions

Cycle Counter; display last 24 hours; see Global Functions

PMCS Display and Control Functions

Provide MANUAL/OFF/AUTO control of Pump

- In MANUAL, provide Start/Stop control
- In AUTO, provide control as per individual Unit Process Loop Specifications

Enable the above control only if the Pump is under PMCS control

Also, enable the Pump Run Fail only if the Pump is under PMCS control

Modular Function: RUN Command/Speed Adjust

PMCS Discrete Display

ON Status

Pump Run Fail

Pump under PMCS control (Field Hand Switch in Remote)

Enable/Disable Status (if provided)

PMCS Value Display

Elapsed Run Time; display last 24 hours; see Global Functions

Cycle Counter; display last 24 hours; see Global Functions

Pump Speed

PMCS Display and Control Functions

Provide MANUAL/OFF/AUTO control at Pump

- In MANUAL, provide Start/Stop control and manual speed adjust.
- In AUTO, provide control and speed adjust as per individual Unit Process Loop Specifications

Enable the above control only if the Pump is under PMCS control

Also, enable Pump Run Fail only if the Pump is under PMCS control

Modular Function: RUN Status

PMCS Discrete Display

ON Status

Pump Run Fail

Pump under PMCS Control (Field Hand Switch – if provided - in Remote)

PMCS Value Display

Elapsed Run Time; display last 24 hours; see Global Functions

Cycle Counter; display last 24 hours; see Global Functions

Modular Function: Speed

PMCS Value Displays

Speed

PMCS Trends

See Global Function

Modular Function: Speed Adjust

PMCS Discrete Display

Drive Fail

Pump under PMCS Control (Field Hand Switch in Remote)

PMCS Value Display

Pump Speed

PMCS Control Functions

Provide Manual Speed Adjust

Modular Function: Two Mode Feedback Control

PMCS Discrete Displays

Setpoint Deviation Alarm

PMCS Value Displays

Process Variable

Process Variable Setpoint

Tuning Parameters such as Proportional band and reset rate

PMCS Display and Control Functions

Provide Two Mode Feedback Control

Create error alarm if process variable deviates by more than x absolute units from setpoint for a sustained time

UNIT PROCESSES

Loop 40-30 Fluoride Storage Tanks:

One new bulk Fluoride tank will be installed adjacent to an existing bulk Fluoride Tank. New radar level instruments will be installed for use with the new tanks. Verify new level readings are accurate and properly scaled. Add tank levels to SCADA graphics.

Tanks will be filled by delivery trucks. While filling, the tank levels can be monitored locally on LCP-40-30.

The Containment Area for the Fluoride tanks will be monitored for HIGH level (LSHH-40-30-1) with a normally-closed contact. When High level is detected, the contact will open and the alarm will be active on the plant HMI.

<u>Loop 35-2</u> Finished Water Pumps:

One new Pressure Indicating Transmitter (35-PIT-2-1) and one new Magmeter (35-FIT-2-1) will be provided on this project. Provide scaled readings for each signal on the HMI. Five new Finished Water pumps will be provided on this project. Pumps may be remotely started/stopped Automatically from CP-FWPS PLC when the Pump is placed in REMOTE at the Pump. Monitor status and alarm signals as shown on the Drawings. In REMOTE perform pump staging using Pump Speed to start and stop pumps as necessary to maintain pressure within an operator-adjustable setpoint on the HMI. Pumps shall be added if the Pump Speed rises above an operator-adjustable Maximum Speed setpoint. Additional pumps may be started after the previous pump has been running for 90 seconds, to prevent staging too quickly. If the Pump Speed drops below an operator-adjustable Minimum Speed setpoint, pumps may be turned off one at a time. Additional pumps may be stopped after the previous pump has been off for 30 seconds if the pressure is still high. If one pump is failed, the next pump in sequence shall automatically take over control. When pumps are not faulted, the pumps shall automatically alternate daily at 8:00am.

A pump is considered faulted under any of the following conditions (Latched Alarms):

- Pump Fault Status ACTIVE
- Pump Run Command ACTIVE without Run Status after 10 second delay

On the HMI, add the five new Finished Water Pumps and allocate space for the two future High Service Pumps. Provide an Operator setpoint for Pressure in PSI and setpoints for High and Low Pressure with units matching the Pressure reading. Provide a Pump Alarm Reset pushbutton on the HMI to reset the Latched Alarms. Provide alarm status for Low Suction Pressure and High Discharge Pressure for each pump.

<u>Loops 50-1, 50-2</u> Electrical:

On the HMI, monitor the following hardwired signals from SCADA PLC-FW:

50LIT-1-1	GENERATOR 1 FUEL TANK LEVEL
EG-50-1-1-FA	GENERATOR 1 FAIL
EG-50-1-1-YS	GENERATOR 1 RUN STATUS
50LIT-2-1	GENERATOR 2 FUEL TANK LEVEL
EG-50-2-1-FA	GENERATOR 2 FAIL
EG-50-2-1-YS	GENERATOR 2 RUN STATUS
50LIT-1-1	ATS IN UTILITY POSITION
ATS-50-1-1-FA	ATS IN GENERATOR POSITION
ATS-50-1-1-YC1	GENERATOR INHIBIT
ATS-50-1-1-YC2	RUN GENERATOR UNDER LOAD

On the HMI, monitor the following Modbus TCP signals from Switchgear Side A and Side B:

PMB1-50-1-1:II-A	SWITCHGEAR SIDE A CURRENT LINE A
PM B1-50-1-1:II-B	SWITCHGEAR SIDE A CURRENT LINE B
PM B1-50-1-1:II-C	SWITCHGEAR SIDE A CURRENT LINE C
PM B1-50-1-1:II	SWITCHGEAR SIDE A CURRENT AVERAGE
PM B1-50-1-1:EI-AB	SWITCHGEAR SIDE A VOLTS LINE-LINE A-B
PM B1-50-1-1:EI-BC	SWITCHGEAR SIDE A VOLTS LINE-LINE B-C
PM B1-50-1-1:EI-CA	SWITCHGEAR SIDE A VOLTS LINE-LINE C-A
PM B1-50-1-1:EI-NA	SWITCHGEAR SIDE A VOLTS LINE-NEUTRAL A
PM B1-50-1-1:EI-NB	SWITCHGEAR SIDE A VOLTS LINE-NEUTRAL B
PM B1-50-1-1:EI-NC	SWITCHGEAR SIDE A VOLTS LINE-NEUTRAL C
PM B1-50-1-1:BI-KW	SWITCHGEAR SIDE A KILOWATTS
PM B1-50-1-1:BI-KVA	SWITCHGEAR SIDE A KILOVOLT-AMPS
PM B1-50-1-1:BI-KVAR	SWITCHGEAR SIDE A KILOVOLT-AMPS REACTIVE
PM B1-50-1-1:BI-FQ	SWITCHGEAR SIDE A FREQUENCY
PM B1-50-1-1:BI-PF	SWITCHGEAR SIDE A POWER FACTOR
PMB2-50-2-1:II-A	SWITCHGEAR SIDE B CURRENT LINE A
PMB2-50-2-1:II-B	SWITCHGEAR SIDE B CURRENT LINE B
PMB2-50-2-1:II-C	SWITCHGEAR SIDE B CURRENT LINE C
PMB2-50-2-1:II	SWITCHGEAR SIDE B CURRENT AVERAGE
PMB2-50-2-1:EI-AB	SWITCHGEAR SIDE B VOLTS LINE-LINE A-B
PMB2-50-2-1:EI-BC	SWITCHGEAR SIDE B VOLTS LINE-LINE B-C
PMB2-50-2-1:EI-CA	SWITCHGEAR SIDE B VOLTS LINE-LINE C-A
PMB2-50-2-1:EI-NA	SWITCHGEAR SIDE B VOLTS LINE-NEUTRAL A
PMB2-50-2-1:EI-NB	SWITCHGEAR SIDE B VOLTS LINE-NEUTRAL B
PMB2-50-2-1:EI-NC	SWITCHGEAR SIDE B VOLTS LINE-NEUTRAL C
PMB2-50-2-1:BI-KW	SWITCHGEAR SIDE B KILOWATTS
PMB2-50-2-1:BI-KVA	SWITCHGEAR SIDE B KILOVOLT-AMPS
PMB2-50-2-1:BI-KVAR	SWITCHGEAR SIDE B KILOVOLT-AMPS REACTIVE
PMB2-50-2-1:BI-FQ	SWITCHGEAR SIDE B FREQUENCY
PMB2-50-2-1:BI-PF	SWITCHGEAR SIDE B POWER FACTOR

On the HMI, monitor up to 30 Modbus TCP signals Circuit Breakers. Signal list to be upon approval of Circuit Breaker manufacturer submittal.

Loop 25-1 Air Stripper Towers: (Additive Alternate 2)

On the HMI, monitor/control the following hardwired signals from SCADA PLC-AS:

25-PIT-1-7	AIR STRIPPER TOWER 7 WATER PRESSURE
25-PT-2-7	AIR STRIPPER TOWER 7 BLOWER AIR PRESSURE
25-B-1-7:RK	AIR STRIPPER TOWER 7 BLOWER RUN COMMAND
25-B-1-7:YS	AIR STRIPPER TOWER 7 BLOWER RUN STATUS

Loop 37-1 Surge Tank

On the HMI, monitor/control the following hardwired signal from SCADA PLC-FW:

37-T-1-1	SURGE TANK COMMON ALARM

Vibration and RTD Monitoring

On the HMI, monitor 2 vibration analog signals and 8 RTD status signals for each Finished Water Pump. Include Vibration operator-adjustable alarm setpoints with 5 second delay. Include a Vibration Trend page and RTD Trend page for each Finished Water pump to include two vibration analog signals and 8 RTD signals for each pump.

END OF LOOP SPECIFICATIONS

TAG	QTY	COMP CODE	COMPONENT TITLE	OPTIONS	P&ID	INST. DETAIL
40LE-30-1 40LE-30-2	2	L007R	Level Element and Transmitter, Radar, Type R	Range: 0 - 12 Feet Span: 0 - 11 Feet Zero Reference: Bottom of Tank 6" Flange Mount	08-N-001	4091-252 4091-415BG
35FE/FIT-2-1	1	F4	Flow Element And Transmitter, Electromagnetic	Meter Size: 36 Inches Process: Finished Water Range: 0 - 30 MGD Span: 0.1 - 30 MGD	08-N-001	4091-219G 4091-420AG
35PIT-2-1	1	P9	Pressure Transmitter	Range: 0 - 120 PSI	08-N-001	4091-302 4091-304A 4091-415BG
35PSL-2-1A 35PSL-2-2A 35PSL-2-3A 35PSL-2-4A 35PSL-2-5A	5	P8	Pressure Switch, Fixed Dead Band	Setpoint: 1 PSI, Falling Normal Range: 2-5 PSI	08-N-001	4091-302 4091-304A 4091-415BG
35PSH-2-1B 35PSH-2-2B 35PSH-2-3B 35PSH-2-4B 35PSH-2-5B	5	P8	Pressure Switch, Fixed Dead Band	Setpoint: 250 PSI, Rising Normal Range: 170-210 PSI	08-N-001	4091-302 4091-304A 4091-415BG
35PI-2-1B 35PI-2-2B 35PI-2-3B 35PI-2-4B 35PI-2-5B	5	P4	Pressure Gauge	Range: 0 - 300 PSI	08-N-001	4091-302 4091-304A 4091-415BG
BSAH-35-20-1	1	M30A	Combination Horn And Strobe			

NOTE: PROVIDE SUNSHADES FOR ALL ANALOG TRANSMITTERS MOUNTED OUTSIDE. REFER TO DETAIL DRAWING E-SRS.

Tag No.	Function/Description	DI	DO	AI	AO	MBTCP	Remarks
40LIT-30-1	FLUORIDE TANK 1 LEVEL			1			
40LIT-30-2	FLUORIDE TANK 2 LEVEL			1			
35PIT-2-1	FINISHED WATER PRESSURE			1			
35FE/FIT-2-1	FINISHED WATER FLOW			1			
P-35-2-1-YC	FINISHED WATER PUMP 1 CALL TO RUN		1				
P-35-2-1-YS	FINISHED WATER PUMP 1 RUN STATUS	1					
P-35-2-1-HS:LR	FINISHED WATER PUMP 1 IN REMOTE	1					
P-35-2-1-FA	FINISHED WATER PUMP 1 FAIL ALARM	1					
P-35-2-1:II	FINISHED WATER PUMP 1 AMPS - AVERAGE			1			
P-35-2-1:TSH	FINISHED WATER PUMP 1 HIGH TEMPERATURE	1					
P-35-2-1:PSL	FINISHED WATER PUMP 1 LOW SUCTION PRESSURE	1					
P-35-2-1:DIS	FINISHED WATER PUMP 1 LOW SUCTION - PUMPS DS	1					
P-35-2-2-YC	FINISHED WATER PUMP 2 CALL TO RUN		1				
P-35-2-2-YS	FINISHED WATER PUMP 2 RUN STATUS	1					
P-35-2-2-HS:LR	FINISHED WATER PUMP 2 IN REMOTE	1					
P-35-2-2-FA	FINISHED WATER PUMP 2 FAIL ALARM	1					
P-35-2-2:II	FINISHED WATER PUMP 2 AMPS - AVERAGE			1			
P-35-2-2:TSH	FINISHED WATER PUMP 2 HIGH TEMPERATURE	1					
P-35-2-2:PSL	FINISHED WATER PUMP 2 LOW SUCTION PRESSURE	1					
P-35-2-2:DIS	FINISHED WATER PUMP 2 LOW SUCTION - PUMPS DS	1					
P-35-2-3-YC	FINISHED WATER PUMP 3 CALL TO RUN		1				
P-35-2-3-YS	FINISHED WATER PUMP 3 RUN STATUS	1					
P-35-2-3-HS:LR	FINISHED WATER PUMP 3 IN REMOTE	1					
P-35-2-3-FA	FINISHED WATER PUMP 3 FAIL ALARM	1					
P-35-2-3:II	FINISHED WATER PUMP 3 AMPS - AVERAGE			1			
P-35-2-3:TSH	FINISHED WATER PUMP 3 HIGH TEMPERATURE	1					
P-35-2-3:PSL	FINISHED WATER PUMP 3 LOW SUCTION PRESSURE	1					
P-35-2-3:DIS	FINISHED WATER PUMP 3 LOW SUCTION - PUMPS DS	1					
P-35-2-4-YC	FINISHED WATER PUMP 4 CALL TO RUN		1				
P-35-2-4-YS	FINISHED WATER PUMP 4 RUN STATUS	1					
P-35-2-4-HS:LR	FINISHED WATER PUMP 4 IN REMOTE	1					
P-35-2-4-FA	FINISHED WATER PUMP 4 FAIL ALARM	1					
P-35-2-4:II	FINISHED WATER PUMP 4 AMPS - AVERAGE			1			
P-35-2-4:TSH	FINISHED WATER PUMP 4 HIGH TEMPERATURE	1					
P-35-2-4:PSL	FINISHED WATER PUMP 4 LOW SUCTION PRESSURE	1					
P-35-2-4:DIS	FINISHED WATER PUMP 4 LOW SUCTION - PUMPS DS	1					

Tag No.	Function/Description	DI	DO	AI	AO	MBTCP	Remarks
P-35-2-5-YC	FINISHED WATER PUMP 5 CALL TO RUN		1				
P-35-2-5-YS	FINISHED WATER PUMP 5 RUN STATUS	1					
P-35-2-5-HS:LR	FINISHED WATER PUMP 5 IN REMOTE	1					
P-35-2-5-FA	FINISHED WATER PUMP 5 FAIL ALARM	1					
P-35-2-5:II	FINISHED WATER PUMP 5 AMPS - AVERAGE			1			
P-35-2-5:TSH	FINISHED WATER PUMP 5 HIGH TEMPERATURE	1					
P-35-2-5:PSL	FINISHED WATER PUMP 5 LOW SUCTION PRESSURE	1					
P-35-2-5:DIS	FINISHED WATER PUMP 5 LOW SUCTION - PUMPS DS	1					
50LSL-1-1	GENERATOR 1 FUEL TANK LOW LEVEL	1					
EG-50-1-1-FA1	GENERATOR 1 MINOR ALARM	1					
EG-50-1-1-FA2	GENERATOR 1 MAJOR ALARM	1					
EG-50-1-1-YS	GENERATOR 1 RUN STATUS	1					
50LSL-2-1	GENERATOR 2 FUEL TANK LOW LEVEL	1					
EG-50-2-1-FA1	GENERATOR 2 MINOR ALARM	1					
EG-50-2-1-FA2	GENERATOR 2 MAJOR ALARM	1					
EG-50-2-1-YS	GENERATOR 2 RUN STATUS	1					
T-37-1-1-FA	HYDROPNEUMATIC TANK SYSTEM COMMON ALALRM	1					
PMB1-50-2-1:II-A	SWITCHGEAR SIDE B1 CURRENT LINE A					1	ETHERNET COMMS
PMB1-50-2-1:II-B	SWITCHGEAR SIDE B1 CURRENT LINE B					1	ETHERNET COMMS
PMB1-50-2-1:II-C	SWITCHGEAR SIDE B1 CURRENT LINE C					1	ETHERNET COMMS
PMB1-50-2-1:II	SWITCHGEAR SIDE B1 CURRENT AVERAGE					1	ETHERNET COMMS
PMB1-50-2-1:EI-AB	SWITCHGEAR SIDE B1 VOLTS 3 PHASE AVERAGE					1	ETHERNET COMMS
PMB1-50-2-1:EI-NA	SWITCHGEAR SIDE B1 VOLTS LINE-NEUTRAL A					1	ETHERNET COMMS
PMB1-50-2-1:EI-NB	SWITCHGEAR SIDE B1 VOLTS LINE-NEUTRAL B					1	ETHERNET COMMS
PMB1-50-2-1:EI-NC	SWITCHGEAR SIDE B1 VOLTS LINE-NEUTRAL C					1	ETHERNET COMMS
PMB1-50-2-1:BI-KW	SWITCHGEAR SIDE B1 KILOWATTS					1	ETHERNET COMMS
PMB1-50-2-1:BI-KVAR	SWITCHGEAR SIDE B1 KILOVOLT-AMPS REACTIVE					1	ETHERNET COMMS
PMB1-50-2-1:BI-PF	SWITCHGEAR SIDE B1 POWER FACTOR					1	ETHERNET COMMS
PMB2-50-2-1:II-A	SWITCHGEAR SIDE B2 CURRENT LINE A					1	ETHERNET COMMS
PMB2-50-2-1:II-B	SWITCHGEAR SIDE B2 CURRENT LINE B					1	ETHERNET COMMS
PMB2-50-2-1:II-C	SWITCHGEAR SIDE B2 CURRENT LINE C					1	ETHERNET COMMS
PMB2-50-2-1:II	SWITCHGEAR SIDE B2 CURRENT AVERAGE					1	ETHERNET COMMS
PMB2-50-2-1:EI-AB	SWITCHGEAR SIDE B2 VOLTS 3 PHASE AVERAGE					1	ETHERNET COMMS
PMB2-50-2-1:EI-NA	SWITCHGEAR SIDE B2 VOLTS LINE-NEUTRAL A					1	ETHERNET COMMS
PMB2-50-2-1:EI-NB	SWITCHGEAR SIDE B2 VOLTS LINE-NEUTRAL B					1	ETHERNET COMMS
PMB2-50-2-1:EI-NC	SWITCHGEAR SIDE B2 VOLTS LINE-NEUTRAL C					1	ETHERNET COMMS

Tag No.	Function/Description	DI	DO	AI	AO	MBTCP	Remarks
PMB2-50-2-1:BI-KW	SWITCHGEAR SIDE B2 KILOWATTS					1	ETHERNET COMMS
PMB2-50-2-1:BI-KVAR	SWITCHGEAR SIDE B2 KILOVOLT-AMPS REACTIVE					1	ETHERNET COMMS
PMB2-50-2-1:BI-PF	SWITCHGEAR SIDE B2 POWER FACTOR					1	ETHERNET COMMS
	CIRCUIT BREAKER SIGNALS (UP TO 30 TBA)					30	ETHERNET COMMS
37-T-1-1	SURGE TANK COMMON ALARM	1					
BSSH-35-10-1	FINISHED WATER ELEC ROOM HVAC SMOKE ALARM 1	1					
BSSH-35-10-2	FINISHED WATER ELEC ROOM HVAC SMOKE ALARM 2	1					
	TOTAL FOR SCADA PLC-FW	**42**	**5**	**9**	**0**	**52**	
N/A	ELECTRIC PHASE FAIL	1					EXISTING
N/A	ELECTRICAL BUILDING ENTRY ALARM	1					EXISTING
25PIT-1-1	AIR STRIPPER TOWER 1 WATER PRESSURE (LEVEL)			1			EXISTING
25B-1-1:RK	AIR STRIPPER TOWER 1 BLOWER RUN COMMAND		1				EXISTING
25B-1-1:YS	AIR STRIPPER TOWER 1 BLOWER RUN STATUS	1					EXISTING
25PIT-1-2	AIR STRIPPER TOWER 2 WATER PRESSURE (LEVEL)			1			EXISTING
25B-1-2:RK	AIR STRIPPER TOWER 2 BLOWER RUN COMMAND		1				EXISTING
25B-1-2:YS	AIR STRIPPER TOWER 2 BLOWER RUN STATUS	1					EXISTING
25PIT-1-3	AIR STRIPPER TOWER 3 WATER PRESSURE (LEVEL)			1			EXISTING
25B-1-3:RK	AIR STRIPPER TOWER 3 BLOWER RUN COMMAND		1				EXISTING
25B-1-3:YS	AIR STRIPPER TOWER 3 BLOWER RUN STATUS	1					EXISTING
25PIT-1-4	AIR STRIPPER TOWER 4 WATER PRESSURE (LEVEL)			1			EXISTING
25B-1-4:RK	AIR STRIPPER TOWER 4 BLOWER RUN COMMAND		1				EXISTING
25B-1-4:YS	AIR STRIPPER TOWER 4 BLOWER RUN STATUS	1					EXISTING
25PIT-1-5	AIR STRIPPER TOWER 5 WATER PRESSURE (LEVEL)			1			EXISTING
25B-1-5:RK	AIR STRIPPER TOWER 5 BLOWER RUN COMMAND		1				EXISTING
25B-1-5:YS	AIR STRIPPER TOWER 5 BLOWER RUN STATUS	1					EXISTING
25PIT-1-6	AIR STRIPPER TOWER 6 WATER PRESSURE (LEVEL)			1			EXISTING
25B-1-6:RK	AIR STRIPPER TOWER 6 BLOWER RUN COMMAND		1				EXISTING
25B-1-6:YS	AIR STRIPPER TOWER 6 BLOWER RUN STATUS	1					EXISTING
25B-1-7:RK	AIR STRIPPER TOWER 7 BLOWER RUN COMMAND		1				ADDITIVE ALTERNATE 2
25B-1-7:YS	AIR STRIPPER TOWER 7 BLOWER RUN STATUS	1					ADDITIVE ALTERNATE 2
	TOTAL NEW SIGNALS FOR SCADA PLC-AS	**1**	**1**	**0**	**0**	**0**	

SUPPLEMENT 4 - CONTROL PANEL SCHEDULE

PANEL TAG #	PANEL DESCRIPTION	Drawing	NEMA Rating	APPROXIMATE SIZE (H x W x D)	COMMENTS
SCADA PLC-FW	Finished Water PLC	08-N-001	4X	36" x 36" x 18"	304 Stainless Steel, Wall Mount, Single door, front access, lockable, 36" x 36" x 18" with Floor Stand Kit in matching color; Major Components (Component Code): (1) AC Surge Suppressor (2.03.C.5.a) (1) Programmable Logic Controller by DFS (6) Signal Surge Suppressors (2.03.C.5.b) (1) UPS (Y40) (1) Ethernet Switch (Y90) (1) Shelf for Ethernet Switch and Media Converter Provide panel space for Fiber Optic Patch Panel and Media Converter (provided by others) Provide circuit breaker and 12-48 VDC power for Media Converter.
LCP-40-30	Fluoride Monitoring	08-N-001	4X	24" x 24" x 12"	304 Stainless Steel, Powder Coat White, Wall Mount, Single door, front access, lockable, 24" x24" x 12" with Floor Stand Kit in matching Powder Coat White; (2) Tank Level Displays (S27) (2) Signal Surge Suppressors (2.03.C.5.b) (2) Analog Signal Splitters (S125) (1) Sun shield for Level Indicators (Y83) (1) Breather/Drain
MAIN PLC	Existing DFS PLC	08-N-001	12	24" x 24" x 12"	Replace with updated controller in new control panel with UPS and 50% higher I/O capacity (Additive Alternate 3). Refer to 08-N-001 Keynote 1 for details.
SCADA PLC-AS	Existing DFS PLC	08-N-002	12	24" x 24" x 12"	Provide I/O modules if required for new signals on Air Stripper Tower 7. (Additive Alternate 2)

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. All other Part 2 articles cover components that are referenced by Instrument Lists in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

2.02 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funneled shaped inputs to facilitate wire entry.

f. Mounting:
   1) Standard DIN rail.
   2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
   3) End Stops: Minimum of one at each end of rail.
g. Wire Preparation: Stripping only permitted.
h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
i. Marking System:
   1) Terminal number shown on both sides of terminal block.
   2) Allow use of preprinted and field marked tags.
   3) Terminal strip numbers shown on end stops.
   4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
   5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

2. Terminal Block, General Purpose:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 24 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25 inch, maximum.
   g. Test Sockets: One screw test socket 0.079-inch diameter.
   h. Manufacturer and Product: Entrelec; Type M4/6.T or Approved Equal.
3. Terminal Block, Ground:
   a. Wire Size: 24 AWG to 10 AWG.
   b. Rated Wire Size: 10 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25 inch, maximum.
   e. Grounding: Electrically grounded to mounting rail.
   f. Manufacturer and Product: Entrelec; Type M4/6.P or Approved Equal.
4. Terminal Block, Blade Disconnect Switch:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 10 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body, orange switch.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.SNT or Approved Equal.

5. Terminal Block Diode:
   a. Rated Voltage: 24V dc.
   b. Rated Current: 30 ma.
   c. Wire Size: 16 AWG.
   d. Manufacturer and Product: Phoenix Contact ST-IN or Approved Equal.
6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: LED diode 24V dc.
   h. Spacing: 0.512 inch, maximum.
   i. Manufacturer and Product: Entrelec; Type ML10/13.SFD or Approved Equal.
7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 25 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: Neon lamp, 110V ac.
   h. Leakage Current: 1.8 mA, maximum.
   i. Spacing: 0.512 inch, maximum.
   j. Manufacturer and Product: Entrelec; Type ML10/13.SFL or Approved Equal.
8. Terminal Block, Fused, 120V ac, High Current:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 35 amps.
   c. Wire Size: 18 AWG to 8 AWG.
   d. Rated Wire Size: 8 AWG.
   e. Color: Gray.
   f. Fuse: 13/32 inch by 1.5 inches.
   g. Spacing: 0.95 inch, maximum.
9. Manufacturer and Product: Entrelec; Type MB10/24.SF or Approved Equal.

B. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide holddown clips.
2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 5 amps at 28V dc or 120V ac.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
   k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA or Approved Equal.
3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP or Approved Equal.
4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).

g. Expected Mechanical Life: 500,000 operations.
h. Expected Electrical Life at Rated Load: 50,000 operations.
i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP or Approved Equal.

5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 30V dc or 277V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
   i. Time Delay Setpoint: As noted or shown.
   j. Mode of Operation: As noted or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.
   l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.
6. Alternating Relay:
   a. Type: Alternating Relay to switch between two loads.
   b. Contact Arrangement: SPDT.
   c. Contact Rating: 10A at 24V dc or 240V ac.
   d. Coil Voltage: As required.
   e. Expected Mechanical Life: 10,000,000 operations.
   f. Expected Electrical Life at Rated Load: 100,000 operations.
   g. Manufacturer and Product: Macromatic; Series ARPxxxA6R or Approved Equal.

C. Surge Suppressors:

1. General:
   a. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
   b. Response: 5 nanoseconds maximum.
   c. Recovery: Automatic.
   d. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
   e. Enclosure Mounted: Encapsulated inflame retardant epoxy.

2. Suppressors on 120V ac Power Supply Connections:
    a. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
    b. First-Stage Clamping Voltage: 350 volts or less.
    c. Second-Stage Clamping Voltage: 210 volts or less.
    d. Power Supplies for Continuous Operation:
        1) Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
        2) All Other Applications: Minimum 30 amps at 130V ac.
3. Suppressors on Analog Signal Lines:
    a. Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
    b. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
        1) dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
        2) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
        3) Maximum Loop Resistance: 18 ohms per conductor.
4. Suppressors on Ethernet Cables:
    a. Type: Inline.
    b. Speed: To match maximum capability of PLC, minimum.
    c. Connector: RJ45.
5. Manufacturers and Products:
    a. 120V ac Lines (Type SS1): ASCO Model 252.
    b. Panel Analog Signals (Type SS2) Lines: ASCO Model 175 or DRS-036 series.
    c. Field Analog Signals (Type SS3): ASCO Model 157.
    d. Field 4-Wire Analog Signals (Type SS4): Schneider Electric SLACSE.
    e. Ethernet Cables (Type SS6): Eaton DNET1.
    f. Approved Equal.

D. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
    a. Protect instruments from damage due to power supply failure.
    b. Protect power supply from damage due to external failure.

4. Enclosures: NEMA 1.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
    a. Type: Indicating.
    b. Mount so fuses can be easily seen and replaced.

2.03 I&C COMPONENTS

A. F04 Flow Element and Transmitter, Electromagnetic:

1. General:
    a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
    b. Type:
        1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
        2) Full bore meter with magnetic field traversing entire flow-tube cross section.
        3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
    c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
2. Service:
    a. Stream Fluid:
        1) As noted.
        2) Suitable for liquids with a minimum conductivity of 20 microS/cm.
3. Operating Temperature:
    a. Element:
        1) Ambient: Minus 4 to 158 degrees F, typical.
        2) Process: 33 to 122 degrees F, typical.
    b. Transmitter:
        1) Ambient: Minus 4 to 140 degrees F, typical.
4. Performance:
    a. Flow Range: As noted.
    b. Accuracy: Plus or minus 0.4 percent of rate for all flows resulting from pipe velocities of 2 to 30 feet per second.
    c. Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.

5. Features:
    a. Zero stability feature to eliminate the need to stop flow to check zero alignment.
    b. No obstructions to flow.
    c. Very low pressure loss.
    d. Measures bi-directional flow.
6. Process Connection:
    a. Meter Size (diameter inches): As noted.
    b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
    c. Flange Material: Carbon steel, unless otherwise noted.
7. Power (Transmitter): 120V ac, 60-Hz.
8. Element:
    a. Meter Tube Material: Type 316 stainless steel.
    b. Liner Material:
        1) Teflon.
        2) For potable water service, must have appropriate approvals.
    c. Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
    d. Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
    e. Electrode Material: Type 316 stainless steel.
    f. Grounding Ring:
        1) Required.
        2) Quantity: Two.
        3) Material: Type 316 stainless steel.
    g. Enclosure: NEMA 4X, minimum.
    h. Submergence:
        1) Temporary: If noted.
        2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.
    i. Straight Pipe Length Installation Requirements:
        1) 5 x DN Upstream.
        2) 2 x DN Downstream.
        3) Hazardous Area: As noted.

9. Transmitter:
    a. Installation: Remote from sensor.
    b. Mounting: Surface (wall), unless otherwise noted.
    c. Display: Required.
        1) Digital LCD display, indicating flow rate and total.
        2) Bi-directional Flow Display: Not required, unless otherwise noted.
            a) Forward and reverse flow rate.
            b) Forward, reverse and net totalization.
    d. Parameter Adjustments: By keypad or non-intrusive means.
    e. Enclosure: NEMA 4X, minimum.
    f. Empty Pipe Detection:
        1) If noted.
        2) Drives display and outputs to zero when empty pipe detected.
10. Signal Interface (at Transmitter):
    a. Analog Output:
        1) Isolated 4 mA to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
11. Cables:
    a. Types: As recommended by manufacturer.
    b. Lengths: As required to accommodate device locations.
12. Built-in Diagnostic System:
    a. Features:
        1) Field programmable electronics.
        2) Self-diagnostics with troubleshooting codes.
        3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
        4) Initial flow tube calibration and subsequent calibration checks.
13. Factory Calibration:
    a. Calibrated in an ISO 9001 and NIST certified factory.
    b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
    c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.
14. Manufacturers:
    a. ABB, WaterMaster FEW Series.
    b. Endress + Hauser Proline Promag W 400 Series.

B. M30A Combination Horn and Strobe, Indoor/Outdoor:

1. General:
   a. Function: Audible and visual alarm. Produces sound by electro-mechanical vibration of a diaphragm.
   b. Parts: Strobe and horn assembly and spare lamps.
2. Performance:
   a. Temperature, Operating: Minus 31 degrees F to 150 degrees F.
   b. Sound Output Level: 85 dB nominal at 10 feet (95 dB at 1 meter).
   c. Flash Rate: Nominally 70 per minute.
3. Features:
   a. Dimensions: 6.48 inches in height and 5.76 inches in diameter.
   b. Body: Injection molded plastic.
   c. Diaphragm: Stainless steel.
   d. Projector: None, unless otherwise noted.
   e. Listings: UL, cUL listed.
   f. Dome: Polycarbonate
   g. Dome Color: Red, unless otherwise noted.
   h. Lamp Life: 50,000 hours.
   i. Lamp: Red LED.
4. Enclosure:
   a. Type: NEMA 3R housing.
   b. Mounting: Surface.
5. Power: 120V ac, 50/60-Hz, unless otherwise noted.
6. Spare Bulbs: Provide two for each light.
7. Manufacturer: Federal Signal Corp.; Model AV1-LED-120R.

C. L007R Level Element and Transmitter, Radar, Type R:

1. General:
   a. Function: Continuous level measurement.
   b. Type: Radar, Noncontacting.
   c. Loop-powered.
   d. Parts: Element/integral transmitter and cable as noted.
2. Service:
   a. Application: Fluoride.
   b. Humidity: 0 to 99 percent relative humidity, noncondensing.
   c. Operating Temperature Range:
      1) Ambient: Minus 40 degrees F to plus 176 degrees F.
      2) At Flange (Inside Vessel):
         a) Dependent on antenna type and O-ring material.
         b) For cone antenna and Buna-N seal, minus 40 degrees F to plus 230 degrees F.
         c) Pressure Rating: -1 to +3 bar.

3. Performance:
   a. Process Range: As noted.
   b. Zero Reference: As noted.
   c. Frequency: 80 GHz.
   d. Beam Angle 8 degrees maximum.
   e. Accuracy at Reference Conditions: 0.1 inch (3mm).
   f. Repeatability: 0.04 inch (1mm).
   g. Transition Zone (not recommended for measurement): 10 inches maximum from lower end of antenna.
      1) Medium Suitability: Suitable for most liquids with measuring range decreasing for liquids with smaller dielectric constants.
4. Element/Integral Transmitter:
   a. Materials of Construction: Suitable for chemical compatibility.
   b. Cable: Provide sufficient cabling included with transmitter to reach control panel terminations without requiring splice connections.
   c. Process Connection:
      1) Front thread adapter mount using 1-1/2-inch NPT threads to 6-inch ANSI 150-pound flange.
      2) Material: Compatible with tank material and Fluoride.
   d. Approvals:
      1) FM Intrinsic Safety and Nonincendive: Not required.
      2) FM, Explosion-proof: Not required.
      3) Others: If noted.
5. Signal and Electrical Interface:
   a. Analog: 4 mA to 20 mA dc with maximum impedance of 650 ohms and nominal 24V dc power supply.
6. Manufacturer and Product: Vega Puls C21 series.

D. P4 Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.
2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: Plus or minus 0.50 percent of full scale.
3. Features:
   a. Dial: 4-1/2-inch diameter.
   b. Pointer Vibration Reduction: Required. Use one of the following methods.
      1) Liquid filled gauge front.
         a) Glycerin fill.
      2) Use 1279 PLUS!.

c. Case Material: Black thermoplastic.
d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components): Stainless steel.
e. Pointer: Adjustable by removing ring and window.
f. Window: Glass or acrylic.
g. Threaded reinforced polypropylene front ring.
h. Case Type: Solid front with blow-out back.

4. Process Connection:
   a. Mounting: Lower stem.
   b. Size: 1/2-inch MNPT.
5. Accessories:
   a. Throttling Device: Required.
      1) Type suitable for the intended service.
      2) Install in gauge socket bore.
6. Manufacturers and Products:
   a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!

E. P8 Pressure Switch, Fixed Deadband:

1. General:
   a. Function: Monitor pressure.
   b. Type: Diaphragm actuated switch.
2. Performance:
   a. Setpoint:
      1) As noted.
      2) Repeatability: Plus or minus 1 percent.
   b. Range: Noted setpoint shall fall between 20 percent and 80 percent of range.
   c. Overpressure Proof Pressure: At least 400 percent of rated maximum static pressure.
   d. Operating Temperature Range:
      1) Dependent on actuator seal materials.
      2) For Buna-N seal, 0 degree F to 150 degrees F.
3. Features:
   a. Actuator Seal: Buna-N.
   b. Differential (deadband): Fixed.
   c. Reset: Automatic.
   d. Mounting: Surface.
4. Process Connection:
   a. 1/4-inch NPT female connections.
   b. Materials: Nickel-plated brass.

5. Enclosure: NEMA 4X.
6. Signal Interface:
    a. Contact Type:
        1) SPDT.
        2) Rated for 10 amps minimum at 120V ac.
    b. Hermetically Sealed Switch: Not required.
7. Manufacturers and Products:
    a. Ashcroft; Type 400, B Series.
    b. United Electric; 400 Series.

E. P9 Pressure Transmitter:

1. General:
    a. Function: Measure pressure and transmit signal proportional to pressure.
    b. Type:
        1) Electronic variable capacitance or silicon strain gauge.
        2) Two-wire transmitter; “smart electronics”.
    c. Parts: Transmitter and accessories.
2. Performance:
    a. Range: Match existing.
        1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL but does not exceed it.
    b. Accuracy: Minimum plus or minus 0.075 percent of span, unless otherwise noted.
    c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
    d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
    e. Humidity: 0 to 100 percent relative humidity.
    f. Hazardous Location Certifications: If and as noted.
3. Features:
    a. Type: Differential pressure.
    b. Adjustable damping.
    c. LCD indicator, unless otherwise noted.
        1) Display in either percent or engineering units, field configurable.
    d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
        1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
    e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.

f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
g. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
5. Signal Interface:
   a. 4mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
7. Accessories:
   a. Provide mounting brackets as required for complete installation.
8. Manufacturers and Products:
   a. Differential Pressure Units:
      1) Emerson Rosemount; Model 2051.
      2) Endress+Hauser; Model PMD75.

F. S27 Indicator, Digital Panel:

1. General:
   a. Function: Digital indication of analog signal.
   b. Type: 3.5-digit LED display.
2. Performance:
   a. Accuracy: Plus or minus 0.05 percent of full scale plus or minus one count.
   b. Display Update Rate: 2.5 second minimum.
   c. Operating Temperature Range: 0 degree C to 60 degrees C.
   d. Relative Humidity: 0 percent to 90 percent noncondensing.
3. Features:
   a. Display:
      1) LED.
      2) At least 3.5-digits.
      3) 0.56-inch height.
   b. Overrange indication.
   c. Input Impedance: 100 ohms maximum.

4. Enclosure:
    a. 1/8 DIN, high impact plastic.
    b. Nominal Maximum Dimensions: 2-1/2 inches high by 4.7 inches wide by 4 inches deep.
    c. Nominal Cutout Dimensions: 1.8 inches high by 3.6 inches wide.
    d. Suitable for panel mounting.
    e. Maintains NEMA 4X Panel Rating: Required.
        1) Furnish accessories as required.
5. Power: 115V ac, unless otherwise noted.
6. Signal Interfaces:
    a. Process Inputs:
        1) Field Selectable: 4 mA to 20 mA, 1 volt to 5 volts.
    b. Relays:
        1) Minimum of two (2).
        2) Programmable.
    c. Loop Power Supply: If noted.
        1) 24V dc, at least 25 mA.
7. Manufacturer and Products:
    a. Newport Electronics, Santa Ana, CA; Model 202A-P.
    b. Precision Digital, Natick, MA; Model Trident Model PD765.
    c. Approved Equal.

G. S125 Analog Signal Splitter:

1. General:
    a. Function: Split and isolate an analog input current signal into two identical isolated analog output current signals.
    b. Type:
        1) Solid state with external power supply.
        2) Four-way isolation of the input signal, output signals, and external power supply.
    c. Parts: Signal splitter.
2. Performance:
    a. Isolation:
        1) Four-way isolation between input, output 1, output 2, and power circuits for common mode voltages up to 250V ac, or 354V dc off ground, on a continuous basis.
        2) Able to withstand 1,500V ac dielectric strength test for 60 seconds without breakdown.
    b. Output Ripple: Less than plus or minus 0.1 percent of maximum output span.
    c. Accuracy: Plus or minus 0.1 percent of output span.
    d. RFI Resistance: 10V/meter at frequencies of 80 to 1,000 MHz AM and 900 MHz keyed carrier, per EN61000-4-3 and ENV50204.

e. EMI resistance: Less than plus or minus 0.25 percent of output span effect under the influence of electromagnetic fields from switching solenoids or commutator motors and drill motors.
f. Ambient Temperature, Operating: Minus 13 degrees F to plus 167 degrees F.

3. Features:
   a. Two 15-turn potentiometers, Zero and span, per output channel, accessible from front of unit.
   b. Calibration independent of load.
4. Signal Interface:
   a. Input:
      1) 4 to 20mA dc.
      2) Impedance: 150 ohms at full scale.
   b. Output:
      1) 4 to 20 mA dc each channel.
      2) Drives output load impedance up to 950 ohms.
5. Enclosure:
   a. NEMA 1, unless otherwise noted.
   b. Mounting: DIN Rail, unless otherwise noted.
6. Power: 24V dc, unless otherwise noted.
7. Manufacturer:
   a. Phoenix Contact; MCR-FL-C-UI-2UI-DCI.
   b. Acromag; Model 633T-0100.
   c. Action; I/Q Q404-4.
   d. Approved Equal.

H. Y40 UPS System:

1. General: Provide an isolated, regulated, and uninterrupted AC power source to the control panel during a complete or partial interruption of incoming line power.
2. Performance:
   a. Full Load Rating: 850 VA.
   b. Input Power: 120V ac, 60Hz.
   c. Output Power: 120V ac, 60Hz.
   d. Alarm Relay Contacts: Dry contact I/O relay box, form C contact for On Battery, low battery, and UPS shutdown alarms. Refer to Accessories.
   e. Connections: Plug connections to UPS receptacle. Refer to Accessories.
   f. Backup Battery: Sealed, non-spillable, lead-acid batteries.

g. Backup Runtime (default internal battery):
   1) Half-load: Twenty minutes minimum.
   2) Full-load: Four minutes minimum.
h. Recharge Time: Complete discharge to 90 percent: Eight hours maximum.
i. Operating Temperature: 0 degrees to 50 degrees C.
j. Operating Relative Humidity: Zero percent to 95 percent non-condensing.
k. UL 1778 Listed, with two-year limited warranty.

3. Physical:
   a. Dimensions & Mounting Type: 4.88 inches high by 11.1 inches by 4.55 inches deep, DIN-Rail or back panel mount with brackets.
4. Accessories:
   a. Cord and Plug Pigtail: Provide cord and plug pigtail for each UPS installation to plug into simplex receptacle.
5. Manufacturers & Products: Sola HD UPS part number SDU 850 with mounting brackets as required for mounting on back panel.
6. Approved Equal.

I. Y83 Sunshade System:

1. General: Provide an outdoor-rated protective cover for analog displays on control panels to block sunlight and dust and improve visibility.
2. Performance:
   a. Collapsible top and sides.
   b. Does not require de-rating NEMA 4X control panel when installed.
3. Manufacturers: Shade Aide or approved equal.

J. Y90 Ethernet Switch:

1. General:
   a. Provide Ethernet communication between PLC’s and HMI computer.
2. Performance:
   a. Ports: 8 minimum.
   b. Connections: RJ-45.
   c. Speed: Gigabit.
3. Manufacturers and Products: TP-Link part number TL-SG108E or Approved Equal.

K. Y99 Fiber Optic Media Converter:

1. General: Furnish and install fiber optic converters to convert Ethernet signal transmitted over copper conductors to Ethernet signal transmitted over fiber.
2. Characteristics:
   a. Environmental: Minus 40 to plus 75 degrees C, 5-95 percent humidity, non-condensing.
   b. Input Power: 12 to 48V dc.
   c. Input Signal: 10/100/1000BASE-TX (RJ-45 connectors).
   d. Output Signal: 1000BASE-FX
   e. SFP Module: 1310nm SM LC connectors.
      1) Distance: 6.2 miles on 9/125 micron fiber.
3. Product:
   a. Transition Networks, Model SISTG1014-211-LRT-B, with TN-SFP-GE-L module.
   b. “Or-equal.”

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
   a. S-83-596, Optical Fiber Premises Distribution Cable.
   b. S-87-640, Optical Fiber Outside Plant Communications Cable.
   c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
4. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
5. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. QuEST Forum (QF): TL 9000, Quality Management Systems.
8. Rural Development Utilities Programs (RDUP):
   a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
   b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
9. Telecommunications Industry Association (TIA):
   a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
   b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
   c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
   d. 568-C.3, Optical Fiber Cabling Components Standard.
   e. 598, Optical Fiber Cable Color Coding.
   f. 606, Administration Standard for Commercial Telecommunications Infrastructure.

10. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
    a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.
    b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
    c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
    d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
    e. 492AAAC, Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
    f. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
    g. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
    h. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
    i. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
    j. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
    k. 942, Telecommunications Infrastructure Standard for Data Centers.
    l. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.
11. Underwriter Laboratories (UL): 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.

B. dB: Decibel.

C. FIM: Facilities Information Management.

D. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

E. FOCS: Fiber Optic Communication System.

F. FOIRL: Fiber Optic Inter Repeater Link.

G. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

H. Hybrid Cable: Cable containing more than one type of fiber.

I. LAN: Local Area Network.

J. m: Meter.

K. Mbps: Megabits per Second.

L. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

M. Megahertz (MHz): One million cycles per second.

N. MHz: Megahertz.

O. Micron: Micrometer or one millionth meter.

P. mm: Millimeter.

Q. N: Newton.

R. nm: Nanometer.

S. OFL: Over-filled Launch.

T. OFN: Nonconductive Optical Fiber Cable.

U. OFNP: Nonconductive Optical Fiber Plenum Cable.

V. OFNR: Nonconductive Optical Fiber Riser Cable.

W. OLTS: Optical Loss Test Sets.

X. OTDR: Optical Time Domain Reflectometer.

Y. PIC: Process Instrumentation and Control.

Z. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.

AA. UPS: Uninterruptible Power Supply.

BB. V ac, VAC: Volts Alternating Current.

CC. WAN: Wide Area Network.

1.03 SYSTEM DESCRIPTION

A. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.

B. Provide a complete FOCS based on referenced standards for a wide area Fast Ethernet network.

1. Provide fiber optic network hardware and cabling to connect new fiber communications nodes into the facility's existing network.

1.04 SUBMITTALS

A. Action Submittals:

1. Cable Schedule Showing:
   a. Cable identification.
   b. Fiber counts for each cable and identification of used fiber pairs.
   c. Cable length and attenuation, with two connector pairs and no splices, based on TIA 568-C.3, Annex H.
2. Component Data:
   a. Manufacturer and model number.
   b. General data and description.
   c. Engineering specifications and data sheet.
   d. Scaled drawings and mounting arrangements.

B. Informational Submittals:

1. Manufacturer's statement that installer is certified to perform installation Work.
   a. Testing and acceptance plan, 30 days prior to beginning of testing.
   b. Fiber test results. Documentation covering fiber facility testing, not later than 2 days after testing, showing:
      1) Manufacturer's tag of attenuation per fiber as recorded from OTDR reading before shipment.
      2) Attenuation of each fiber upon delivery to Site.

3) Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
4) Flux Budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength.

c. For each maintenance organization, identify location of base of service and how required coverage will be achieved.

2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
3. Manufacturer's suggested installation practice.
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. Equipment:

1. Outside, Aboveground: Minus 40 degrees C to 80 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 24 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Housing: ISO 9001 and QF TL 9000 registered.

3. Connector:
    a. ISO 9001 or QF TL 9000 registered.
    b. Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
4. Jumper Cable: ISO 9001 and QF TL 9000 registered.

B. Installer Qualifications:

1. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
2. Certified by fiber cable manufacturer.

C. Tester Qualifications: Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.

1. Technician: Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
    a. Manufacturer of fiber optic cable and fiber optic connectors.
    b. Manufacturer of test equipment used for field certification.
    c. Other independent training organizations acceptable to Owner.

D. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

1.07 SPECIAL GUARANTEE

A. Provide manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of work specified in this specification section found defective during a period of 4 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

1.08 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare equipment and tools.

Item	Quantity
Jumpers of each length needed	One complete set

B. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 SINGLEMODE FIBER OPTIC CABLE

A. Type 9/125 OS2 Indoor/Outdoor Cable:

1. Individual Fibers: 9/125 microns.
2. Assembly:
   a. Distribution Style with core of individually tight-buffered fibers surrounded by nonmetallic sheath.
   b. Cable: Comply with ICEA S-104-696.
3. Protective Covering: Flame retardant and UV resistant outer jacket with pull string.
4. Manufacturers and Products:
   a. Corning Cabling Systems; (FREEDM One) cable, model 006E8F-31131-29.
   b. Or approved equal.

2.02 FIBER CENTERS

A. Function: Provides secure place to terminate fiber optic cables.

B. Features:

1. Compartments: Two; one for fiber optic cable, one for jumpers to individual equipment.
2. Coil Former: Former to wind slack cable around, provides controlled long radius bends.
3. Connectors: Minimum 6 LC connectors for entry and exit.
4. Size: Maximum 450 mm by 300 mm by 100 mm.
5. Construction: 1.5-mm steel with corrosion proof finish.
6. Mountings: Suitable for permanent attachment as shown, or provide separate mountings that do not obscure covers and doors.
7. Doors: Separate lockable doors for cable and jumper terminations.

C. Locations: Provide at PLC cabinet and Control Room as shown on drawings and connect all fibers.

D. Manufacturers:

1. Ortronics.
2. AT&T.
3. Siecor.

2.03 CONNECTORS

A. General:

1. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-C.3.
2. LC duplex connectors.
3. Pull Strength: 0.2 N minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
   a. Ferrules: Free-floating low loss ceramic.
   b. Polarizing key on duplex connector systems.
5. Attenuation:
   a. In accordance with TIA 568-C.3.
   b. Maximum of 0.75 dB per connector pair.
6. Manufacturer: Corning.

2.04 PATCH CORDS

A. General:

1. In accordance with TIA 568-C.3.
2. Function: Connect fiber centers to network nodes, such as computer workstations.
3. Fiber Characteristics: In accordance with requirements for fiber optic cable.
4. Cable Configuration:
   a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
   b. Protected with Kevlar strength members and enclosed in thermoplastic jacket.
5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.

6. Connectors:
   a. As required by Article Connectors.
   b. On-axial Pull Strength: 33 N.
   c. Normal-to-Axial Pull Strength: 22 N.
7. Cable Rating: OFNR or OFNP.
8. Color: Per standards or as indicated.
9. Measured for insertion loss with the following values for each connector: Typical of 0.3 dB and maximum of 0.5 dB (LC typical of 0.1 dB and maximum of 0.3 dB).

2.05 CONDUIT

A. In accordance with Section 26 05 33, Raceway and Boxes.

2.06 ACCESSORIES

A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on Drawings.
2. Installation by manufacturer's certified installer.
3. Install cables in accordance with manufacturer's requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
   a. Not dented, nicked, or kinked.
   b. Not subjected to pull stress greater than manufacturer's specification.
   c. Not bent to a radius below manufacturer's minimum bend radius.
   d. Not subjected to treatment that may damage fiber strands during installation.
5. Cables per Conduit or Innerduct: In accordance with NFPA 70 NEC conduit fill limitations.
6. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
7. Splices:
   a. Install fiber optic cables in unspliced lengths from fiber centers to switches or hubs.

8. Connector: Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections not permitted.
9. Identification:
    a. Identify cable on both ends, in access holes, and pull points.
    b. In accordance with TIA 606.
10. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.
11. Access Holes:
    a. Provide supports for cables in access and handholes at minimum 600 mm.
    b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. Fiber Center, Fiber Distribution Frame, Housing, Panel, Splice Tray: Install securely in field panels or enclosures as shown on Drawings.

C. Cable Terminations:

1. In accordance with TIA 568-C.3.
2. Fan out fiber cable to allow direct connectorization of connectors.
    a. Sleeve over individual fibers with transparent furcation tubes.
    b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.
3. Break-out Kits:
    a. Terminate cables using manufacturer-supplied break-out kits.
    b. Terminate in accordance with manufacturer’s recommendations.
4. Slack:
    a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
    b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
5. Connectors:
    a. Terminate 100 percent fibers in each cable to specified connector.
    b. Connect into fiber management system.

D. Conduit: Install in accordance with Section 26 05 33, Raceway.

3.02 FIELD QUALITY CONTROL

A. General:

1. Advise Engineer at least 72 hours in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results: Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
    a. Field test instrument shall be within calibration period recommended by manufacturer.
    b. Optical Loss Test Set (OLTS):
        1) Single-mode Optical Fiber Light Source:
            a) Provide dual laser light sources with central wavelength of 1,310 nm (plus or minus 20 nm).
            b) Output Power: Minus 10 dBm, minimum.
            c) Manufacturer: Fluke Networks.
        2) Multimode Optical Fiber Light Source:
            a) Provide dual LED light sources with central wavelength of 1,300 nm (plus or minus 20 nm).
            b) Output Power: Minus 20 dBm minimum.
            c) Meet launch requirements of TIA/EIA 455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap, as described in Clause 11 of TIA 568-C.3, with Category 1 light source.
            d) Manufacturer: Fluke Networks.
        3) Power Meter:
            a) Provide 850 nm, 1,310 nm wavelength test capability.
            b) Power Measurement Uncertainty: Plus or minus 0.25 dB.
            c) Store reference power measurement.
            d) Save at least 100 results in internal memory.
            e) PC interface (serial or USB).
            f) Manufacturer: Fluke Networks.

4) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.

3. Optical Time Domain Reflectometer (OTDR):
   a. Bright, color transmissive LCD display with backlight.
   b. Rechargeable for 8 hours of normal operation.
   c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
   d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
   e. Serial and USB ports to transfer data to PC.
   f. Single-mode OTDR:
      1) Wavelength: 1,310 nm (plus or minus 20 nm).
      2) Event Dead Zone: 2 meters maximum at 1,310 nm.
      3) Attenuation Dead Zone: 15 meters maximum at 1,310 nm.
      4) Distance Range: Minimum 10,000 meters.
      5) Dynamic Range: Minimum 10 dB at 1,310 nm.
4. Fiber Microscope:
   a. Magnification: 250X or 400X for end-face inspection.
   b. Manufacturer: Fluke Networks.
5. Integrated OLTS, OTDR, and Fiber Microscope:
   a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
   b. Manufacturer: Fluke Networks.

C. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
   a. LIA Z136.2.
   b. TIA/EIA 455-78.
   c. TIA/EAI 455-133.
   d. TIA 526-7.
   e. TIA 526-14.
   f. TIA 568-C.1.
   g. TIA 568-C.3.
   h. TIA TSB 140.
2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

7. Document Tests:
   a. OLTS dual wavelength attenuation measurements for single-mode and multimode links and channels.
   b. OTDR traces and event tables for single-mode and multimode links and channels.

D. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode and multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.
         b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

   b. OTDR Testing:
      1) Reflective Events: Maximum 0.75 dB.
      2) Nonreflective Events: Maximum 0.3 dB.
   c. Magnified Endface Inspection:
      1) Visually inspect fiber connections for end-face quality.
      2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

E. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

F. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

G. Test Execution:

1. Optical Fiber Cable Testing:
    a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
    b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated.
        1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
    c. Perform Testing:
        1) On each cabling segment (connector to connector).
        2) On each cabling channel (equipment to equipment).
        3) Using high-quality test cords of same fiber type as cabling under test.
            a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
            b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.
2. Optical Loss Testing (OLTS):
    a. Backbone Link:
        1) Test single-mode at 1,310 nm in accordance with TIA 526-7, Method A.1, One Reference Jumper or equivalent method.
        2) Perform tests in both directions.
3. OTDR Testing:
    a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
        1) Single-mode: 1,310 nm.
    b. Test each fiber link and channel in one direction.
    c. Install launch cable between OTDR and first link connection.
    d. Install receive cable after last link connection.
4. Length Measurement:
    a. Record length of each fiber.
    b. Measure optical length using OLTS or OTDR.

5. Polarity Testing:
   a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
   b. Verify polarity of paired duplex fibers using OLTS.
6. Test Results Documentation:
   a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.
   c. Database for project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on USB stick prior to Owner acceptance of building. USB stick shall include software tools required to view, inspect, and print test reports.
   d. Circuit IDs reported by test instrument shall match specified label identification.
   e. Provide in electronic database for each tested optical fiber with the following information:
      1) Identification of Site.
      2) Name of test limit selected to execute stored test results.
      3) Name of personnel performing test.
      4) Date and time test results were saved in memory of tester.
      5) Manufacturer, model, and serial number of field test instrument.
      6) Version of test software and version of test limit database held within test instrument.
      7) Fiber identification number.
      8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
      9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
      10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
      11) Length for each optical fiber as calculated by the OTDR.
      12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

H. Drawings:

1. Record Copy: Provide at end of Project on USB stick.
   a. CAD format and include notations reflecting as-built conditions of additions and variations from Drawings provided, such as to cable path and termination point.
   b. CAD drawings are to incorporate test data imported from test instruments.
2. As-built Drawings:
   a. Include, but not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts, and frame installation details.
   b. Include field changes made up to construction completion:
      1) Field directed changes to pull schedule.
      2) Field directed changes to cross connect and patching schedule.
      3) Horizontal cable routing changes.
      4) Backbone cable routing or location changes.
      5) Associated detail drawings.

3.03 SUPPLEMENTS

A. Supplement listed below, following “End of Section,” is part of this Specification.

1. As-Built Fiber Optic Cable Installation Form.

END OF SECTION

PROJECT: Paul B. Krebs Water Treatment Plan Improvements Project

Contractor: _____

Signed by: _____

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Sheet 1 of 1

Cable Identification:
Routing: From: In:
(Identify field panel, control room, etc. in building)

Through: 1
(Identify access hole, building, gallery, etc.)
Through: 2 Through: 5
Through: 3 Through: 6
Through: 4 Through: 7
To: In:
See As-Built Conduit/Innerduct Installation forms for identification of conduits/innerducts cable is routed through.

Acceptable Attenuation:
Single mode Fibers

		cable length*			
1300 nm:	0.3 dB/km x	km + 0.5 dB =	dB		

*Contractor to provide actual length installed, within ±10 m.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
			1,310 nm		1,310 nm

END OF SUPPLEMENT

SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.01 REFERENCE

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

1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. Instrumentation, Systems, Automation Society (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
   c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL): 508A, Standards for Safety, Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer’s factories.

B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer’s factory.

1.03 SUBMITTALS

A. Action Submittals:

1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
2. Catalog information on electrical devices furnished with system.
3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.

5. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.

B. Informational Submittals:

1. Programmable Controller Submittals:
   a. Complete set of user manuals.
   b. Fully documented ladder logic listings.
   c. Function listing for function blocks not fully documented by ladder logic listings.
   d. Cross-reference listing.
2. Manufacturer's list of proposed spares, expendables, and test equipment.
3. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.05 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:

1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
2. Light Bulb: 100 percent, 2 minimum, of each type used.
3. Fuse: 100 percent, 5 minimum, of each type used.
4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Section 40 90 00, Instrumentation and Control for Process Systems.

2.02 SIGNAL CHARACTERISTICS

A. Analog Signals:

1. 4 mA to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
2. Unless otherwise specified or shown, use Type 2, two-wire circuits.

3. Transmitters: Load resistance capability conforming to Class L.
4. Fully isolate input and output signals of transmitters and receivers.

B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.

1. Power source: Less than 30V dc.

C. Discrete Signals:

1. Two-state logic signals.
2. Utilize 120V ac sources for control and alarm signals.
3. Alarm signals shall be normally open, close to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

2.03 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering; Model A-HCI.

2.04 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

B. Conform to NEMA ratings as specified in individual equipment sections.

C. Minimum Metal Thickness: 14 gauge.

D. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.

E. Doors:

1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and 12 panels with doors higher than 18 inches.
2. For other doors, stainless steel quick release clamps.

F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Temperature Control:

1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
2. Furnish cooling fans with air filters if required to dissipate heat.
3. For panels outdoors or in unheated areas, furnish hygrostatically controlled heaters to maintain temperature above 40 degrees F.

I. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

J. Lighting: Minimum of one hand switch or door switch controlled internal LED light for panels 12 cubic feet and larger.

K. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

L. Finish:

1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer’s standard gray unless otherwise specified.
2. Internal Surfaces: White enamel.

M. Panel Manufacturers:

1. Hoffman.
2. H.F. Cox.

N. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

2.05 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures shall be UL listed.

C. Control Panels without Motor Starters:

1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
3. Circuit Breakers:
    a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
    b. Branch Circuit Breakers: 15 amps at 250V ac.
    c. Breaker Manufacturers and Products:
        1) Heineman Electric Co.; Series AM.
        2) Airpax/North American Philips Controls Corp.; Series 205.

D. Control Panels with Three-Phase Power Supplies and Motor Starters:

1. Interlock main circuit breaker with panel door.
    a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
    b. Mount operator controls and indications on front access door.
2. Circuit Breakers:
    a. In accordance with NEMA AB 1.
    b. 18,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
    c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
    d. Tripping: Indicate with operator handle position.
3. Magnetic Motor Starters:
    a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
    b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
    c. Manual reset type with reset button mounted on panel door.
4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
    a. Power Control Transformer:
        1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
        2) Limit voltage variation to 15 percent during contact pickup.
        3) Fuse one side of secondary winding and ground the other.
        4) Furnish primary winding fuses in ungrounded conductors.

5. Power Monitoring Relay:
   a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
   b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
   c. Transient Voltage Protection: 10,000 volts.
   d. Manufacturer and Product: Siemens/Furnas; Class 47.
6. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not “leap frog” power conductors.
7. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Wiring:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.
6. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleeve.
      2) Tyco Electronics.

F. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.
2. For special signals, terminate power (240 volts or greater) at manufacturer’s standard connectors.
3. For panel, terminate at equipment on/with which it is mounted.

G. Terminal Blocks:

1. Quantity:
   a. For external connections.
   b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
   c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
   a. Connection Type: Screw connection clamp.
   b. Compression Clamp:
      1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
      2) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive, and self-locking.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 to plus 110 degrees C.
      2) Two funnel shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: One at each end of rail, minimum.
   g. Wire Preparation: Stripping only.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block.
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown.
3. Terminal Block, 120-Volt Power:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 22 through 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.

4. Terminal Block, Ground:
    a. Wire Size: 22 through 12 AWG.
    b. Rated Wire Size: 12 AWG.
    c. Color: Green and yellow body.
    d. Spacing: 0.25 inch, maximum.
    e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
    f. Manufacturer and Product: Entrelec; Type M4/6.P.
5. Terminal Block, Blade Disconnect Switch:
    a. Use: Provide one for each discrete input and output field interface wire.
    b. Rated Voltage: 600V ac.
    c. Rated Current: 10 amp.
    d. Wire Size: 22 through 12 AWG.
    e. Rated Wire Size: 12 AWG.
    f. Color: Gray body, orange switch.
    g. Spacing: 0.25 inch, maximum.
    h. Manufacturer and Product: Entrelec; Type M4/6.SN.
6. Terminal Block, Fused, 24V dc:
    a. Rated Voltage: 600V dc.
    b. Rated Current: 6.3 amp.
    c. Wire Size: 22 through 12 AWG.
    d. Rated Wire Size: 12 AWG.
    e. Color: Gray body.
    f. Fuse: 5 by 20 GMA fuses.
    g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
    h. Indication: LED diode 24V dc.
    i. Leakage Current: 5.2 mA, maximum.
    j. Spacing: 0.32 inch, maximum.
    k. Manufacturer and Product: Entrelec; Type M4/6.SFD.
7. Terminal Block, Fused, 120V ac:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 6.3 amp.
    c. Wire Size: 22 through 12 AWG
    d. Rated Wire Size: 12 AWG.
    e. Color: Gray body.
    f. Fuse: 5 by 20 GMA fuses.
    g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
    h. Indication: Neon lamp 110V ac.
    i. Leakage Current: 1.8 mA, maximum.
    j. Spacing: 0.32 inch, maximum
    k. Manufacturer and Product: Entrelec; Type M4/6.SFL.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

I. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Provide dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Furnish holddown clips.
2. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP.
3. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
   g. Expected Mechanical Life: 500,000 operations.
   h. Expected Electrical Life at Rated Load: 50,000 operations.
   i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
4. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As specified or shown.
   f. Operating Temperature: Minus 10 to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 to 80 percent or range.

i. Time Delay Setpoint: As specified or shown.
j. Mode of Operation: As specified or shown.
k. Adjustment Type: Integral potentiometer with knob external to dust cover.
l. Manufacturer and Products: Potter and Brumfield.
1) Series CB for 0.1-second to 100-minute delay time ranges.
2) Series CK for 0.1- to 120-second delay time ranges.

J. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
a. Manufacturer and Product: MTL, Inc.; Series MTL 5500.
2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
a. Manufacturer and Product: MTL, Inc.; Series MTL 5500.

K. Programmable Controllers:

1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
2. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
3. Minimum of 12 discrete inputs and 8 discrete outputs, optical isolations rated at 2,500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.
4. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
5. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 to 60 degrees C and up to 95 percent humidity, noncondensing.
6. Furnish with a handheld, CRT, or personal computer programmer that plugs into controller. Program using conventional relay ladder diagram notation and drum sequencer chart notation. Programmer shall provide a force function to set inputs or outputs to a given state regardless of program or input conditions. Programmer shall indicate power flow through internal elements.
7. Manufacturers:
a. Allen-Bradley.
b. Schneider Electric.

L. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:

1. Potentiometer Units:
   a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include legend plates with service markings.
   d. Manufacturers and Products:
      1) Allen-Bradley; Model 800T.
      2) Eaton/Cutler-Hammer; Model 10250T.
2. Indicating Lights:
   a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
   b. LED bulb.
   c. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
   d. Manufacturers and Products:
      1) Eaton/Cutler-Hammer; Type 10250T.
      2) General Electric; CR2940U.
3. Pushbutton, Momentary:
   a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
   b. Standard size legend plates with black field and white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Class 9001, Type K.
      2) Eaton/Cutler-Hammer; Type T.
      3) General Electric; Type CR-2940.
4. Selector Switch:
   a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
   e. Manufacturers and Products for Units with up to Four Selection Positions:
      1) Eaton/Cutler-Hammer; Type T.
      2) Square D; Type K.
   f. Manufacturers and Products for Units with up to 12 Selection Positions:
      1) Rundel-Idec; Standard Cam Switch.
      2) Electroswitch; 31.

M. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
   a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
   c. Include engraved legend plates with service markings.
   d. Manufacturer and Product: Allen-Bradley; Bulletin 800H.
2. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
   b. LED bulb.
   c. Screwed on prismatic lenses and factory engraved legend plates for service legend.
   d. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
3. Pushbutton, Momentary, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.
4. Selector Switch, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
   e. Manufacturer and Products:
      1) Square D; Class 9001, Type SK.
      2) Allen-Bradley; Type 800H.

2.06 INSTRUMENT TAG NUMBERS

A. A shorthand tag number notation is used. For example:

AI-1-12(2)(3)[pH]

Notation	Explanation
AI	ISA designator for Analysis Indicator
1	Unit process number
12	Loop number
(2)	First unit number; number of same component types in a given loop; -1 and 1-2 in this example
(3)	Second unit number; number of same component types with same first unit number in a given loop; -1, -2, and -3 in this example
[pH]	Same notation shown at 2 o'clock position on ISA circle symbol on Process and Instrument Diagram

B. In this example, AI-1-12(2)(3)[pH] is shorthand for:

AI-1-12-1-1[pH], AI-1-12-1-2[pH], AI-1-12-1-3[pH]

AI-1-12-2-1[pH], AI-1-12-2-2[pH], AI-1-12-2-3[pH]

2.07 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.

1. Panel Mounted: Plastic, mounted to instrument behind panel face.
2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:

1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
2. Color: White with black letters.
3. Letter Height: 3/16 inch.
4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2 inch high.

C. Standard Light Colors and Inscriptions: Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	Inscription(s)	Color
ON	ON	Green
OFF	OFF	Red
OPEN	OPEN	Green
CLOSED	CLOSED	Red
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

1. Lettering: Black on white and amber lenses; white on red and green lenses.
2. Standard Pushbutton Colors and Inscriptions:
   a. Use following:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black

Tag Function	Inscription(s)	Color
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:
   1) Black on white and yellow buttons.
   2) White on black, red, and green buttons.

2.08 ELECTRICAL SURGE AND TRANSIENT PROTECTION

A. Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.

B. Suppressor Locations:

1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
2. On analog pairs at each end when the pair travels outside of building.
3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

C. Suppressor Design:

1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
2. Response: 5 nanoseconds maximum.
3. Recovery: Automatic.
4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
5. Enclosure Mounted: Encapsulated inflame retardant epoxy.

D. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Power Supplies for Continuous Operation:
   a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
   b. All Other Applications: Minimum 30 amps at 130V ac.

E. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
   a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
   b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
   c. Maximum Loop Resistance: 18 ohms per conductor.

F. Manufacturers and Products:

1. 120V ac Lines (Type SS1): ASCO Model 252.
2. Analog Signals (Type SS2) Lines: ASCO Model 175 or DRS-036 series.
3. Field Mounted at Two-Wire Instruments (Type SS3): Phoenix Contact; S-PT-EX-24DC-1/2 inch (2800035) OR ASCO Model 157.
4. Field Mounted at Four-Wire Instruments (Type SS4): Schneider Electric; SLACSE series or Phoenix Contact equal.
5. Ethernet Cables (Type SS6): Eaton DNET1.

G. Grounding:

1. Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Section 26 05 26, Grounding, and suppressor manufacturer’s requirements.
2. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

PART 3 EXECUTION

3.01 ELECTRICAL POWER AND SIGNAL WIRING

A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.

D. Do not splice or tap wiring except at device terminals or terminal blocks.

3.02 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

END OF SECTION

SECTION 44 11 25
GROUNDWATER TREATMENT SYSTEM

PART 1 GENERAL

1.01 GROUNDWATER TREATMENT SYSTEM SUPPLIER

A. System Supplier shall either supply a complete system or coordinate Suppliers and subcontracts for integration of all equipment and facilities, as appropriate, to provide one complete and fully-functioning system meeting the requirements as specified herein and in accordance with Specifications listed below.

1. Components of the system include but are not be limited to:
   a. One complete packed tower air stripping systems.
   b. Piping.
   c. Instrumentation.
   d. Electrical.

B. The air stripping towers inlet/outlet elevations shall match that of the existing system.

C. System Supplier shall furnish a performance guarantee.

D. System Supplier shall furnish all certification and warranty including system workmanship and materials.

E. System Supplier shall provide manufacturer services and training as specified.

F. System Supplier shall be responsible for the equipment listed below and in accordance with the referenced Specifications.

1. System Piping, Valves, Ducting and Dampers:
   a. Piping, Ducting, and Appurtenances associated with the system and as shown in the Drawings.
      1) Piping and Valving: See the drawings and manufacturers standard specifications.
      2) Ducting shall be the manufacturer standard thermoset fiberglass or an “Or Equal” approved.

2. Packed Air Stripper:
   a. System Supplier shall supply an air stripper treating influent TCE from a groundwater pumping system. Blower and associated ductwork shown on the Drawings and within the Specification.
3. Instrumentation and Controls: System supplier shall supply instrumentation and controls according to Specifications and Drawings.
4. Electrical equipment: System supplier shall supply instrumentation and controls according to Specifications and Drawings.

1.02 REQUIREMENT

A. The Contractor shall furnish all labor, materials, equipment, and incidentals required to install and test, complete and ready for operation the groundwater treatment system as specified herein.

B. The Contractor survey the existing system to coordinate elevations of the existing system with the new to ensure that inlet and discharged flows are balanced.

C. The system shall be installed in phases as detailed within the Drawings to maintain groundwater treatment.

D. Groundwater treatment systems shall include, but not be limited to the packed air stripping tower, sound attenuation enclosures, filters, air supply fan complete with motor and control, ductwork goosenecks, distribution headers and laterals, distributor, packing support structures, manways, ladders, walkways, platforms and connections, lifting lugs, instruments, and control panel with starters, as specified herein and shown on the Drawings. The system shall include mist eliminator, packing media, clean in place system to include recirculation pump and all necessary accessories. The packed air stripping tower shall be provided by the System Supplier to achieve a single source for warranty and process performance responsibility as well as to achieve standardization of appearance, operations, maintenance, spare parts, and manufacturer’s services. System Supplier of the packed air stripping tower systems shall coordinate and supply interconnecting fiber glassed reinforced ducts and accessories.

E. The packed tower air stripping system shall provide for 99.9 percent removal of TCE from the influent to the packed air stripping tower.

F. The packed air stripping tower Supplier shall have supplied at least ten systems with at least five installed within the last 5 years at least 11 feet in diameter and with treatment capacity of at least 2.5 million gallons per day (mgd).

1.03 REFERENCES

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

1. American Society of Mechanical Engineers (ASME): RTP-1, Specification for reinforced thermoset plastic corrosion resistant equipment.
2. Air Movement and Control Association International (AMCA):
   a. 99, standards handbook.
   b. 210, laboratory methods of testing fans for rating.
   c. 211, certified ratings program-product rating manual for fan air performance.
3. ASTM International (ASTM):
   a. C581, Determining chemical resistance of thermosetting resins used in glass fiber reinforced structures intended for liquid service.
   b. C582, Contact-molded reinforced thermosetting plastic (RTP) laminates for corrosion resistant equipment.
   c. D638, Test for tensile properties of plastics.
   d. D695, Test for compressive properties of rigid plastics.
   e. D746, Test method for brittleness temperature of plastics and elastomers by impact.
   f. D790, Test for flexural properties of plastic.
   g. D883, Standard nomenclature relating to plastics.
   h. D1505, Test method for density of plastics by the density gradient technique.
   i. D1693, Test method for environmental stress cracking of ethylene plastics.
   j. D2310, Machine made reinforced thermosetting resin pipe.
   k. D2563, Recommended practice for classifying visual defects in glass reinforced laminated parts.
   l. D2583, Standard test method for indentation hardness of rigid plastics by means of a Barcol lmpressor.
   m. D2996, Filament wound, reinforced thermosetting polyester chemical resistant tanks.
   n. D3299, Filament-wound glass fiber reinforced thermoset resin chemical-resistant tanks.
   o. D4097, Contact molded fiber reinforced thermoset chemical resistant tanks.
   p. D4167, Standard Specifications for fiber-reinforced plastic fans and blowers.
4. National Bureau of Standards (NBS): PS15-69, Custom contact molded reinforced-polyester chemical-resistant process equipment.

5. American Petroleum Institute (API):
   a. Standard 610, Centrifugal pumps for petroleum, petrochemical, and natural gas industries.
   b. Standard 670, Machinery protection systems.
6. Hydraulic Institute Standards (HIS):
   a. 9.6.4, Rotodynamic pumps for vibration measurements and allowable values.
   b. 14.6, Rotodynamic pumps for hydraulic performance acceptance tests.
7. National Electrical Manufacturer's Association (NEMA): MG 1, motors and generators.

1.04 SYSTEM SUPPLIER SUBMITTALS

A. Action Submittals:

1. Materials and Shop Drawings: The System Supplier shall submit complete Shop Drawings of all the equipment as a complete system. The equipment Shop Drawing submittal shall contain all structural calculations and Drawings for the vessels, thickness, vessel anchoring system including anchor bolt size and location, supports and bracing of pipes and ducts to vessels, lifting hooks, ladders, platforms and loads imposed by appurtenances such as inlet ducting and piping. All structural drawings, structural calculations and process calculations shall be signed and sealed by a structural professional engineer and a civil engineer respectively. These Engineers shall be registered in the State of Alabama.
2. Complete master power and control wiring diagram, elementary or control schematics, and suitable outline drawings of control schematics and control panel shall be furnished as part of the Shop Drawings. Details of the feed water distribution system and packing media support plate shall be included with this submittal.
3. Make, model, weight, and horsepower of each equipment assembly.
4. Base ring detail including the number, size, and spacing of the necessary anchor bolts, design, tower weight, design overturning moment, and base ring thickness.
5. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
6. Catalogue cut sheets for all tower internals including packing media, packing support grating, and mist eliminator.
7. Catalog cut sheets for blower(s) and any other specified air handling components.
8. Catalog cut sheets for all specified instrumentation and control components.

9. Elevation and plan views of the air stripping tower including the location and orientation of all nozzles, body flanges, manways, and connections.
10. Elevation and plan views of the blower(s), ductwork, and all air handling components.
11. Calculations:
    a. If piping diameter or any elevations vary from that shown on the Drawings (and that do not match the existing system) provide total dynamic head calculations. This may result in a change in the vertical turbine pump.
    b. Torsional analysis for rotating assembly. Analysis report shall include the specific items of API 610, Part 2.8, dynamics.
    c. Structural calculations demonstrating the tower shell's conformance with section 2.3.1.a.
    d. Pressure drop calculations including losses for the packing media, internals, ductwork, and any air handling components.
12. Power and control wiring diagrams, including terminals and numbers.
13. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
14. Factory finish system.
15. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Additional information: System Supplier shall supply certificates for the following:
    a. The resin used shall be in accordance with ASTM C582 and that resin is compatible with an environment consisting of air, caustic, TCE vapor, various aromatic hydrocarbon vapors, droplets of water with TCE, and droplets of water containing chlorine, sodium hydroxide, and sulfuric acid.
    b. The ductwork supplied meets deflection requirements under the vacuum pressure and hoop (point) loading specified herein.
    c. A certificate from the vessel manufacturer listing the nomenclature, composition, and characteristics of the resin. This information shall be supplied with the submittal data, as well as vessel and support calculations as specified.
2. Inspection and factory test reports. Including independent third-party inspection report.
3. Factory test and vibration test reports, including alignment test results for the packed air stripping tower system and fan/blower.
4. Field test log.
5. Special shipping, storage and protection, and handling instructions.

6. Manufacturer’s printed installation instructions.
7. Factory functional and performance test reports and log. Factory test data for each pump shall be submitted, reviewed, and approved by Engineer prior to shipment of equipment.
8. Manufacturer’s 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.
9. Manufacturer’s list special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
10. Operation and maintenance data.
    a. The tower manufacturer shall submit 3 copies of Operation and Maintenance Manuals.
    b. At minimum the following information shall be included:
        1) Manufacturer’s instructions for equipment installation, startup, operation, preventative maintenance, servicing, and troubleshooting procedures.
        2) Air pressure test records, air stripping system data sheets, and final as-built drawings of all equipment.
        3) Name, address, and telephone number of factory trained service technician.
11. Manufacturer’s certificate of proper installation.
12. Manufacturer’s certificate of fan/blower noise level with/without sound attenuation enclosure.
13. Performance test report submittal as specified herein.
14. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.05 QUALITY ASSURANCE

A. Inspections and Testing Requirements: The Engineer reserves the right to reject acceptance of delivery of any or all pieces of equipment found, upon inspection, to have any or all of the following: Blisters, chips, crazing, exposed glass, cracks, burned areas, dry spots, foreign matter, surface porosity, sharp discontinuity or entrapped air at the surface of the laminate.

B. Prior to any exterior gel coating or equivalent of the vessel, notification must be given to the Engineer. The Engineer reserves the right to be present at the fabricator's facility for visual inspection of equipment to be supplied.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed, and the units and equipment are ready for operation.

B. Equipment shall be delivered onsite as fully assembled as transportation will allow.

C. Finished surfaces of all exposed openings shall be protected. All exposed openings shall be protected to prevent entrance of debris, moisture, or water during transportation and storage.

D. Contractor shall notify the manufacturer within 24 hours of any damage to equipment or surface finish due to shipping.

E. Delivery of equipment, spare parts, and special tools shall be properly marked to identify the associated equipment by name, P&ID tag number (if applicable), and manufacturer part number. Parts shall be packaged in a manner for protection against damage from the elements during shipping, handling, and long-term storage. All spare parts and special tools shall be packaged complete and shipped at one time in appropriately sized, hinged covered, hard plastic, or metal boxes. The boxes shall be marked to indicate the contents by name and part number. Parts shall be numbered and named in accordance with the O&M manual identification system.

1.07 WARRANTY

A. Contractor shall warrantee the whole system, both in material and workmanship for a period of 1 year from the day of final acceptance. The warranty period shall extend for 12 months after date of substantial completion.

1.08 SPARE PARTS

A. The following spare parts shall be provided at a minimum:

1. For each of the packed air stripping tower:
   a. One set of fan/blower belts.
   b. One fan/blower bearing set.

PART 2 PRODUCTS

2.01 GROUNDWATER TREATMENT SYSTEM

A. Manufacturers:

1. Monroe.
2. “Or-equal,” approved.

2.02 GENERAL

A. Refer to mechanical process and instrumentation drawings and article on packed air stripping tower system supplier of this section for equipment supplied under this system.

B. Components and materials in contact with groundwater or water with chemicals (e.g., TCE, hydrochloric acid, etc.) shall be the use of tools.

C. The air outlet area shall be designed to ensure that air maximum outlet velocity does not exceed 50 feet per second.

D. The air stripper shall be constructed in a fabrication shop with has an ASME “U” stamp. Manufacturer shall submit a copy of this ASME Certificate Authorization.

E. Welding of the vessel and internals shall be performed by welders qualified in accordance with the latest ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

F. The liquid distribution system shall be a multi-piece weir and trough design that can be disassembled and removed via a 30-inch access hatch. The feed distribution header or trough will extend across the diameter of the packed air stripping tower. Flow from the feed header shall be distributed to multiple parting boxes. The parting boxes will distribute the water to lower troughs that will evenly distribute the water across the full cross section of the packed tower. There shall be a minimum of six keyhole or V-notch pour points per linear foot of the lower troughs and there shall be at least 6.3 pour points per square foot of cross-sectional area. Distribution header and laterals shall be schedule 80 PVC or FRP.

G. The packed air stripping tower system shall be provided with lifting lugs to provide access for maintenance.

H. A minimum of 12 inches space shall be provided between the weir trough and the top of the packing to facilitate water distribution and provide access for maintenance.

I. All connections 2 inches and larger shall be flanged and shall have ANSI standard dimensions and bolting patterns.

J. Comply with requirements of the federal, state, and local requirements and use approved materials. Provide certification by manufacturer or an accredited certification organization recognized by the authority having jurisdiction that components and materials comply with federal, state and local requirements. Use or reuse of components and materials without a traceable certification is prohibited.

K. Equipment supplier shall be responsible for anchorage and bracing design for air stripping tower(s) and associated equipment.

2.03 PACKED AIR STRIPPING TOWER SYSTEM DESIGN REQUIREMENTS

A. Air stripper system design conditions (the system shall meet these criteria with raw water concentrations less than or equal to those listed below):

1. Number of air strippers required: One.
2. Diameter: 11.5 feet.
3. Maximum flow rate, water, each: 2,750 gpm.
4. Average water temperature: Less than 50 degrees F.
5. Airflow Rate: 18,385 cfm.
6. Packing Media Size: 3.5 inches.
7. Packing Media Type: Jaeger Tripacks.
8. Packing Media Bed Depth: 24 feet.

Compound	**Influent (µg/L)**	**Effluent (µg/L)**	**Removal (%)**
Trichloroethylene (TCE)	40	<0.5	>99.8
Radon	500 pCi/L	<1	>99.8

B. Packed Tower Air Stripping Vessels shall be Type 304 stainless steel.

1. For Stainless Steel Manufacturer shall design vessel for negative pressure service conditions as specified for Type II Grade 1 tanks in ASTM 03299.

C. Tower Shell:

1. The air stripper system shall be of the forced draft type with random dumped internal packing.

2. The column shall have a minimum effective internal cross-sectional area of 103 square feet and a minimum overall height of 37 feet. The column shall be constructed entirely of Type 304 stainless steel. Design snow and wind loads shall be as per relevant American National Standard Institution Codes; the design wind pressure shall not be less than 30 lb/sqft. Earthquake loads for seismic zone one and vibrational effects shall also be considered. The column shall be completely self supporting when anchored to a suitable concrete base. The tower shell shall have a minimum thickness of 3/16-inch throughout unless structural design calculations can be provided showing lighter material is sufficient. Calculations shall allow for the addition of 10 feet of packed bed depth for future needs. Under no circumstances shall less than 1/8-inch material be used. The towers shall be properly rolled, welded and reinforced where required. The tower shall be manufactured such that there are no crevices. All welds shall be continuous and shall seal both sides of structural members. The surface of weld joints shall be finished to eliminate roughness and crevices in the well deposit. No undercut will be permitted. Due to the varying structural and operational properties of different materials, no substitution will be accepted.
3. Sufficient anchoring points shall be provided to be compatible with the concrete slab design. Anchoring points shall be located in a continuous base ring around the tower base. The base ring shall have a minimum thickness of 3/4 inch. The base ring shall be designed to safely transmit the maximum overturning moment loads imposed by the design wind or earthquake loads specified above from the shell to the foundation. The base ring shall be designed such that the moment of stability is greater than 1.5 times the overturning moment due to wind or seismic movement, whichever is greater. No guy wires or other supporting devices will be permitted.
4. The exterior of the bottom of the tower shell shall be coated with two coats of high build, cold applied, water resistant coal tar coating. The minimum dry film thickness for each coat shall be 8 to 10 mils. The second coat shall not be applied until the first coat has dried for amendment minimum of 24 hours.
5. The tower shall be provided with the following connections:

Qty	Size	Description
1	14″	Flanged influent nozzle
1	16″	Flanged water effluent nozzle
1	22″ h x 33″ w	Rectangular air inlet nozzle
1	3″	Drain with plug

Qty	Size	Description
1	1/2″	Influent sample tap
1	1/2″	Effluent sample tap
4	24″	Flanged manways
1	3″	Tap w/ plug for ultrasonic level transponder

6. All necessary lifting lugs and pipe support brackets shall also be provided by the tower manufacturer.
7. All nozzle connections shall be flanged, no threaded connections will be allowed due to the internal coating. Shop drawings shall show the exact orientation and elevation of all nozzle connections.
   The manways shall be located as follows. All manways in the packed bed shall be provided with packing retaining screens:
   a. In the tower sump.
   b. At the bottom of the packed bed.
   c. At the top of the packed bed.
   d. In the distributor section.
8. A flanged join shall be provided in the tower shell between the top of the packed bed and the bottom of the distributor tray. The flange shall allow for the installation of additional packed bed depth if required in the future.
9. A flange joint shall be provided in the tower shell between the distributor tray and mist eliminator assembly such that the distributor assembly can be removed from the shell in one piece.
10. Provide welded attachment points adjacent to the upper manway such that a portable ladder and fall arrestor device may be attached when needed to allow safe access to the upper manway.
11. Four (4) equally sized air outlet screens shall be provided on the tower shell above the mist eliminator. Each air outlet shall be provided with 24 mesh screening.
12. The roof of the tower shell shall be fabricated with a domed top to prevent water from building up on top of the tower.

D. Column Internals:

1. Sufficient high efficiency packing shall be provided to yield a packing depth of 24 feet. The packing shall be 3.5 inches in diameter and made of polypropylene material. The packing shall have a surface area of approximately 38 square feet/cubic foot and 95% void space. The pressure drop, under an operating condition of 18,385 CFM of air and 2,750 GPM of water shall not exceed 0.06 inches of water/foot of packing. Packing shall be No. 2 Jaegar Tripacks. Due to the various mass transfer properties of different packings, no substitutes shall be accepted.

2. One (1) packing support grating shall be provided and shall be compatible with the packing furnished. The support grading shall be made of fiberglass reinforced plastic (FRP). The support grading will be designed and supported so that the maximum deflection in the tray is less than 1/2-inch when supporting a maximum load of 450 pounds per square foot at a maximum span of 30 inches. Span and deflection tables shall be submitted for the grading furnished. Calculations shall include the maximum design load. Shop drawings shall show the number and location of all required grading support members such that the Engineer may verify that the packing support system is adequate.
3. A distributor tray shall be provided to uniformly distribute the water flow over the surface of packing and uniform formally collect the exhaust air. The distributor shall be capable of handling a water flow of 1,600 to 3,200 GPM. The distributor tray shall be constructed of 304L stainless steel and be complete with influent velocity breaker, air exhaust stacks, and distributor orifices. The air exhaust stacks will be sized to provide a gas velocity not exceeding 25 feet per second. The distributor orifices shall be sufficient in number to provide even distribution and size to retain a static head of water in the tray over the full range of liquid flow rates anticipated. The tray shall be provided with a welded sidewall of a height 1 inch greater than the maximum water depth or 6 inches, whichever is higher. The bottom of the tray shall be stiffened to withstand a maximum hydrostatic head anticipated without executive deflection. The structural design shall conform to the standards of the AI SC. The tray shall be completely self supporting when mounted to peripheral ledge around the inside diameter of the tower shell. The tray shall be removable through the top of the shell with the mist eliminator section remove. Welding of the tray assembly into the shell will not be permitted. Spray nozzles or pipe distributors will not be acceptable.
4. Liquid redistribution rings shall be provided at 5-foot intervals throughout the height of the packing, as required for efficient packing performance. A minimum of five (5) redistributors shall be provided. The redistributors shall be fabricated from aluminum angles rolled leg out and welded to the tower shell. All welds shall be continuous and shall seal both sides of the redistribution rings.
5. A moisture separation system shall be provided which will eliminate water droplets in the exhaust airstream. A 4-inch thick, 138-inch diameter polypropylene mesh-type mist eliminator shall be provided for this purpose. The mist eliminator shall be provided with bottom stainless steel support grids. All air outlet openings will be provided with 24 mesh insect screens.

E. The system shall be provided with access ports, ladders, and platforms as shown to allow for gravity loading and unloading of the packing, and for maintenance of the distribution laterals and nozzles and packing support system. Ladders and platforms shall be manufactured of Type 316 stainless steel or aluminum and shall be as shown on the Drawings. All support requirements and accessories for mounting the ladder and platform shall be included.

F. As part of the access ports at the top and bottom of the packed air stripping tower, provide an inspection port so that the packing, distribution system, sump and packing support plate can be observed during operation. The access ports shall have a clear hatch cover under a hinged or removable opaque cover. When removed or open the operator can observe the inside of the packed air stripping tower through the clear hatch. The opaque covering plate shall be removable without.

G. Provide a flanged outlet nozzle sized according to manufacturer's design and associated fittings to be connected to 16-inch flange in accordance with the Drawings. The outlet shall be connected to a 90 degree elbow facing the bottom of the sump inside the packed aeration tower. The outlet nozzle shall be high enough on the side wall to allow the bottom of the interior elbow to be 6 inches above the bottom of the sump.

H. Provide a 4-inch flanged drain at the bottom of the sump in accordance with the Drawings.

I. All bolts, fasteners, supports, hinges, lifting lugs, etc., shall be Type 316 stainless steel.

J. Electrical conduits and straps shall be PVC and all electrical boxes shall be NEMA 4X, Type 316 stainless steel.

K. Gaskets shall be NSF approved neoprene or Engineer-approved alternative.

L. Packed air stripping tower feed and cleaning piping shall be supported by the packed tower. All support requirements and accessories for mounting the piping to the packed air stripping tower going to the top of the tower shall be provided by the Supplier.

M. Packed Air Stripper Tower Fan/Blower:

1. One blowers shall be provided capable of delivering 18,385 scfm at 4.1 inches water static pressure.
2. The blower shall be belt-driven backward curve airfoil design, single width, single inlet, Arrangement #10.

3. The blower housing and base shall be a heavy gauge commercial quality carbon steel suitable for temperature up to 250 degree F. The housing and wheels shall be continuously welded in compliance with a SME section IX standards. The wheels shall be commercial quality carbon steel with single thickness blades and have non-overloading horsepower characteristics. The wheel shall be mounted to the fan shaft with a split taper bushing. The shafts shall be ground and polished. The fan bearing shall be heavy duty, self-aligning bold depending on fan size, motor hp, and performance, and relubricable for continuous service. They shall have a minimum L10 life of 50,000 hours. The blower shaft shall be medium carbon steel (1040-45 SAE) and shall not operate above 70 percent of the first critical speed. The belt shall be in oil, heat and static resistance type oversize for continuous duty. The belt drive shall be sized with a service factor not less than 2.0. Drives shall be of the V-belt type with constant pitch. Lifting lungs shall be provided for ease of handling and installation. The blower shall be supplied with a weather cover which combines guarding of the drive as well as protection from the weather, a drain connection, outlet flange, adjustable motor base plate, intake guard, and inlet flange.
4. The blower assembly shall be dynamically balanced with the factory prior to shipping. All blowers shall meet balance requirements of the Acoustical Society of America standard ASA STO2-195(ASNI S2 19-1975), Grade G8.3. The fan performance shall he based on tests conducted in the manufacturers AMC a certified laboratory, and conducted in accordance with the latest revision of AMCA test codes #210 (AIR) and a MCA #300 (Sound). Air and sound performance is a MCA certified and is licensed to bear the AMCA seal.
5. The blower motor shall be squirrel cage induction type electrical motor. The motor shall be a 20 HP designed for 230/460 volt, 3 phase, 60 HZ service. The motor shall be a TEFC motor with a service factor of not less than 1.15. The motor shall be a premium efficiency and energy conserving design, manufactured in accordance with NEMA specifications, NEMA B torque requirements, and Class F non-hydroscopic insulation. The motor shall be manufactured by recognized domestic manufacturer.
6. The blower shall be furnished with an outdoor enamel. The blower shall be finished painted by the general contractor after installation is complete to ensure that all defects and finish occurring in shipment or insulation are corrected. Finish paint shall be as specified elsewhere.

7. General: System Supplier shall provide air supply fans as specified and shown. Fans shall be v-belt drive or direct drive, designed for continuous, 24 hour per day service. The fans shall be sized to provide sufficient pressure for the air to overcome the pressure drop in the packed air stripping towers and shall be able to overcome additional pressure drop in connecting ducts with sheave changes.
    a. Fan shall be an industrial FRP fan, centrifugal type with backwardly inclined wheel of non-overloading design and SWSI Class II in accordance with AMCA 99-2408. Fan shall be constructed in accordance with ASTM D4167. Fan wheel shall be statically and dynamically balanced. Fan and fiberglass construction shall conform to ASTM D4167/C582. Fan resin shall be suitable for exposure to the specified service conditions. Fan housings shall be grounded to support bases. All fan housings shall be constructed of fiberglass and reinforced with rigid bracing to increase structural integrity. Bearing support brackets shall be positioned to directly oppose belt tension forces.
    b. Fan shafts shall be Type 316 stainless steel. Fan shall have self-aligning grease-packed bearings, with neoprene shaft seals and OSHA-approved weatherproof FRP motor/drive cover.
    c. Fan housings shall be of a curved scroll design with a 1-inch NPT drain construction at the bottom of the fan scroll. Fan intake and outlets shall have flanged nozzles.
    d. One complete set of spare belts and bearings shall be provided.
    e. The fan shall be mounted on a concrete pad.
8. Motor: motor shall be squirrel cage induction type, designed, manufactured, and tested in accordance with the latest edition of NEMA MG1.
    a. Motor shall be horizontal, totally-enclosed, fan-cooled, single-speed (TEFC), with non-hygroscopic insulation, extra dips and bakes of insulating varnish for moisture protection of windings, gasketed conduit box halves and moisture seal between conduit box and motor frame and drains and breathers for moisture removal.
    b. The connected load (maximum horsepower required) of motor shall not exceed its nameplate horsepower rating (exclusive of 1.15 service factor) under any anticipated operating condition and shall be selected based on coordination by the System Supplier to meet needs of the packed air stripping tower.

c. Motor shall be NEMA design b unless otherwise indicated.
d. Motor shall be rated for a temperature rise of 40 degrees C above ambient temperature.
e. Motors shall have a grounding terminal in the connection box.
f. If motor is subjected to overhanging loads, it shall be designed for such loads. Magnitude of overhanging load shall not exceed recommendation of the motor manufacturer.
g. Bearings shall be open-type ball bearings installed in labyrinth sealed end bells with pipe plugs.

N. Inlet Air Filters and Filter Housing:

1. The air filter supplied will consist of one filter bank for each blower. The bank will consist of 36 square feet of filter face area. The purpose of these filters is to remove large airborne particulates as well as small dust particles from the air being drawn by the blower.
2. The filter media shall be of the non woven cotton fabric type. The filter media shall have an average efficiency of 25-30 percent on ASHRAE test standard 52-76. It shall have an average arrest in case of 90-92 percent in accordance with that test standard. The effective filter matter shall not be less than 7 square feet of media per one square foot of filter face area and shall contain not less than 11 pleats per linear foot and shall be 4 inches thick. Initial resistance at 600 FPM approach velocity shall not exceed .35-inch w.c. Filters shall be replaced when the pressure drop across them reaches 0.9-inch w.c.
3. The filter shall be contained in a side servicing housing constructed of 16 gauge galvanized steel. The housing shall have preformed tracks to hold the filters in place during operation. The housing will also be fitted with two (2) access doors to facilitate removal and replacement of filters from either side of the unit. The housing shall be properly sealed to prevent any leakage of air from the unit or short circuiting of air around the filters.
4. The differential pressure gauge assembly shall be provided to monitor the pressure drop across the filter bank. The scale of the gauge shall be 0-inch-2-inch w.c. The gauge shall be a Dwyer 2002 or approved equal.
5. One (1) spare set of filter elements shall be furnished, sufficient and number to replace all elements in each housing area.
6. Intake ductwork -- a structural grade aluminum transition duct and vulcanized butyl rubber flex connection shall be provided between the filter housing and blower inlet.

O. Stationary Louver:

1. The 72 inches wide by 72 inches high drainable extruded aluminum stationary louver shall be provided as weather protection for each air filter system. Frame shall be 4 inches deep and 0.081 inch thick 6063-T5 extruded aluminum alloy. Blades shall be made of 0.081 thick 6063-T5 extruded aluminum alloy, be a fixed 45 degree angle, and be of the drainable type. Screen shall be provided on the interior, be removable for cleaning, and consist of 1/2 inch expanded aluminum with extruded aluminum frame. Standard finish of louver shall be mill.
2. Louver shall pass a maximum free area velocity of 900 FPM with less than 0.19 inch w.c. pressure drop and carry less than 0.01 ounces of water per square foot of free area during a 15 minute. Based on tests and procedures performed in accordance with AMCA publication 511 and comply with the requirements of the AMCA certified ratings program, affective November, 1990. Test criteria shall be based on a 48 inch square sample with a minimum free area of 7.24 square feet or 45.2 percent louver shall carry the AMCA certified rating seal for both water penetration and air performance.

P. Ductwork:

1. All duct, dampers, supports, and fittings between the fans, packed air stripping tower, and the vents, shall be supplied by the System Supplier.
2. Discharge Ductwork – The blower shall be provided with a structural grade aluminum transition duct and vulcanized butyl rubber flex connection between the air inlet on the stripper and blower discharge.
3. Blower Inlet – A 24 mesh stainless steel flanged insect screen shall be mounted directly to the blower inlet flange. The screen assembly shall be provided with sufficient screen area such that the velocity through the screen is no higher than if the inlet was unscreened.
4. All aluminum duct shall be of welded construction with a minimum thickness of 12 gage. Ducts fabricated with rivets or lock seams will not be acceptable.

Q. Blower Pressure Switch:

1. A pressure switch shall be installed in the ductwork between each blower discharge and the air inlet on each tower. The switch will be designed to sense low air flow to the tower. The pressure switch shall be a Dwyer series 1950 or approved equal.

2. Design conditions:
    a. Design temperature: 40 to 100 degrees F.
    b. Design pressure rating: 12-inch water gauge (unless otherwise required in accordance with the System Supplier ductwork design).
    c. Wind load: In accordance with Specifications and general sheets in the Drawings.
    d. Location: Outdoors.
    e. Chemical composition of process vapors from treating 2,750 gpm of flow with 2 to 40 µg/l TCE.

R. Tower Accessories:

1. Inlet Piping: All piping shall be STL as shown on the Drawings.
    a. The inlet piping shall be 12-inch diameter Schedule 10 340L stainless steel and shall extend from inside the tower at the center of the water distribution tray to a flanged face 5 feet above the bottom of the tower.
    b. The inlet pipe shall be provided with a 150# flanged connection at the elevation of the top of the packed bed to allow for the installation of additional piping should the tower shell and piping need to be extended in the future.
2. Fasteners:
    a. All fasteners used to bolt the tower shell, piping, accessories and ductwork shall be Type 304 stainless steel.
    b. Type 304 stainless steel cast-in-place anchor bolts and plastic anchor bolt sleeves shall be provided and installed by the General Contractor.
    c. Since the bolts are an integral part of the concrete pad the design of their embedment length is the responsibility of the concrete pad designer. However, it is the responsibility of the packed column manufacturer to supply the concrete pad designer with the size (diameter) and number of bolts which will safely transmit the operational and environmental loads from the packed column to the concrete pad.
3. Gasketing:
    a. All flanged tower connections shall be gasketed with closed cell neoprene sponge.
    b. All flanged piping connections shall be gasketed with red rubber. All threaded piping connections shall be sealed with Teflon tape.

S. Ladder and Platform Assembly:

1. Description: the caged safety ladder/work platform shall be provided as indicated in the contract drawings for access to--and inspection of --the tower internals. The ladder/ platform system shall meet all OSHA requirements. The ladder and platform are intended to provide reasonably easy access to the upper manway on the tower. The latter platform should be constructed to bold onto brackets that are welded to the tower shell. The latter/ platform shall be provided as part of the packed tower by the tower manufacturer.
2. Ladder: the latter shall be made-up of rungs a minimum of 3/4 inch in diameter and 15 inches long period the rung shall have a textured non-slip surface. The distance between rung shall not exceed 12 inches and shall be uniform throughout the length of the latter. The distance from the rungs to the tower shall not be less than 7 inches. The tower shall run from the base of the tower to three feet 6 inches above the upper platform.
3. Cage: the latter shall be provided with a continuous cage beginning no more than 8 feet above the base of the tower and running 3 feet 6 inches above the upper platform. The bottom of the cage shall be flared at least 4 inches. The cage shall extend 27 inches from the center line of the rungs and shall cannot be less than 27 inches wide. Vertical bars shall be located at a minimum spacing of 40 degrees around the circumference of the cage. The cage shall be provided with a locking door to prevent unwarranted access.
4. Platform: A single landing platform shall be provided 27 feet above the base of the tower. It shall be equipped with standard railings, tow boards, safety gates, and non slip gradings all meeting OSHA requirements and so arranged as to allow safe access to the latter. The platform shall be a minimum of three feet wide the stepped across distance from the ladder to the platform shall be between 3 and 12 inches.
5. The ladder and platform assembly shall be fabricated from 6061-T0 structural grade aluminum.

T. Packed air stripping tower instrumentation and controls:

1. General: Control and instrumentation for the equipment supplied by the System Supplier shall be in accordance with the requirements of this Specification.

PART 3 EXECUTION

3.01 PACKED AIR STRIPPING TOWER SYSTEM

A. Inspection of Type 304 stainless steel vessels.

B. Manufacturer's Inspection:

1. All vessels shall be tested at the place of manufacture, and the manufacturer shall provide the following information:
   a. Hardness readings.
   b. Thickness measurements.
   c. Measurements showing compliance with dimensions and tolerances in diameters, lengths, squareness of ends, angles of fittings and flanges, and flatness of flanges.
   d. For vessel laminate quality; presence of pits, foreign inclusions, dry spots, air bubbles, pinhole pimples, and delamination.
2. All vessels shall be factory hydrostatically tested for leaks by filling with water to the maximum operating level after fabrication is complete. Vessels shall be checked for leaks after they have been filled for at least 1 hour. Manufacturer shall run this test prior to the time of shipping for all vessels.
3. A separate inspection record shall be made for each vessel. Inspection records shall be sent to the Engineer for approval prior to shipment of vessels.
4. The vessel and records shall be inspected at place of manufacture by an independent third-party inspector at the manufacturers expense. Final acceptance will be contingent upon satisfactory further inspection upon arrival at the jobsite.
5. If the factory inspection and tests show that any of the vessels do not meet the Specifications, corrective measures shall be taken, or the defective vessel shall be replaced with a new vessel that satisfies the conditions specified prior to shipment to the jobsite.

3.02 SURFACE PREPARATION AND SHOP PAINTING

A. All PVC overlaid with FRP vessels, PVC vessels, and FRP vessels will be coated with a white polyester gel coat on all exterior surfaces at the factory. Other equipment to be supplied under this section requiring surface preparation and shop priming shall be performed as part of the work of this section.

B. The interior of the tower shell shall be prepared in accordance with SSPC-SP10 Near-White Blast Cleaning.

C. The exterior of the tower shell shall be furnished with a mill finish.

D. Coating Systems:

1. All interior aluminum surfaces of the tower shall be coated with an NSF approved epoxy painting system suitable for potable water. The DFT is to be 8 to 10 mils.
2. The painting system shall be Amerlok 2 as manufactured by Ameron.
3. The internal coating is an integral part of the tower shell and must be furnished as specified.

3.03 INSTALLATION

A. All vessels shall be installed in accordance with the manufacturer's technical data and printed instructions, and in the locations shown on the Drawings.

B. The general contractor shall provide all field labor and equipment for installation of the tower (on the general contractor’s concrete foundation). The general contractor shall install the tower shell, tower packing, fans and the air duct assemblies under the direct supervision of the towers manufacturer’s field representative. Electrical connection to the blowers and any instruments or monitoring devices shall be provided by the electrical contractor specified elsewhere.

C. The plywood template shall be delivered to the general contractor by the tower manufacturer to ensure accurate setting of the anchor bolts.

D. The tower manufacturer shall provide a field representative for a total of two (2) days of field services. One (1) day shall be for installation supervision, and one (1) day shall be for operator training and system startup. During startup, one (1) set of influent and effluent samples shall be collected by the tower manufacturer and analyzed by a certified laboratory. Any additional laboratory analysis will be provided by the Owner.

E. The tower manufacturer shall submit a written report to the general contractor upon receipt of certified laboratory results.

F. All startup and/or disinfection chemicals shall be provided and disposed of by the general contractor.

3.04 FIELD AND PERFORMANCE TESTING AND MANUFACTURER'S SERVICES

A. System Supplier shall coordinate manufacturer services as described in this section.

B. The system manufacturer shall furnish the service of a factory representative for the minimum days noted who has complete knowledge of proper operation and maintenance of the equipment to inspect the final installation and to supervise the test runs.

C. Functional Testing:

1. Fan vibration test:
   a. Take measurements at every bearing housing using IRD or general radio calibrated electronic analyzer.
   b. Prepare record log, including location identification and peak-to-peak displacement in a direction parallel to the shaft in a horizontal position and in a direction perpendicular to the shaft in both horizontal and vertical planes.
   c. Air balance the equipment and retest if peak-to-peak amplitude exceeds the following limits. Methods of air balancing shall be in accordance with ASTM D4167, or as approved by the Engineer.

ROTATION SPEED (RPM)	VIBRATION AMPLITUDE (MILS)
300 TO 600	2.5
600 TO 900	2.0
900 TO 1,200	1.5
1,200 TO 1,800	1.0
1,800 TO 3,000	0.6
ABOVE 3,000	0.5

   d. Performance testing (required to be performed on each system).
2. The packed air stripping tower shall be tested on the approximate design concentration of TCE. The Contractor shall furnish utilities, labor, after the packed aeration tower is complete, and flow meter for air flow measuring. The test shall be supervised by the System Supplier and witnessed by representatives of the Engineer and Owner. The system shall provide the specified percentage removal of TCE at design flow conditions or maximum achievable flow rate based on plant operations. A minimum of 1 day shall be required for testing the packed air stripping towers.

3. A performance test report shall be submitted within 14 days of completing the testing. The report shall include all data taken during the performance test. The data shall include water quality analysis of the influent and effluent to the packed aeration tower. Water quality analysis shall include TCE concentration, temperature and PH of the packed aeration tower influent and effluent. Data taken during the testing period shall be presented in graphical and tabular forms including feed flow rate, air feed flow rate, air-to-water ratio, water loading rate, and TCE removal percentage. Data presented in graphical form shall be trended by operating time. The report shall state if the packed air stripping tower system meets the requirements of this Specification.

D. If the system components or any component thereof fails to operate properly, the necessary changes shall be made, or components shall be replaced until the system operates to the satisfaction of the Engineer. Any units that remain unable to meet the operating requirements shall be removed and replaced with satisfactory units at no cost to the Owner.

E. System Supplier shall have a service company knowledgeable in troubleshooting and proper operation of the system. The service company shall be in the State of Alabama to assure quick response to the Owner's needs. The service company shall have a minimum of 5 years in the State of Alabama working on this type of equipment.

F. Cleaning and Disinfection: Before testing and installation of media, the Contractor shall vacuum clean and disinfect the FRP structure piping and ductwork and all surfaces that come into contact with the process stream. This cleaning must be witnessed by the Engineer or Owner's representative.

G. Field finishing: Manufacturer standard for outside installation.

3.05 MANUFACTURER'S SERVICES

A. Manufacturer's representative for the packed air stripping tower systems: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded. Since the units are started up in two phases the time listed shall be broken down as part of two trips:

1. 6 person-days for installation assistance and inspection.
2. 6 person-days for functional and performance testing and completion of manufacturer's certificate of proper installation.
3. 2 person-days for prestartup classroom or site training.
4. 2 person-days for facility startup.
5. 2 person-days for post-startup training of Owner's personnel.

B. When so specified, a manufacturer's certificate of proper installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.

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

3.06 TRAINING

A. General:

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

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
   a. Respective manufacturer.
   b. Estimated dates for installation completion.
   c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.

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

1. Title and objectives.
2. Recommended attendees (such as, managers, engineers, operators, maintenance).

3. Course description, outline of course content, and estimated class duration.
4. Format (such as, lecture, self-study, demonstration, hands-on).
5. Instruction materials and equipment requirements.
6. Resumes of instructors providing training.

D. Pre-startup training:

1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives, and with submission of operation and maintenance manuals.
2. Complete at least 14 days prior to beginning of facility startup.

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

F. Recording of Training Sessions:

1. Furnish audio and color recording of prestartup and post-startup instruction sessions, including manufacturers' representatives' hands-on equipment instruction and classroom sessions.
2. Video training materials shall be produced by a qualified, professional video production company.
3. Use DVD format suitable for playback on standard equipment available commercially in the United States. Blu-Ray®DVD format is not acceptable without Engineer's prior approval.
4. Include one training session on each DVD. DVD may contain multiple training sessions. If multiple training sessions included on a DVD, provide with on-screen menu for playback selection.

3.07 CLEANING AND DISINFECTION

A. Before testing and installation of media, the Contractor shall vacuum clean and disinfect the FRP structure piping and ductwork and all surfaces that come into contact with the process stream. This cleaning must be witnessed by the Engineer or Owner's representative.

END OF SECTION

SECTION 44 42 56.03
VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. American Petroleum Institute (API):
   a. 610, Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries.
   b. 670, Machinery Protection Systems.
3. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A536, Standard Specification for Ductile Iron Castings.
   c. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
4. Hydraulic Institute Standards (HIS):
   a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
   b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
5. National Electrical Manufacturer’s Association (NEMA): MG 1, Motors and Generators.
6. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 DEFINITIONS

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

1.03 SUBMITTALS

A. Action Submittals:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions.
4. Calculations:
    a. Torsional analysis for complete rotating assembly. Analysis report shall include the specific items of API 610, Part 2.8, Dynamics.
    b. Lateral vibration analysis for discharge head motor assembly and for column pipe bowl assembly.
5. Pump maximum downthrust or upthrust in pounds.
6. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of components.
7. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, parts nomenclature, flow straightening basket, and materials of construction lists.
8. Baseplate drawings with leveling jackscrew details, anchor bolt and sleeve details, and minimum foundation installation and leveling requirements.
9. Power and control wiring diagrams, including terminals and numbers.
10. Complete motor nameplate data, as defined by NEMA, motor manufacturer, including motor modifications.
11. Factory finish system.
12. Vibration monitoring system information including technical product bulletins and descriptions, specification data sheets, wiring diagrams, communications hardware and software, documentation sufficient for configuration of functions specified herein and shown on Drawings.
13. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that factory finish system is identical to requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Factory Functional and Performance Test Reports and Log Factory test data for each pump shall be submitted, reviewed, and approved by Engineer prior to shipment of equipment.
6. Suggested spare parts list to maintain 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.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for each pump:

1. Complete set bearings.
2. Complete set gaskets and O-ring seals.
3. Complete set of shaft sleeves.
4. Complete set keys, dowels, pins, etc.
5. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Lateral and Torsional Vibrations:

1. Pump and motor assembly shall have no natural frequencies within 20 percent of operating speed range.
2. Fundamental critical speed of rotating assembly shall be no less than 50 percent above the rated speed.

3. Pump manufacturer shall conduct an analysis of the lateral and torsional vibration of pump and motor assembly.
   a. Excitation frequency range of the analysis shall include, but not be limited to, number of motor poles and number of impeller vanes.
   b. Perform detailed stress analysis for pump, coupling, motor system at each critical speed, and steady-state operating condition.
   c. Stress analysis shall demonstrate that in no case shall maximum stress on pump, coupling and motor component exceed endurance limits of pump, coupling and motor assembly components materials of construction.

B. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SUPPLEMENTS

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

2.03 SHAFT SEALS

A. Mechanical Seal Requirements: Per Data Sheet.

2.04 VIBRATION AND TEMPERATURE TRANSDUCERS AND MONITORING SYSTEM

A. General:

1. Meet requirements specified herein and with motor temperature and vibration sensors specified in Section 26 20 00, Low-Voltage AC Induction Motors.
2. Provide temperature and vibration monitoring systems in cabinet as shown in Process and Instrumentation Diagram (P&ID), program, test, calibrate, fully configure and place into operation.

B. Bearing Temperature Elements:

1. Permanently installed by motor manufacturer.
2. Sensor shall be as specified in Section 26 20 00, Low-Voltage AC Induction Motors.

C. Motor Casing Velocity Transducer: As specified in Section 26 20 00, Low-Voltage AC Induction Motors.

D. Vibration and temperature transducers shall be installed in accordance with guidelines provided by API 670.

2.05 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

D. Flow Straightening Basket: Type 316 stainless steel, cathodically isolated from the pump bowl, designed by supplier.

2.06 FACTORY FINISHING

A. Prepare and prime, and finish coat in accordance with Section 09 90 00, Painting and Coating Manufacturer’s standard baked enamel finish.

2.07 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment actually furnished.

C. Factory Test Report: Include test data sheets, curve test results, performance test logs.

D. Functional Test: Perform manufacturer's standard, test on equipment. Include vibration test, as follows:

1. Dynamically balance rotating parts of each pump and its driving unit before final assembly. Balance Quality Grade G2.5.

E. Performance Test:

1. Conduct on each pump at rated speed.
2. Perform under simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Performance Test 1U per ANSI/HI 14.6.
5. Vibration Test Level per ANSI/HIS 9.6.4.
6. Test Log: Record the following:
   a. Total head.
   b. Capacity.
   c. Horsepower requirements.
   d. Flow measured by factory instrumentation and storage volumes.
   e. Average distance from suction well water surface to pump discharge centerline for duration of test.
   f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
   g. Calculated velocity head at the discharge flange.
   h. Bowl head.
   i. Driving motor voltage and amperage measured for each phase.
7. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

F. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

G. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so there is no change of level or springing of baseplate when anchor bolts are tightened.

C. Adjust pump assemblies such that driving units are properly aligned, plumb, and level with driven units and interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03 62 00, Grouting. Remove wedges after grout is set and pack void with grout.

E. Vibration and Temperature Transducers:

1. Install in accordance with API 670.
2. Install two terminal junction boxes mounted on motor housing.
3. Install conduit and cable from motor bearing temperature transducers to one of the terminal junction boxes. Install conduit and cable from motor vibration transducers to the other junction box.

F. Connect suction and discharge piping without imposing strain to pump flanges.

G. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

A. As specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test:
   a. Test with unit installed and in normal operation, and discharging to connected piping systems at rates between low discharge head and high discharge head conditions specified, and with actual building structures and foundations provided shall not develop vibration exceeding 80 percent of limits specified in HIS 9.6.4 2022.
   b. If unit exhibits vibration in excess of limits specified, adjust or modify as necessary. Unit that cannot be adjusted or modified to conform as specified shall be replaced.

3. Flow Output: Measured by plant instrumentation and storage volumes.
4. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
5. Test for continuous 3-hour period.
6. Test Report Requirements: In accordance with HIS 14.6.

B. Performance Test: In accordance with Hydraulic Institute Standards.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 3 person-days for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 2 person-days for prestartup classroom or Site training.
4. 1 person-day for facility startup.
5. 1 person-day for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENTS

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

1. Pump Data Sheet.

END OF SECTION

VERTICAL TURBINE PUMP DATA SHEET, 44 42 56.03-01

Tag Numbers: P-35-2-1, P-35-2-2, P-35-2-3, P-35-2-4, P-35-2-5

Pump Name: Finished Water Pump 1, Finished Water Pump 2, Finished Water Pump 3, Finished Water Pump 4, Finished Water Pump 5

Manufacturers and Product: (1) Goulds Water Technology - VIC- 18DXC 4 Stage

(2) Sulzer Johnston – JT-18TMC 6 Stage

(3) Flowserve – 20EKL 3 Stage

(4) FloWay – 18MKL 4 Stage

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Drinking Water

Pumping Temperature (Fahrenheit): Normal 55-65 Max 75 Min 45

Specific Gravity at 60 Degrees F: 1 Viscosity Range: 1.2

pH: 6-8

Abrasive (Y/N): N/A Caused by: _____

Possible Scale Buildup (Y/N): N/A Caused by: _____

Corrosive (Y/N): N/A Caused by: _____

Altitude (Feet above Mean Sea Level): 595 ft

Area Classification: Unclassified

Ambient Temperature (degrees F.): 70

Location: Indoor (Y/N): Y Outdoor (Y/N): N

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 4080 Secondary: 4930

Total Dynamic Head (Ft)*: Rated: 488.5 Secondary: 361.5

*TDH is measured at the centerline of the pump discharge flange. This TDH includes an allowance of 3.5′ for losses with the pump bowls, shaft, discharge head, etc. If loss is higher than the allowance contractor shall adjust the TDH accordingly.

Max Horse Power (hp): 700 hp Secondary: 700 hp

Maximum Shutoff Pressure (Ft): 720

Min. Pump Hydraulic Efficiency at Rated Capacity (%): 82.5

Max. NPSH Required (Ft. Absolute): 30

Max. Pump Speed at Rated Capacity (rpm): 1775

Constant (Y/N): Y

Adjustable (Y/N): N

Reverse Rotation: Pump shall be capable of operating at runaway speed in reverse rotation without damage. Non-Reverse Ratchet device to be provided by the pump manufacturer.

DESIGN AND MATERIALS

Pump Type: Open Line Shaft (Y/N) Y Enclosed Line Shaft (Y/N) N

Bowl: ASTM A48, Cast Iron Bowl Wear Rings: ASTM B148, Bronze, AL C95400 Bowl Lining: Epoxy, see Remarks Bowl and Suction Bell Maximum Diameter (inches): 20

Flow Straightening Basket (Y/N): Y, 316 SST designed by pump MFG

Bowl Bearings: Visconite Hilube

Column: ASTM A53, Carbon Steel

Line Shafting: ASTM A582, SST 416, Keyed to prevent shaft separation upon reverse spin. Threaded not allowed.

Bearing Span (Feet): 5

Line Shaft Bearings: Visconite Hilube

Discharge Head:

Type: Fabricated, VIT

Material: Fabricated Steel, ASTM A36/A36M

Discharge Nozzle Size (inches): 20 Flange Standard/Class: 150#

Plain End (Y/N): Y Thrust Tie Lugs (Y/N): N

Suction Can (Y/N): Y Can Nominal Diameter (Inches): 30 Can Material: Carbon Steel Suction Can Bottom Elevation and Suction Nozzle Location as Shown on Drawings. See Remarks below.

Impeller:

Type: Hydraulic Balanced

Material: 316 SST

Impeller Wear Rings: ASTM B148, Bronze, AL

Head Shaft Material: ASTM A582, SST 416

Shaft Sealing: Packing (Y/N) N Mechanical (Y/N) Y

Type: Split Chesterton 442

Seal Lubrication: API Plan 13

Coupling: Falk (Y/N) N_____ Fast: (Y/N) _N_____ Spring-Grid (Y/N) __N____

Gear Type (Y/N) _N_____ Spacer (Y/N) __N____

Manufacturer Standard (Y/N) Y____

Baseplate Material: Carbon Steel

Sole Plate (Y/N) N___ Material ____

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors.)

Horsepower: 700 hp Voltage: 460 Phase: 3

Synchronous Speed (rpm): 1775

Service Factor: 1.15

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC _____ CISD-TEFC _____ TEWAC _____ WPI X WPII _____

Mounting Type: Vertical Hollow Shaft X Nonreverse Ratchet (Y/N) Y

Vertical Solid Shaft _____

ABMA 9 and ABMA 11, B-10 Motor Bearing Life (hrs): 100,000

REMARKS All portions of the pump exposed to the pumped water shall be NSF 61 compliant or coated with an NSF 61 compliant system rated for the service conditions such as Belzona 1341 or an equal submitted and approved prior to bidding of the Project.

PART 4

DRAWINGS
(BOUND SEPARATELY)