Magna Water District

Magna Water Reclamation Facility
Influent Project

Project No 181301587

Volume 1 of 3
Specifications

Issued for Construction – March 2024

Stantec
2890 East Cottonwood Parkway Suite 300
Salt Lake City, Utah 84121

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The responsible party for each specification section is shown in the table below.

Responsible Party Legend	
MB	Madison Bertoch Professional Engineer Stantec 2890 East Cottonwood Parkway, Suite 300 Salt Lake City, UT 84121
NR	Nathan Rogers Professional Engineer Bowen Collins & Associates 154 E 14075 S Draper, UT 84020
BNZ	Benan N. Zahawi Professional Structural Engineer Stantec 2890 East Cottonwood Parkway, Suite 300 Salt Lake City, UT 84121
ALV	Audrey L. Voorhies Architect Stantec 410 17th Street, Suite 1400 Denver, CO 80202
SAS	Shivani A. Saptarishy Professional Engineer Stantec 100-401 Wellington Street West Toronto ON M5V 1E7
KES	Keith E. Smith Professional Engineer Stantec 11311 Aurora Avenue Des Moines, IA 50322
BH	Barbara Herrera Professional Engineer Stantec 410 17th Street, Suite 1400 Denver, CO 80202

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Magna Water District
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Madison Bertoch, Professional Engineer in the State of Utah, license number 11487985-2202, has prepared and/or was in direct charge of preparing the following technical specification sections for the above project. Their professional responsibility extends only to those specifications so identified, and accompanying engineering drawings bearing their stamp, signature and date.

Section		Title
00 00 30	MB	Notice Inviting Bids
00 21 13	MB	Instructions to Bidders
00 41 00	MB	Bid Forms
00 52 13	MB	Agreement
00 61 13	MB	Performance Bond
00 61 16	MB	Payment Bond
00 72 13	MB	General Conditions
00 73 13	MB	Supplementary General Conditions
01 10 00	MB	Summary of Work
01 14 00	MB	Construction Constraints
01 29 00	MB	Measurement and Payment
01 29 73	MB	Schedule of Values
01 32 16	MB	CPM Construction Schedule
01 33 00	MB	Submittal Procedures
01 35 53	MB	Site Security
01 42 13	MB	Abbreviations of Institutions
01 42 19	MB	Reference Standards
01 45 00	MB	Quality Control
01 50 10	MB	Protection of Existing Facilities
01 51 00	MB	Temporary Utilities
01 55 00	MB	Site Access and Storage
01 57 19	MB	Temporary Environmental Controls
01 58 13	MB	Temporary Project Sign
01 60 00	MB	Products, Materials, Equipment, and Substitutions
01 71 13	MB	Mobilization
01 75 00	MB	Equipment Testing and Plant Startup
01 77 00	MB	Project Closeout
01 79 00	MB	Owner Staff Training
01 93 00	MB	Maintenance
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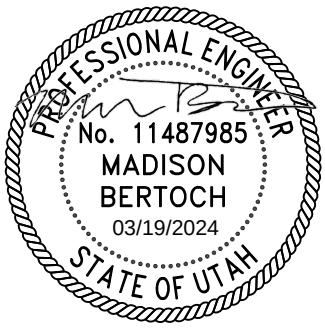
02 41 00	MB	Demolition
09 96 00	MB	High-Performance Coatings
40 05 01	MB	Piping General
40 05 02	MB	Piping Identification
40 05 06	MB	Couplings, Adapters, and Specials for Process Piping

40 05 07	MB	Hangers and Supports for Process Piping
40 05 19	MB	Ductile Iron Process Pipe
40 05 31.13	MB	Polyvinyl Chloride Process Pipe
40 05 51	MB	Common Requirements for Process Valves
40 05 57	MB	Actuators for Process Valves and Gates
40 05 62	MB	Plug Valves
40 05 63	MB	Ball Valves
40 05 65.10	MB	Check Valves
43 21 00	MB	Pumps, General
43 25 06	MB	Submersible Solids-Handling Pumps
43 30 52	MB	Miscellaneous Valves
46 10 00	MB	Equipment General Provisions



Madison Bertoch
License No. 11487985-2202

Magna Water District
Design Specifications for
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Nathan Rogers, Professional Engineer in the State of Utah, license number 11699772-2202, has prepared and/or was in direct charge of preparing the following technical specification sections for the above project. Their professional responsibility extends only to those specifications so identified, and accompanying engineering drawings bearing their stamp, signature and date.

Section		Title
01 74 20	NR	Gravity Piping Testing and Inspection
02 22 00	NR	Site Condition Surveys
31 10 00	NR	Site Preparation
31 30 00	NR	Earthwork
32 12 16	NR	A.C. Pavement and Base
33 05 07	NR	Polyvinyl Chloride (PVC) Pipe (AWWA C900 and C905, Modified)
33 13 00	NR	Water Pipeline Testing and Disinfection
40 05 58	NR	Sluice Gates

3/18/2024

Nathan Rogers
License No. 11699772-2202

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Magna Water District
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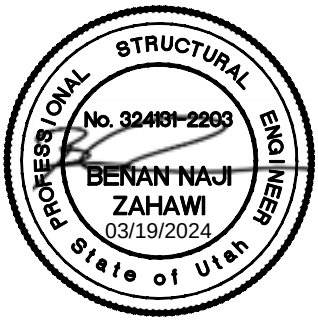
Benan N. Zahawi, Professional Structural Engineer in the State of Utah, license number 324131-2203, has prepared and/or was in direct charge of preparing the following technical specification sections for the above project. Their professional responsibility extends only to those specifications so identified, and accompanying engineering drawings bearing their stamp, signature and date.

Section		Title
01 33 17	BNZ	Structural Design, Support and Anchorage
03 01 30	BNZ	Concrete Repair and Rehabilitation
03 11 00	BNZ	Concrete Forming
03 21 00	BNZ	Reinforcement Steel
03 31 00	BNZ	Cast-in-Place Concrete
03 32 00	BNZ	Joints in Concrete
03 60 00	BNZ	Grouting
04 05 19.16	BNZ	Post-Installed Anchors in Masonry
04 22 00	BNZ	Reinforced Concrete Block Masonry
05 05 19	BNZ	Post-Installed Anchors in Concrete
05 50 00	BNZ	Miscellaneous Metalwork



Benan N. Zahawi
License No. 324131-2203

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Audrey L. Voorhies, Architect in the State of Utah, license number 13354832-0301, has prepared and/or was in direct charge of preparing the following technical specification sections for the above project. Their professional responsibility extends only to those specifications so identified, and accompanying engineering drawings bearing their stamp, signature and date.

Section		Title
04 21 15	ALV	Masonry Veneer
06 10 00	ALV	Rough Carpentry
07 11 00	ALV	Dampproofing
07 14 00	ALV	Fluid Applied Waterproofing
07 19 00	ALV	Water Repellents
07 21 13	ALV	Board Insulation
07 27 00	ALV	Air and Vapor Barrier
07 54 19	ALV	Single-Ply Membrane Roofing
07 60 00	ALV	Flashing and Sheet Metal
07 92 13	ALV	Elastomeric Joint Sealants
08 11 13	ALV	Hollow Metal Doors and Frames
08 23 00	ALV	Overhead Coiling Doors
08 51 13	ALV	Aluminum Windows
08 62 23	ALV	Tubular Daylighting Devices
08 71 00	ALV	Door Hardware
08 81 00	ALV	Glass Glazing
08 91 00	ALV	Louvers
10 14 00	ALV	Signage
10 44 00	ALV	Fire Protection Specialties

Audrey L. Voorhies
License No. 13354832-0301

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Magna Water District
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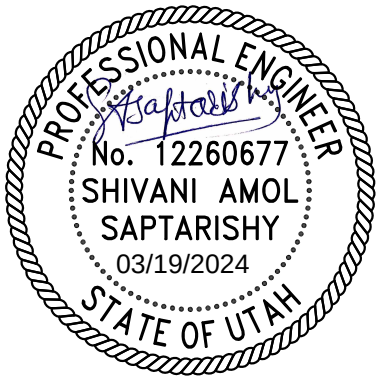
Shivani A. Saptarishy, Professional Engineer in the State of Utah, license number 12260677-2202, has prepared and/or was in direct charge of preparing the following technical specification sections for the above project. Their professional responsibility extends only to those specifications so identified, and accompanying engineering drawings bearing their stamp, signature and date.

Section		Title
22 10 00	SAS	Plumbing Piping
23 05 00	SAS	Common Work Results for HVAC
23 05 29	SAS	Hangers and Supports for HVAC Piping and Equipment
23 05 48	SAS	Vibration and Seismic Controls for HVAC
23 05 53	SAS	Identification for HVAC Piping and Equipment
23 05 93	SAS	Testing, Adjusting, and Balancing for HVAC
23 07 00	SAS	HVAC Insulation
23 08 00	SAS	Commissioning of HVAC
23 09 01	SAS	Instrumentation and Control for HVAC Systems (Standalone System)
23 23 00	SAS	Refrigeration Piping
23 31 13	SAS	Metal Ducts
23 34 00	SAS	HVAC Fans
23 55 00	SAS	Fuel-Fired Heaters
23 70 10	SAS	Air Conditioning Equipment



Shivani A. Saptarishy
License No. 12260677-2202

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Magna Water District
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Keith E. Smith, Professional Engineer in the State of Utah, license number 6677342-2202, has prepared and/or was in direct charge of preparing the following technical specification sections for the above project. Their professional responsibility extends only to those specifications so identified, and accompanying engineering drawings bearing their stamp, signature and date.

Section		Title
26 00 00	KES	Electrical Work, General
26 01 26	KES	Electrical Tests
26 05 10	KES	Electric Motors
26 05 15	KES	Industrial Control Panels
26 05 19	KES	Wire and Cabling
26 05 26	KES	Grounding
26 05 33	KES	Electrical Raceway Systems
26 05 36	KES	Wiring Devices
26 05 43	KES	Underground Raceway Systems
26 05 73	KES	Protective Device Studies
26 12 16	KES	Panelboards and General Purpose Dry Type Transformers
26 29 00	KES	Low-Voltage Motor Control Centers
26 29 23	KES	Variable Frequency Drive Units
26 41 23	KES	Lighting Protection Systems
26 43 00	KES	Surge Protection Devices (SPD)
26 50 00	KES	Lighting

Keith E. Smith
License No. 6677342-2202

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Magna Water District
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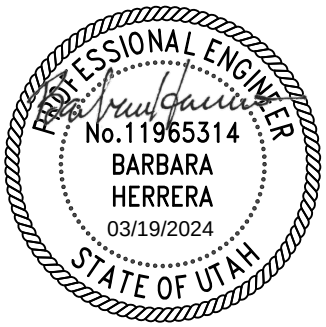
Barbara Herrera, Professional Engineer in the State of Utah, license number 11965314-2202, has prepared and/or was in direct charge of preparing the following technical specification sections for the above project. Their professional responsibility extends only to those specifications so identified, and accompanying engineering drawings bearing their stamp, signature and date.

Section		Title
40 90 10	BH	Control Strategies
40 91 00	BH	Process Control and Instrumentation Systems
40 91 02	BH	In-Line Liquid Flow Measuring
40 91 06	BH	Level Measuring
40 91 07	BH	Level Detection
40 91 08	BH	Pressure Measuring
40 92 00	BH	Control Panels
40 92 01	BH	Control Panel Instrumentation
40 95 10	BH	PLC Based Control System Hardware
40 95 20	BH	PLC Based Control System Software



Barbara Herrera
License No. 11965314-2202

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SECTION 00 00 30 - NOTICE INVITING BIDS

RECEIPT OF BIDS: Sealed Bids must be received no later than 2:00 PM, on May 23, 2024, for the Magna Water Reclamation Facility Influent Project. Any Bids received after the specified time and date will not be considered. Bids must be delivered as hard copies to the office of Magna Water District, 8885 W 3500 S, Magna, Utah.

OPENING OF BIDS: The Bids will be publicly opened and read at 2:00 PM on May 23, 2024, at the above-mentioned office of the Owner.

PREQUALIFICATION: Prequalification of Bidders is required. Due to the specialized nature of the construction, the experience and qualifications of Bidders will be evaluated by the Owner prior to the opening of Bids. Only those Bids submitted by Bidders determined by the Owner to be qualificed will be considered. Bids received from Bidders who are not prequalified will be returned.

COMPLETION OF WORK: The Work must be Substantially Complete within eighteen (18) months of Notice to Proceed and Final Completion to occur within 60 days thereafter.

DESCRIPTION OF WORK: The Work for the Magna Water Reclamation Facility Influent Design Project will generally include the following elements: new grit washing building with grit washing and electrical rooms, new influent screw pump station, expansion of existing intermediate pump station, replacement of existing grit pumps and chamber equipment, installation of Owner pre-procured equipment (screw pumps and grit washing equipment), piping, utilities, civil site improvements, and electrical, instrumentation and control work.

SITE OF WORK: The site of the Work is located 7650 W 2100 S, Magna, Utah, 84044.

OBTAINING CONTRACT DOCUMENTS: The Contract Documents are available at the Magna Water District website (magnawater.com/procurement-projects).

All questions regarding the Contract Documents shall be emailed to the District's Engineer, Trevor Andra (Trevor@magnawater.com) or the Project Engineer, Madison Bertoch (madison.bertoch@stantec.com).

BID SECURITY: Each Bid shall be accompanied by a certified or cashier's check or Bid Bond in the amount of five (5) percent of the Total Bid Price payable to Magna Water District as a guarantee that the Bidder, if its Bid is accepted, will promptly execute the Agreement. A bid shall not be considered unless one of the forms of Bidder's security is enclosed with it.

BIDS TO REMAIN OPEN: The Bidder shall guarantee the Total Bid Price for a period of 60 calendar days from the date of bid opening.

PRE-BID CONFERENCE AND VISIT TO SITE: Prospective bidders are required to attend a mandatory pre-bid conference and Site visit that will begin at **10:00 AM** on **April 17, 2024**, at the Magna Water Reclamation Facility, 7650 W 2100 S, Magna, Utah. The purposes of the pre-bid conference and site visit are to discuss the scope of the project and bidding requirements and to acquaint bidders with site conditions. Detailed technical questions may be submitted in writing but they will be answered, if warranted, by addenda later. Oral statements may not be relied upon and will not be binding or legally effective.

PROCUREMENT CONTRACT TO BE ASSIGNED: Owner has executed procurement contracts with Lakeside Equipment Corporation and Smith & Loveless, Inc. for the procurement of goods and special services for supply of influent screw pumps and grit equipment, respectively. The

materials and equipment to be provided through the procurement contract are to be furnished and delivered to the site for installation by the Contractor. Owner will accept the assignment and will be responsible to the Owner for the performance of obligations by the manufacturers, which will become a subcontractor or supplier to the Contractor. See Section 00 73 13 for more details.

Bidders may examine the contract documents for the procurement of goods and special services for the Magna WRF Influent Pre-Procurement Project at Magna Water District offices at 8885 West 3500 South, Magna, Utah.

OWNER'S RIGHTS RESERVED: The Owner reserves the right to reject any or all bids, to waive any informality in a bid, and to make awards to the lowest responsive, responsible bidder as it may best serve the interest of the Owner.

- END OF NOTICE INVITING BIDS -

SECTION 00 21 13 - INSTRUCTIONS TO BIDDERS

1. DEFINED TERMS. Terms used in these Instructions to Bidders and the Notice Inviting Bids which are defined in the General Conditions have the meanings assigned to them in the General Conditions. The term "Bidder" means one who submits a Bid directly to Owner, as distinct from a sub-bidder, who submits a price or quote to a Bidder.

2. LOCAL BUSINESS LICENSE. All Contractors, including Subcontractors, not already having a local business license for the Work contemplated, will be required to secure the appropriate license before a Contract can be executed.

3. INTERPRETATIONS AND ADDENDA.

3.1 All questions about the meaning or intent of the Contract Documents are to be directed to the Engineer. Additions, deletions, or revisions to the Contract Documents considered necessary by the Engineer in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by the Engineer or Owner as having received the Contract Documents. Questions received less than 14 days prior to the date of Bids may not be answered. Only answers to such questions issued by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

3.2 Addenda may also be issued to make other additions, deletions, or revisions to the Contract Documents.

3.3 Bidders shall make no special interpretation or inference of intent from differing formats in the Technical Specifications.

4. BIDDER'S EXAMINATION OF CONTRACT DOCUMENTS AND SITE.

4.1 It is the responsibility of each Bidder before submitting a Bid:

A. To examine thoroughly the Contract Documents and other related data identified in the Bidding Documents (including "technical" data referred to below);

B. To attend the mandatory Pre-Bid Conference and Site Visit. Failure to attend may be grounds for rejection of the Bid.

C. To visit the Site to become familiar with local conditions that may affect cost, progress, or performance, of the Work;

D. To consider federal, state, and local Laws and Regulations that may affect cost, progress, or performance of the Work;

E. To study and carefully correlate the Bidder's observations with the Contract Documents; and

F. To notify the Engineer of all conflicts, errors, ambiguities, or discrepancies in or between the Contract Documents and such other related data.

4.2 Reference is made to the Supplementary General Conditions for identification of:

A. Those reports of explorations and tests of subsurface conditions at the Site which have been utilized by the Engineer in the preparation of the Contract Documents.

B. Those drawings of physical conditions in or relating to existing surface and subsurface conditions (except Underground Utilities) which are at or contiguous to the Site have been utilized by the Engineer in the preparation of the Contract Documents.

C. The Engineer makes no representation as to the completeness of the reports or drawings referred to in Paragraphs 4.2A and 4.2B above or the accuracy of any data or information contained therein. The Bidder may rely upon the accuracy of the technical data contained in such reports and drawings. However, the Bidder may not rely upon any interpretation of such technical data, including any interpretation or extrapolation thereof, or any non-technical data, interpretations, and opinions contained therein.

4.3 Copies of reports and drawings referred to in Paragraph 4.2 will be made available by the Owner to any Bidder on request, if said reports and drawings are not bound herein. Those reports and drawings are not part of the Contract Documents, but the technical data contained therein upon which the Bidder is entitled to rely, as provided in Paragraph SGC-4.2 of the Supplementary General Conditions, are incorporated herein by reference.

4.4 Information and data reflected in the Contract Documents with respect to Underground Utilities at or contiguous to the Site are based upon information and data furnished to the Owner and the Engineer by the owners of such Underground Utilities or others, and the Owner does not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise in the Supplementary General Conditions or Section 01 50 10 - Protection of Existing Facilities.

4.5 Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders on subsurface conditions, Underground Utilities, and other physical conditions, and possible changes in the Contract Documents due to differing conditions appear in Paragraphs 4.2, 4.3, and 4.4 of the General Conditions.

4.6 Before submitting a Bid, each Bidder will, at Bidder's own expense, make or obtain any additional examinations, investigations, explorations, tests, and studies and obtain any additional information and data which pertain to the physical conditions (surface, subsurface, and Underground Utilities) at or contiguous to the Site or otherwise which may affect cost, progress, or performance of the Work and which the Bidder deems necessary to determine its Bid for performing the Work in accordance with the time, price, and other terms and conditions of the Contract Documents.

4.7 On request a minimum of 2 business days in advance, the Owner will provide each Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as each Bidder deems necessary for submission of a Bid. Location of any excavation or boring shall be subject to prior approval of Owner and applicable agencies. Bidder shall fill all holes, restore all pavement to match existing structural section, and shall clean up and restore the Site to its former condition upon completion of such explorations. Owner reserves the right to require Bidder to execute an Access Agreement with the Owner prior to accessing the Site.

4.8 The lands upon which the Work is to be performed, rights-of-way, and easements for access thereto and other lands designated for use by the Contractor in performing the Work are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities or storage of materials and equipment are to be provided by the Contractor. Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by the Owner unless otherwise provided in the Contract Documents.

4.9 The submission of a Bid will constitute an incontrovertible representation by the Bidder that the Bidder has complied with every requirement of this Paragraph 4 and the following:

A. That the Bid is premised upon performing the Work required by the Contract Documents without exception and such means, methods, techniques, sequences, or procedures of construction (if any) as may be required by the Contract Documents;

B. That Bidder has given the Engineer written notice of all conflicts, errors, ambiguities, and discrepancies in the Contract Documents and the written resolution thereof by the Engineer is acceptable to the Bidder; and

C. That the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance of the Work.

5. BID FORMS. The Bid shall be submitted on the Bid Forms bound herein and the pages shall not be removed from the bound volume. All blanks on the Bid Forms shall be completed in ink. All names must be printed below the signatures. The Bid shall be submitted in a sealed envelope which shall be plainly marked in the upper left hand corner with the name and address of the Bidder and shall bear the words "BID FOR" followed by the title of the Contract Documents for the Work, the name of the Owner, the address where Bids are to be delivered or mailed to, and the date and hour of opening of Bids.

5.1 Certain attachments to the Bid may be required.

6. BID CERTIFICATES

6.1 Bids by corporations must be executed in the corporate name by the president, a vice-president, or other corporate officer. Such Bid shall be accompanied by the enclosed Certificate of Authority to sign, attested by the secretary or assistant secretary, and with the corporate seal affixed. The corporate address and state of incorporation must appear below the signature.

6.2 Bids by partnerships must be executed in the partnership name and be signed by a managing partner, accompanied by the enclosed Certificate of Authority to sign, and his/her title must appear under the signature and the official address of the partnership must appear below the signature.

6.3 Bids by joint ventures must be executed in the joint venture name and be signed by a joint venture managing partner, accompanied by the enclosed Certificate of Authority to sign, and his/her title must appear under the signature and the official address of the joint venture must appear below the signature.

7. DISQUALIFICATION OF BIDDERS. More than one Bid from an individual, firm, partnership, corporation, or association under the same or different names will not be

considered. If the Owner believes that any Bidder is interested in more than one Bid for the Work contemplated, all Bids in which such Bidder is interested will be rejected. If the Owner believes that collusion exists among the Bidders, all Bids will be rejected. A party who has quoted prices to a Bidder is not hereby disqualified from quoting prices to other Bidders, or from submitting a Bid directly for the Work.

8. QUANTITIES OF WORK. The quantities of Work or material stated in Unit Price items of the Bid are supplied only to give an indication of the general scope of the Work; the Owner does not expressly or by implication agree that the actual amount of Work or material will correspond therewith, and reserves the right after award to increase or decrease the quantity of any Unit Price item of the Work by an amount up to and including 25 percent of any Bid item, without a change in the Unit Price, and shall include the right to delete any Bid item in its entirety, or to add additional Bid items up to and including an aggregate total amount not to exceed 25 percent of the Bid price.

9. SUBSTITUTE OR "OR EQUAL" ITEMS. Whenever materials or equipment are specified or described in the Contract Documents by using the name of a particular Manufacturer and the name is followed by the words "or equal", the Bidder may write the name of a substitute manufacturer (which the Bidder considers as an "or equal") in the List of Proposed Substitutions in the Bid Forms. These substitute Manufacturers will only be considered after award of the Contract. The procedure for the submittal of substitute or "or equal" products is specified in Section 01 60 00 - Products, Materials, Equipment, and Substitutions. The Bidder shall not be relieved of any obligations of the Contract Documents or be entitled to an adjustment in the Contract Price in the event any proposed substitute manufacturer is not subsequently approved.

11. SUBMISSION OF BIDS. The Bid shall be delivered by the time and to the place stipulated in the Notice Inviting Bids. It is the Bidder's sole responsibility to see that its Bid is received in proper time and at the proper place.

12. BID SECURITY, BONDS, AND INSURANCE. Each Bid shall be accompanied by a certified or cashier's check or approved Bid Bond in the amount stated in the Notice Inviting Bids. Said check or bond shall be made payable to the Owner and shall be given as a guarantee that the Bidder, if awarded the Work, will enter into an Agreement with the Owner, and will furnish the necessary insurance certificates, Payment Bond, and Performance Bond; each of said bonds to be in the amount stated in the Supplementary General Conditions. In case of refusal or failure to enter into said Agreement, the check or Bid Bond, as the case may be, shall be forfeited to the Owner. If the Bidder elects to furnish a Bid Bond as its Bid security, the Bidder shall use the Bid Bond form bound herein, or one conforming substantially to it in form. Bid Bonds shall comply with the requirements applicable to Payment and Performance Bonds in the General Conditions.

13. DISCREPANCIES IN BIDS. In the event there is more than one Bid item in a Bid Schedule, the Bidder shall furnish a price for all Bid items in the Schedule, and failure to do so will render the Bid non-responsive and shall cause its rejection. In the event there are Unit Price Bid items in a Bidding schedule and the amount indicated for a Unit Price Bid item does not equal the product of the Unit Price and quantity, the Unit Price shall govern and the amount will be corrected accordingly, and the Bidder shall be bound by said correction. In the event there is more than one Bid item in a Bid Schedule and the total indicated for the Schedule does not agree with the sum of the prices Bid on the individual items, the prices Bid on the individual items shall govern and the total for the Schedule will be corrected accordingly, and the Bidder shall be bound by said correction.

14. MODIFICATIONS AND UNAUTHORIZED ALTERNATIVE BIDS. Unauthorized conditions, limitations, or provisions attached to the Bid shall render it informal and may cause its rejection as being non-responsive. The Bid forms shall be completed without interlineations, alterations, or erasures in the printed text. Alternative Bids will not be considered unless called for. Oral, telegraphic, or telephonic Bids or modifications will not be considered.

15. WITHDRAWAL OF BID. The Bid may be withdrawn by the Bidder by means of a written request, signed by the Bidder or its properly authorized representative. Such written request must be delivered to the place stipulated in the Notice Inviting Bids for receipt of Bids prior to the scheduled closing time for receipt of Bids.

16. AWARD OF CONTRACT. Award of the contract, if awarded, will be made to the lowest responsive, responsible Bidder whose Bid complies with the requirements of the Contract Documents. Unless otherwise specified, any such award will be made within the period stated in the Notice Inviting Bids that the Bids are to remain open. Unless otherwise indicated, a single award will be made for all the Bid items in an individual Bid Schedule. In the event the Work is contained in more than one Bid Schedule, the Owner may award Schedules individually or in combination. In the case of two Bid Schedules which are alternative to each other, only one of such alternative schedules will be awarded.

17. RETURN OF BID SECURITY. Within 14 days after award of the Contract, the Owner will, if requested, return the Bid securities accompanying such Bids that are not being considered in making the award. All other Bid securities will be held until the Agreement has been finally executed. They will then be returned, if requested, to the respective Bidders whose Bids they accompany.

18. EXECUTION OF AGREEMENT. The Bidder to whom award is made shall execute a written Agreement with the Owner on the form of agreement provided, shall secure all insurance, and shall furnish all certificates and Bonds required by the Contract Documents within 14 calendar days after receipt of the Agreement forms from the Owner. Failure or refusal to enter into an Agreement as herein provided or to conform to any of the stipulated requirements in connection therewith shall be just cause for annulment of the award and forfeiture of the Bid security. If the lowest responsive, responsible Bidder refuses or fails to execute the Agreement, the Owner may award the Contract to the second lowest responsive, responsible Bidder. If the second lowest responsive, responsible Bidder refuses or fails to execute the Agreement, the Owner may award the Contract to the third lowest responsive, responsible Bidder. On the failure or refusal of such second or third lowest Bidder to execute the Agreement, each such Bidder's Bid securities shall be likewise forfeited to the Owner.

19. LIQUIDATED DAMAGES. Provisions for liquidated damages, if any, are set forth in the Agreement.

- END OF INSTRUCTIONS TO BIDDERS –

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SECTION 00 41 00 - BID FORMS

BID TO: MAGNA WATER DISTRICT

1. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with the Owner in the form included in the Contract Documents to perform the Work as specified or indicated in said Contract Documents entitled MAGNA WATER RECLAMATION FACILITY INFLUENT DESIGN PROJECT.

2. Bidder accepts all of the terms and conditions of the Contract Documents, including without limitation those in the Notice Inviting Bids and Instructions to Bidders, dealing with the disposition of the Bid security.

3. This Bid will remain open for the period stated in the "Notice Inviting Bids" unless otherwise required by law. Bidder will enter into an Agreement within the time and in the manner required in the "Notice Inviting Bids" and the "Instructions to Bidders", and will furnish the insurance certificates, Payment Bond, and Performance Bond required by the Contract Documents.

4. Bidder has examined copies of all the Contract Documents including the following addenda (receipt of all of which is hereby acknowledged):

Number	Date
_____	_____
_____	_____
_____	_____
_____	_____

Failure to acknowledge Addenda shall render the Bid non-responsive and shall be cause for its rejection.

5. Bidder has familiarized itself with the nature and extent of the Contract Documents, Work, Site, locality where the Work is to be performed, the legal requirements (federal, state and local laws, ordinances, rules, and regulations), and the conditions affecting cost, progress or performance of the Work and has made such independent investigations as Bidder deems necessary.

To all the foregoing, and including all Bid Forms contained in this Bid, said Bidder further agrees to complete the Work required under the Contract Documents within the Contract Time stipulated in said Contract Documents, and to accept in full payment therefor the Contract Price based on the Total Bid Price(s) named in the aforementioned Bid Forms.

Dated: _____ Bidder: _____

By: _____
(Signature)

Title: _____

BID CERTIFICATE
(if Corporation)

STATE OF)
) SS:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Board of Directors of the _____

_____

_____

a corporation existing under the laws of the State of _____, held on _____, 20____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as

_____ President of this Corporation, be and is hereby authorized to execute the Bid dated _____, 20___, to the MAGNA WATER DISTRICT by this Corporation and that his/her execution thereof, attested by the Secretary of this Corporation, and with the Corporate Seal affixed, shall be the official act and deed of this Corporation."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the corporation this _____, day of _____, 20____.

_____
Secretary

(SEAL)

BID CERTIFICATE
(if Partnership)

STATE OF)
) SS:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Partners of the _____

_____

_____

a partnership existing under the laws of the State of _____, held on _____, 20_____, the following resolution was duly passed and adopted:

> "RESOLVED, that _____, as General Partner of the Partnership, be and is hereby authorized to execute the Bid dated _____, 20_____, to the MAGNA WATER DISTRICT by this Partnership and that his/her execution thereof, attested by the General Partner shall be the official act and deed of this Partnership."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____, day of _____, 20_____.

_____
General Partner

(SEAL)

BID CERTIFICATE
(if Joint Venture)

STATE OF)
) SS:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Principals of the _____

_____

_____

a joint venture existing under the laws of the State of _____, held on

_____, 20_____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ of the Joint Venture, be and is hereby authorized to execute the Bid dated _____, 20_____, to the MAGNA WATER DISTRICT by this Joint Venture and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Joint Venture."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____, day of _____, 20_____.

_____
Managing Partner

(SEAL)

BID SCHEDULE - LUMP SUM

Schedule of prices for construction of Magna Water Reclamation Facility Influent Design Project in accordance with the Contract Documents.

Item	Description

1. Bid Prices: Bidder shall complete the Work in accordance with the Contract Documents for the Lump Sum Prices indicated below:

   a. Installation of Pre-Procured Equipment (screw pumps, grit washing equipment) $_____

   b. Site Work (grading, paving, landscaping, etc.) $_____

   c. Earthwork (excavation and fill for new structures) $_____

   d. Concrete (structures, flatwork, forming, materials, etc.) $_____

   e. Mechanical (fittings, valves, pipes, equipment install, etc.) $_____

   f. Electrical and I&C (panel, conduit, wire, terminations, etc.) $_____

   g. Allowance Items (Section 01 95 00) $ 400,000

   h. Other (mobilization, bonds/insurance, OH&P) $_____

   Base Bid - Total Lump Sum (Sum items of a through h) $_____

   _____
   (Base Bid Amount in Words)

   i. Bid Alternate A – Replacement of Existing Intermediate Pumps (Section 01 95 10)

   $_____

   Total Lump Sum Bid (Base Bid plus item i) $_____

   _____
   (Total Lump Sum Bid Amount in Words)

LIST OF SUBCONTRACTORS

The Bidder shall list below the name and the location of the place of business of each Subcontractor who will perform Work or labor or render service to the prime contractor in or about the construction of the Work or improvement, or a Subcontractor who, under subcontract to the prime contractor, specially fabricates and installs a portion of the Work or improvement according to detailed drawings contained in the plans and specifications, in an amount in excess of one-half of 1 percent of the prime contractor's total Bid or, in the case of Bids or offers for the construction of streets or highways, including bridges, in excess of one-half of 1 percent of the prime contractor's total Bid or ten thousand dollars ($10,000), whichever is greater. The Bidder shall also list below the portion of the Work which will be performed by each Subcontractor under its contract. The prime contractor shall list only one Subcontractor for each portion as is defined by the prime contractor in its Bid. The Bidder's attention is directed to the provisions of Paragraph entitled "Subcontract Limitations," of the Supplementary General Conditions which stipulates the percent of the Work to be performed with the Bidder's own forces. Failure to comply with this requirement will render the Bid non-responsive and may cause its rejection.

Work to be Performed	Subcontr. License Number	Percent of Total Bid	Subcontractor's Name & Address
1.			
2.			
3.			
4.			
5.			

Note: Attach additional sheets if required.

LIST OF NAMED EQUIPMENT/MATERIAL MANUFACTURERS

The Bidder shall indicate below which Manufacturer the Bidder intends to use for each item of equipment or material listed on this form by writing in one of the named Manufacturers specified in the Technical Specifications for that equipment or material. (Proposed substitutes may be listed on the List of Proposed Substitutions but will only be considered after award of the Contract.) If no Manufacturer is named in the Technical Specifications, the Bidder may list any Manufacturer whose product meets all of the requirements and technical criteria specified. The listing of more than one Manufacturer for each item of equipment/material to be furnished with the words "and/or" will not be permitted. Failure to comply with this requirement may render the Bid non-responsive and may cause its rejection.

Specification Section	Equipment/Material	Named Manufacturer (List Only One)

LIST OF PROPOSED SUBSTITUTIONS

The Bidder proposes the following substitute or "or equal" products identified below:

Specification Section	Substitute Equipment or Material	Substitute Manufacturer (List Only One For Each Equipment or Material)

Note: Substitute products will only be considered after award of the Contract. The procedure for the submittal of substitute or "or equal" products is specified in the General Requirements.

INFORMATION REQUIRED OF BIDDER

The Bidder shall furnish the following information. Additional sheets shall be attached as required. Failure to complete Item Nos. 1, 3 and 4, will cause the Bid to be non-responsive and may cause its rejection. In any event, no award will be made until all of the Bidder's General Information is delivered to the Owner.

1. Contractor's name and address:

   _____

   _____

   _____

2. Contractor's telephone number: _____

   Contractor's fax number: _____

3. Contractor's license: Primary classification _____

   State License No. and Expiration Date _____

   Specialty classifications held, if any: _____

   Name of Licensee, if different from (1) above: _____

   _____

   _____

4. Name, address, and telephone number of surety company and agent who will provide the required Bonds on this contract:

   _____

   _____

   _____

NONCOLLUSION AFFIDAVIT TO BE EXECUTED BY BIDDER AND SUBMITTED WITH BID

STATE OF)
) ss.
COUNTY OF _____)

_____, being first duly sworn, deposes and says that he or she is _____ of _____ the party making the foregoing Bid that the Bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the Bid is genuine and not collusive or sham; that the Bidder has not directly or indirectly induced or solicited any other Bidder to put in a false or sham Bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any Bidder or anyone else to put in a sham Bid, or that anyone shall refrain from Bidding; that the Bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the Bid price of the Bidder or any other Bidder, or to fix any overhead, profit, or cost element of the Bid price, or of that of any other Bidder, or to secure any advantage against the public body awarding the Contract or anyone interested in the proposed Contract; that all statements contained in the Bid are true; and further, that the Bidder has not, directly or indirectly, submitted his or her Bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham Bid.

Signed: _____

Subscribed and sworn to before me

this _____day of_____ , 20__

_____
Notary Public in and for the

County of _____

State of _____

(SEAL)

BID BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____ as Principal, and _____ as Surety, are held and firmly bound unto Magna Water District, hereinafter called "Owner," in the sum of dollars,

for the payment of which sum, well and truly to be made, we jointly and severally bind ourselves, our heirs, executors, administrators, successors, and assigns firmly by these presents.

WHEREAS, said Principal has submitted a Bid to said Owner to perform the Work required under the Bidding schedule(s) of the Owner's Contract Documents entitled Magna Water Reclamation Facility Influent Design Project.

NOW THEREFORE, if said Principal is awarded a contract by said Owner and, within the time and in the manner required in the "Notice Inviting Bids" and the "Instructions to Bidders" enters into a written Agreement on the form of Agreement bound with said Contract Documents, furnishes the required certificates of insurance, and furnishes the required Performance Bond and Payment Bond, and performs in all other respects the agreement created by this Bid, then this obligation shall be null and void, otherwise it shall remain in full force and effect. The Surety stipulates and agrees that the obligation of said Surety shall in no way be impaired or affected by an extension of the time within which the Owner may accept such Bid and Surety further waives notice of any such extension. In the event suit is brought upon this Bond by said Owner and Owner prevails, said Principal and Surety shall pay all costs incurred by said Owner in such suit, including reasonable attorney's fees and costs to be fixed by the court.

SIGNED AND SEALED, this day of _____, 20____

_____(SEAL) _____(SEAL)
(Principal) (Surety)

By: _____ By: _____
(Signature) (Signature)

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

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SECTION 00 52 13 - AGREEMENT

THIS AGREEMENT is dated as of the _____ day of _____ in the year 20___

by and between Magna Water District (hereinafter called Owner) and

_____

(hereinafter called Contractor).

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

ARTICLE 1. WORK.

Contractor shall complete the Work as specified or indicated in the Owner's Contract Documents entitled Magna Water Reclamation Facility Influent Design Project.

The Work is generally described in Section 01 10 00 – Summary of Work.

ARTICLE 2. CONTRACT TIMES.

The Work shall be Substantially Complete within 18 months from the commencement date stated in the Notice to Proceed. Substantially Complete is defined as certificates of proper installation, training, and start-up completed for the mechanical equipment and all electrical, I&C and SCADA required for operational system. Final completion shall occur within 60 days after approved Substantial Completion.

ARTICLE 3. LIQUIDATED DAMAGES.

Owner and the Contractor recognize that time is of the essence of this Agreement and that the Owner will suffer financial loss if the Work is not completed within the time specified in Article 2 herein, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense, and difficulties involved in proving in a legal proceeding the actual loss suffered by the Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, the Owner and the Contractor agree that as liquidated damages for delay (but not as a penalty) the Contractor shall pay the Owner $500 for each day that expires after the time specified in Article 2 herein.

ARTICLE 4. CONTRACT PRICE.

Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents in current funds the amount set forth in the Bid Schedule(s).

ARTICLE 5. PAYMENT PROCEDURES.

Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

ARTICLE 6. CONTRACT DOCUMENTS.

The Contract Documents which comprise the entire agreement between Owner and Contractor concerning the Work consist of this Agreement and the following attachments to this Agreement:

Notice Inviting Bids (Section 00 00 30).

Instructions to Bidders (Section 00 21 13).

Bid Forms including the Bid, Bid Schedule(s), Information Required of Bidder, Bid Bond, and all required certificates and affidavits (Section 00 41 00).

Performance Bond (Section 00 61 13).

Payment Bond (Section 00 61 16).

General Conditions (Section 00 72 13).

Supplementary General Conditions (Section 00 73 13).

Technical Specifications, as listed in the Table of Contents.

Drawings, as listed in the Sheet Index.

Addenda numbers _____ to _____, inclusive.

Change Orders which may be delivered or issued after Effective Date of the Agreement and are not attached hereto.

There are no Contract Documents other than those listed in this Article 6. The Contract Documents may only be amended by Change Order as provided in Paragraph 3.5 of the General Conditions.

ARTICLE 7. ASSIGNMENT

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

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 of all covenants, agreements and obligations contained in the Contract Documents.

IN WITNESS WHEREOF, Owner and Contractor have caused this Agreement to be executed the day and year first above written.

Owner _____	Contractor _____
_____	_____
By _____	By _____
	[CORPORATE SEAL]
Attest _____	Attest _____
Address for giving notices	Address for giving notices
_____	_____
	License No. _____
Approved as to Form:	
_____	Agent for service of process: _____
(Signature)	
_____	_____
(Title)	

AGREEMENT CERTIFICATE
(if Corporation)

STATE OF)
) SS:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Board of Directors of the _____

_____

_____
a corporation existing under the laws of the State of _____, held on _____, 20____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ President of the Corporation, be and is hereby authorized to execute the Agreement dated _____, 20___, by and between this Corporation and Magna Water District and that his/her execution thereof, attested by the Secretary of the Corporation, and with the Corporate Seal affixed, shall be the official act and deed of this Corporation."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the corporation this _____, day of _____, 20____.

_____
Secretary

(SEAL)

AGREEMENT CERTIFICATE
(if Partnership)

STATE OF)
) SS:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Partners of the _____

_____

_____
a partnership existing under the laws of the State of _____, held on _____, 20_____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ of the Partnership, be and is hereby authorized to execute the Agreement dated _____, 20_____, by and between this Partnership and Magna Water District and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Partnership."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____, day of _____, 20_____.

_____
Partner

(SEAL)

AGREEMENT CERTIFICATE
(if Joint Venture)

STATE OF)
) SS:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Principals of the _____

_____

_____

a joint venture existing under the laws of the State of _____, held on

_____, 20_____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ of the Joint Venture, be and is hereby authorized to execute the Agreement dated _____, 20_____, by and between this Joint Venture and Magna Water District and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Joint Venture."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____, day of _____, 20_____.

_____
Managing Partner

(SEAL)

- END OF AGREEMENT -

SECTION 00 61 13 - PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____ as Contractor,

and _____ as Surety,

are held and firmly bound unto Magna Water District hereinafter called "Owner," in the sum of

_____ dollars,

for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that said Contractor has been awarded and is about to enter into the annexed Agreement with said Owner to perform the Work as specified or indicated in the Contract Documents entitled Magna Water Reclamation Facility Influent Design Project.

NOW THEREFORE, if said Contractor shall perform all the requirements of said Contract Documents required to be performed on its part, at the times and in the manner specified therein, then this obligation shall be null and void, otherwise it shall remain in full force and effect.

PROVIDED, that any alterations in the Work to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of said Contract Documents, shall not in any way release said Contractor or said Surety hereunder, nor shall any extensions of time granted under the provisions of said Contract Documents, release either said Contractor or said Surety, and notice of such alterations or extensions of the Agreement is hereby waived by said Surety.

IN WITNESS WHEREOF, we have hereunder set our hands this_____day of_____, 20_____.

(SEAL)	(SEAL)
_____	_____
(Contractor)	(Surety)
By: _____	By:_____
(Signature and SEAL)	(Signature and SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

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SECTION 00 61 16 - PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS,

That _____ as Contractor,

and _____ as Surety,

are held and firmly bound unto Magna Water District hereinafter called "Owner," in the sum of

_____ dollars,

for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION ARE SUCH, that said Contractor has been awarded and is about to enter into the annexed Agreement with said Owner to perform the Work as specified or indicated in the Contract Documents entitled Magna Water Reclamation Facility Influent Design Project.

NOW THEREFORE, if said Contractor, or Subcontractor, fails to pay for any materials, equipment, or other supplies, or for rental of same, used in connection with the performance of Work contracted to be done, or for amounts due under applicable State law for any Work or labor thereon, said Surety will pay for the same in an amount not exceeding the sum specified above, and, in the event suit is brought upon this Bond, reasonable attorney's fees to be fixed by the court. This Bond shall inure to the benefit of any persons, companies, or corporations entitled to file claims under applicable State law so as to give a right of action to them or their assigns in any suit brought upon this Bond.

PROVIDED, that any alterations in the Work to be done or the materials to be furnished, or changes in the time of completion, which may be made pursuant to the terms of said Contract Documents, shall not in any way release said Contractor or said Surety thereunder, nor shall any extensions of time granted under the provisions of said Contract Documents release either said Contractor or said Surety, and notice of such alterations or extensions of the Agreement is hereby waived by said Surety.

IN WITNESS WHEREOF, we have hereunto set our hands and seals this _____ day of_____, 20_____.

_____	_____
(Contractor)	(Surety)
By: _____	By:_____
(Signature and SEAL)	(Signature and SEAL)

(SEAL AND NOTARIAL ACKNOWLEDGEMENT OF SURETY)

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SECTION 00 72 13 - GENERAL CONDITIONS

TABLE OF CONTENTS

ARTICLE 1 -- DEFINITIONS

Wherever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated in this Article 1 which meanings are applicable to both the singular and plural thereof. If a word which is entirely in upper case in these definitions is found in lower case in the Contract Documents, then the lower case word will have its ordinary meaning.

Addenda - Written or graphic instruments issued prior to the opening of Bids which make additions, deletions, or revisions to the Contract Documents.

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

Application for Payment - The form accepted by the Engineer which is to be used by the Contractor to request progress payments or final payment and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

Asbestos - Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

Base Bid – The offer or proposal of the Bidder submitted on the prescribed form setting forth the price or prices for the Work, excluding any amounts proposed for additive or deductive items called out in the Bid Schedule.

Bid - The offer or proposal of the Bidder submitted on the prescribed form setting forth the price or prices for the Work.

Bonds - Bid, Performance, and Payment Bonds and other instruments of security.

Change Order - A document recommended by the Engineer, which is signed by the Contractor and the Owner, and authorizes an addition, deletion, or revision in the Work, or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

Clarification - A document issued by the Engineer to the Contractor that interprets the requirement(s) and/or design intent of the Contract Documents, which may not represent an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times.

Contract - Depending on the context, (a) the Agreement, or (b) respectively, the Contract Documents which establish the respective obligations of the Owner and the Contractor.

Contract Documents - The Notice Inviting Bids, Instructions to Bidders, Bid Forms (including the Bid, Bid Schedule(s), Information Required of Bidder, Bid Bond, and all required certificates, affidavits and other documentation), Agreement, Performance Bond, Payment Bond, General Conditions, Supplementary General Conditions, Technical Specifications, Drawings, all Addenda, and Change Orders executed pursuant to the provisions of the Contract Documents. Shop Drawings are not Contract Documents.

Contract Price - The total monies payable by the Owner to the Contractor under the terms and conditions of the Contract Documents.

Contract Times - The number or numbers of successive Days or dates stated in the Contract Documents for the completion of the Work.

Contractor - The individual, partnership, corporation, joint-venture, or other legal entity with whom the Owner has executed the Agreement.

Day - A calendar day of 24 hours measured from midnight to the next midnight.

Defective Work - Work that is unsatisfactory, faulty, or deficient; or that does not conform to the Contract Documents; or that does not meet the requirements of any inspection, reference standard, test, or approval referred to in the Contract Documents; or Work that has been damaged prior to the Engineer's recommendation of final payment.

Drawings - The drawings, plans, maps, profiles, diagrams, and other graphic representations which indicate the character, location, nature, extent, and scope of the Work and which have been prepared by the Engineer and are included and/or referred to in the Contract Documents. Shop Drawings are not Drawings as so defined.

Effective Date of the Agreement - The date indicated in the Agreement on which it becomes effective, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the 2 parties to sign and deliver.

Engineer - The individual, partnership, corporation, joint-venture, or other legal entity named as such by the Owner as set forth in the Supplementary General Conditions.

Field Order - A written order issued by the Engineer which may or may not involve a change in the Work.

General Requirements - Division 1 of the Technical Specifications.

Hazardous Material - The term “Hazardous Material” as used herein shall mean any flammable materials, explosives, petroleum products, hazardous wastes, toxic substances, or related materials, including without limitation, asbestos, asbestos-containing materials, polychlorinated biphenyl (PCB), PCB-containing materials, and any substances defined as or included in the definition of “hazardous substances”, “hazardous wastes”, “hazardous materials”, or “toxic substances”, under any applicable federal, state, or local laws or regulations, now in effect or enacted prior to Substantial Completion of the Project.

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

Lien or Mechanic's Lien - A form of security, an interest in real property, which is held to secure the payment of an obligation. When related to public works construction, Lien or Mechanic's Lien may be called Stop Notice.

Milestone - A principal event specified in the Contract Documents relating to an intermediate completion date of a separately identifiable part of the Work or a period of time within which the separately identifiable part of the Work should be performed prior to Substantial Completion of all the Work.

Notice of Award - The written notice by the Owner to the apparent successful Bidder stating that upon compliance by the apparent successful Bidder with the conditions precedent enumerated therein within the time specified, the Owner will enter into an Agreement.

Notice of Completion - A form signed by the Engineer and the Contractor recommending to the Owner that the Work is Substantially Complete and fixing the date of Substantial Completion. After acceptance of the Work by the Owner's governing body, the form is signed by the Owner and filed with the County Recorder. This filing starts the 30 Day Lien filing period on the Work.

Notice to Proceed - The written notice issued by the Owner to the Contractor authorizing the Contractor to proceed with the Work and establishing the date of commencement of the Contract Times.

Owner - The public body or authority, corporation, association, firm, or person with whom the Contractor has entered into the Agreement and for whom the Work is to be provided.

Partial Utilization - Use by the Owner of a substantially completed part of the Work for the purpose for which it is intended prior to Substantial Completion of all the Work.

PCBs - Polychlorinated biphenyls.

Petroleum - Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline, kerosene, and oil mixed with other non-Hazardous Materials and crude oils.

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

Radioactive Material - Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 USC Section 2011 et seq.) as amended from time to time.

Resident Project Representative - The authorized representative of the Engineer who is assigned to the Site or any part thereof.

Samples - Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

Shop Drawings - All drawings, diagrams, illustrations, schedules, and other data which are specifically prepared by or for the Contractor and submitted by the Contractor to illustrate some portion of Work.

Site - Lands or other areas designated in the Contract Documents as being furnished by the Owner for the performance of the construction, storage, or access.

Specifications - (Same definition as for Technical Specifications hereinafter).

Stop Notice - A legal remedy for subcontractors and suppliers who contribute to public works, but who are not paid for their work, which secures payment from construction funds possessed by the Owner.

Subcontractor - An individual, partnership, corporation, joint-venture, or other legal entity having a direct contract with the Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

Substantial Completion - The time at which the Work (or specified part thereof) has progressed to the point where it is sufficiently complete, in accordance with the Contract Documents so that the Work (or specified part) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to any Work refer to Substantial Completion thereof.

Supplementary General Conditions - The part of the Contract Documents which make additions, deletions, or revisions to these General Conditions.

Supplier - A manufacturer, fabricator, distributor, materialman, or vendor having a direct contract with the Contractor or with any Subcontractor to furnish materials, equipment, or product to be incorporated in the Work by the Contractor or any Subcontractor.

Technical Specifications - Divisions 1 through 43 of the Contract Documents consisting of the General Requirements and written technical descriptions of products and execution of the Work.

Total Bid Price – The offer or proposal of the Bidder submitted on the prescribed form setting forth the price or prices for the Work including the Base Bid and any amounts proposed for additive or deductive items called out in the Bid Schedule.

Utilities - All pipelines, conduits, ducts, cables, wires, tracks, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities which have been installed underground or above the ground to furnish any of the following services or materials: water, sewage, sludge, drainage, fluids, electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, traffic control, or other control systems. Utilities as used herein do not include any facilities that Contractor is to install pursuant to the Contract Documents.

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

ARTICLE 2 -- PRELIMINARY MATTERS

2.1 DELIVERY OF BONDS AND INSURANCE CERTIFICATES

A. When the Contractor delivers the signed Agreement to the Owner, the Contractor shall also deliver to the Owner such Bonds and insurance policies and certificates as the Contractor may be required to furnish in accordance with the Contract Documents.

2.2 COPIES OF DOCUMENTS

A. The Owner will furnish to the Contractor the required number of copies of the Contract Documents specified in the Supplementary General Conditions.

2.3 COMMENCEMENT OF CONTRACT TIMES; NOTICE TO PROCEED

A. The Contract Times will start to run on the commencement date stated in the Notice to Proceed.

2.4 STARTING THE WORK

A. The Contractor shall begin to perform the Work on the commencement date stated in the Notice to Proceed, but no Work shall be done at the Site prior to said commencement date.

B. Before undertaking each part of the Work, the Contractor shall review the Contract Documents in accordance with Paragraph 3.3.

2.5 PRECONSTRUCTION CONFERENCE

A. The Contractor is required to attend a preconstruction conference. This conference will be attended by the Owner, Engineer, and others as appropriate in order to discuss the Work in accordance with the applicable procedures specified in Section 01 10 00 - Summary of Work.

B. The Contractor shall provide its initial schedule submittals no fewer than 3 Days prior to the preconstruction conference. The Contractor's initial schedule submittals for Shop Drawings, obtaining permits, and Plan of Operation and CPM Schedule will be reviewed and finalized. As a minimum, the Contractor's representatives should include its project manager and schedule expert. The Contractor should plan on this meeting taking no less than 8 hours. If the submittals are not finalized at the end of the meeting, additional meetings will be held so that the submittals can be finalized prior to the submittal of the first Application for Payment. No Application for Payment will be processed prior to receiving acceptable initial submittals from the Contractor.

ARTICLE 3 -- INTENT AND USE OF CONTRACT DOCUMENTS

3.1 INTENT

A. The Contract Documents comprise the entire agreement between the Owner and the Contractor concerning the Work. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of the State in which the Project is located.

B. It is the intent of the Contract Documents to describe the Work, functionally complete, to be constructed in accordance with the Contract Documents. Contractor shall provide any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result whether or not called for specifically.

C. When words or phrases which have a well-known technical or construction industry or trade meaning are used to describe Work, materials, or equipment, such words or phrases shall be interpreted in accordance with that meaning unless a definition has been provided in Article 1 of the General Conditions.

3.2 REFERENCE TO STANDARDS

A. Reference to standard specifications, manuals, or codes of any technical society, organization, or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual or code shall be effective to change the duties and responsibilities of the Owner, the Contractor, the Engineer, or any of their consultants, agents, or employees, from those set forth in the Contract Documents, nor shall it be effective to assign to Owner, Engineer, or any of Engineer's consultants, agents, or employees any duty or authority to direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.3 REVIEW OF CONTRACT DOCUMENTS

A. If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any such Law or Regulation applicable to the performance of the Work or of any such standard, specification, manual, or code, or of any instruction of any Supplier, Contractor shall report it to Engineer in writing at once, and Contractor shall not proceed with the Work affected thereby (except in an emergency as authorized by Paragraph 6.12) until a Clarification, Field Order, or Change Order to the Contract Documents has been issued.

3.4 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

A. In resolving conflicts resulting from errors or discrepancies in any of the Contract Documents, the order of precedence shall be as follows:

1. Permits from other agencies as may be required by Law or Regulations
2. Change Orders
3. Agreement
4. Addenda
5. Contractor's Bid (Bid Form)
6. Supplementary General Conditions
7. Notice Inviting Bids
8. Instructions to Bidders
9. General Conditions
10. Technical Specifications
11. Referenced Standard Specifications
12. Drawings

B. With reference to the Drawings the order of precedence is as follows:

1. Figures govern over scaled dimensions
2. Detail drawings govern over general drawings
3. Addenda/Change Order drawings govern over any other drawings
4. Drawings govern over standard drawings

3.5 AMENDING CONTRACT DOCUMENTS

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by a Change Order issued in accordance with Article 10.

3.6 REUSE OF DOCUMENTS

A. Neither the Contractor, nor any Subcontractor or Supplier, nor any other person or organization performing any of the Work under a contract with the Owner shall have or acquire any title to or ownership rights in any of the Drawings, Technical Specifications, or other documents used on the Work, and they shall not reuse any of them on the extensions of the Project or any other project without written consent of Owner.

ARTICLE 4 -- SITE OF THE Work

4.1 AVAILABILITY OF LANDS

A. The Owner will furnish, as indicated in the Contract Documents, the lands upon which the Work is to be performed, rights-of-way and easements for access thereto, and such other lands which are designated for the use of the Contractor. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by the Owner, unless otherwise provided in the Contract Documents. Nothing contained in the Contract Documents shall be interpreted as giving the Contractor exclusive occupancy of the lands or rights-of-way provided. The Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment; provided, that the Contractor shall not enter upon nor use any property not under the control of the Owner until a written temporary construction easement agreement has been executed by the Contractor and the property owner, and a copy of said easement furnished to the Engineer prior to said use; and said easement shall expressly provide that neither the Owner nor the Engineer will be liable for any claims or damages resulting from the Contractor's trespass on or use of any such properties. The Contractor shall provide the Owner with a signed release from the property owner confirming that the lands have been satisfactorily restored upon completion of the Work.

4.2 REPORTS OF PHYSICAL CONDITIONS

A. **Subsurface Explorations:** Reference is made to the Supplementary General Conditions for identification of those reports of explorations and tests of subsurface conditions at the Site that have been utilized by the Engineer in the preparation of the Contract Documents.

B. **Existing Structures:** Reference is made to the Supplementary General Conditions for identification of those drawings of physical conditions in or relating to existing surface and subsurface structures (except underground Utilities referred to in Paragraph 4.3 herein) which are at or contiguous to the Site that have been utilized in the preparation of the Contract Documents.

C. Neither the Owner nor Engineer makes any representation as to the completeness of the reports or drawings referred to in Paragraph 4.2 A or B above or the accuracy of any data or information contained therein. The Contractor may rely upon the accuracy of the technical data contained in such reports and drawings. However, the Contractor may not rely upon any interpretation of such technical data, including any interpolation or extrapolation thereof, or any non-technical data, interpretations, and opinions contained therein.

4.3 PHYSICAL CONDITIONS - UNDERGROUND UTILITIES

A. **Indicated:** The information and data indicated in the Contract Documents with respect to existing underground Utilities at or contiguous to the Site are based on information and data furnished to the Owner or the Engineer by the owners of such underground Utilities or by others. Unless it is expressly provided in the Supplementary General Conditions and/or Section 01 50 10 - Protection of Existing Facilities, the Owner and the Engineer will not be responsible for the accuracy or completeness of any such information or data, and the Contractor shall have full responsibility for reviewing and checking all such information and data, for locating all underground Utilities indicated in the Contract Documents, for coordination of the Work with the owners of such underground Utilities during construction, for the safety and protection thereof and repairing any damage thereto resulting from the Work, the cost of all of which are deemed to have been included in the Contract Price.

B. **Not Indicated:** If an underground Utility is uncovered or revealed at or contiguous to the Site which was not indicated in the Contract Documents and which the Contractor could not reasonably have been expected to be aware of, the Contractor shall identify the owner of such underground Utility and give written notice thereof to that owner and shall notify the Engineer in accordance with the requirements of the Supplementary General Conditions and Section 01 50 10 - Protection of Existing Facilities.

4.4 DIFFERING SITE CONDITIONS

A. The Contractor shall notify the Engineer, in writing, of the following unforeseen conditions, hereinafter called differing Site conditions, promptly upon their discovery (but in no event later than 2 Days after their discovery) and before they are disturbed:

1. Subsurface or latent physical conditions at the Site of the Work differing materially from those indicated, described, or delineated in the Contract Documents, including those reports discussed in Paragraph 4.2, 4.3, and 4.5; and

2. Unknown physical conditions at the Site of the Work of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents, including those reports and documents discussed in Paragraph 4.2, 4.3, and 4.5.

B. The Engineer will review the pertinent conditions, determine the necessity of obtaining additional explorations or tests with respect thereto, and advise the Owner, in writing, of the Engineer's findings and conclusions.

C. If the Owner concludes that because of newly discovered conditions a change in the Contract Documents is required, a Change Order will be issued as provided in Article 10 to reflect and document the consequences of the difference.

D. In each such case, an increase or decrease in the Contract Price or an extension or shortening of the Contract Times, or any combination thereof, will be allowable to the extent that they are attributable to any such difference. If the Owner and the Contractor are unable to agree as to the amount or length thereof, a claim may be made therefor as provided in Articles 11 and 12.

E. The Contractor's failure to give notice of differing Site conditions within 2 Days of their discovery and before they are disturbed shall constitute a waiver of all claims in connection therewith, whether direct or consequential in nature.

4.5 HAZARDOUS MATERIALS

A. Reference is made to the Supplementary General Conditions for identification of those reports and drawings relating to Hazardous Material identified at the Site that have been utilized by the Engineer in the preparation of the Contract Documents.

B. Owner shall be responsible for any Hazardous Material uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work and which may present a substantial danger to persons or property exposed thereto in connection with the Work at the Site. Owner will not be responsible for any such material brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.

1. Upon discovery of any Hazardous Material that was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of Work, the Contractor shall immediately stop all Work in any area affected thereby (except in an emergency as required by Paragraph 6.13) and notify Owner and Engineer (and thereafter confirm such notice in writing). Contractor shall not be required to resume any Work in any such affected area until after Owner has obtained any required permits related thereto and delivered to Contractor special written notice. Such written notice will specify that such condition and any affected area is or has been rendered safe for the resumption of the Work or specify any special conditions under which the Work may be resumed safely. If Owner and Contractor cannot agree as to entitlement to or the amount or extent of adjustment, if any, in Contract Price or Contract Times as a result of such Work stoppage or such special conditions under which Work is agreed by Contractor to be resumed, either party may make a claim therefor as provided in Articles 11 and 12.

2. If, after receipt of such special 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 special conditions, then Owner may order such portion of the Work that is in connection with such hazardous condition or in such affected area to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a claim therefor as provided in Articles 11 and 12. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 7.

3. To the fullest extent permitted by Laws and Regulations, Owner will indemnify and hold harmless Contractor, Subcontractors, Engineer, Engineer's consultants, and the officers, directors, employees, agents, other consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages arising out of or resulting from such Hazardous Material discovered on the Site; 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. Nothing in this Paragraph shall obligate Owner to indemnify a person or entity from and against the consequences of that person's or entity's own negligence.

C. The provisions of Paragraphs 4.2, 4.3, and 4.4 are not intended to apply to Hazardous Material uncovered or revealed at the Site.

D. In the event that Hazardous Materials are brought on to the Site or are discharged or released by the Contractor, any Subcontractor, Supplier, or any person or entity under the direct or indirect control of any of them, and not withstanding any other item or provision of the Contract, the Contractor agrees to defend, indemnify, and hold the Owner and the Engineer and the officers, directors, employees, agents, other consultants, and subcontractors of each and any of them harmless from and against any and all claims, liability, fines, penalties, response costs, damages, or judgments associated with the presence, discharge, release, or escape of such materials or contamination. Upon request of the Owner, the Contractor shall take such steps, at its own expense, as are reasonably necessary to remove from the Site the Hazardous Material or contamination brought onto the Site by the Contractor, Subcontractor, Supplier, or any person or entity under the direct control of any of them. The requirements of this paragraph are in addition to, and do not replace, the provisions of Paragraph 6.17 Indemnification. Contractor shall not be responsible for pre-existing Hazardous Material, and the foregoing indemnification obligation shall not apply thereto, unless Contractor causes Hazardous Material to be discharged, or fails to respond promptly and appropriately to the discovery or discharge of Hazardous Material.

4.6 REFERENCE POINTS

A. The Owner will provide one bench mark, near or on the Site of the Work, and will provide 2 points near or on the Site to establish a base line for use by the Contractor for alignment control. Unless otherwise specified in the Supplementary General Conditions, the Contractor shall furnish all other lines, grades, and bench marks required for proper execution of the Work.

B. The Contractor shall preserve all bench marks, stakes, and other survey marks, and in case of their removal or destruction by any party, the Contractor shall be responsible for the accurate replacement of such reference points by personnel qualified under the applicable state codes governing land surveyors.

ARTICLE 5 -- BONDS AND INSURANCE

5.1 BONDS

A. The Contractor shall furnish Performance and Payment Bonds, each in the amount set forth in the Supplementary General Conditions, as security for the faithful performance and payment of all the Contractor's obligations under the Contract Documents. The Contractor shall also furnish such other Bonds as are required by the Supplementary General Conditions.

B. All Bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Audit Staff, Bureau of Government Financial Operations, U.S. Treasury Department. All Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.

C. If the surety on any Bond furnished by the Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Work is located, the Contractor shall within 7 Days thereafter substitute another Bond and surety, which must be acceptable to the Owner.

D. All Bonds required by the Contract Documents to be purchased and maintained by Contractor shall be obtained from surety companies that are duly licensed or authorized in the State in which the Project is located to issue Bonds for the limits so required. Such surety companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary General Conditions.

5.2 INSURANCE

A. The Contractor shall purchase and maintain the insurance required under this Paragraph. Such insurance shall include the specific coverages set out herein and be written for not less than the limits of liability and coverages provided in the Supplementary General Conditions, or required by Laws or Regulations, whichever are greater. All insurance shall be maintained continuously during the life of the Agreement up to the date of Substantial Completion and at all times thereafter when the Contractor may be correcting, removing, or replacing Defective Work in accordance with Paragraph 13.5. The Contractor's liabilities under this Agreement shall not be deemed limited in any way to the insurance coverage required.

B. All insurance required by the Contract Documents to be purchased and maintained by the Contractor shall be obtained from insurance companies that are duly licensed or authorized to issue insurance policies for the limits and coverages so required in the State in which the Project is located. Such insurance companies shall have a current Best's Rating of at least an "A" (Excellent) general policy holder's rating and a Class VII financial size category and shall also meet such additional requirements and qualifications as may be provided in the Supplementary General Conditions.

C. The Contractor shall furnish the Owner, with copies to each additional insured who is indicated in the Supplementary General Conditions, with certificates and original endorsements showing the type, amount, class of operations covered, effective dates and dates of expiration of policies. All of the policies of insurance so required to be purchased and maintained (or the certificates or other evidence thereof) shall contain a provision or endorsement that the coverage afforded will not be canceled, reduced in coverage, or renewal refused until at least 30 Days prior written notice has been given to the Owner and additional insureds by certified mail. All such insurance required herein (except for worker's compensation and employer's liability) shall name the Owner, the Engineer, and their consultants and subconsultants and their officers, directors, agents, and employees as "additional insureds" under the policies. The Contractor shall purchase and maintain the following insurance:

1. Workers' Compensation and Employer's Liability: This insurance shall protect the Contractor against all claims under applicable workers' compensation laws or federal acts, including claims for injury, disease, or death of employees which, for any reason, may not fall within the provisions of a workers' compensation law. This insurance shall include an "all states" endorsement. In the event of a "monopolistic" state, Contractor shall certify all employees are covered by the state fund or shall provide a separate policy providing "all states" benefits. Employer's liability "stop gap" coverage for monopolistic states shall be provided under either a worker's compensation policy or general liability policy. The Contractor shall require each Subcontractor similarly to provide workers' compensation insurance for all of the latter's employees to be engaged in such Work unless such employees are covered by the protection afforded by the Contractor's workers' compensation insurance. In case any class of employees is not protected under the workers' compensation laws, the Contractor shall provide and shall cause each Subcontractor to provide adequate employer's liability insurance for the protection

of such of its employees as are not otherwise protected. The Contractor and each Subcontractor shall provide a waiver of subrogation in favor of the Owner and Engineer.

2. Commercial General Liability: This insurance shall be written in comprehensive form and shall protect the Contractor against all claims arising from

   a. Injuries to persons other than its employees or

   b. damage to property of the Owner or others arising out of any act or omission of the Contractor or its agents, employees, or Subcontractors.

   The policy shall also include protection against claims insured by personal injury liability coverage and contractual coverage to insure the contractual liability assumed by the Contractor under the indemnification provisions in the General Conditions. To the extent that the Contractor's Work, or Work under its direction, may require blasting, explosive conditions, or underground operations, the comprehensive or commercial general liability coverage shall specifically include coverage relative to blasting, explosion, collapse, and/or underground hazards.

3. Commercial Automobile Liability: This insurance shall be written in comprehensive form and shall protect the Contractor against all claims for injuries to members of the public and damage to property of others arising from the use of motor vehicles, and shall cover operation on or off the Site of all motor vehicles licensed for highway use, whether they are owned, nonowned, or hired.

4. Subcontractor's Public Liability and Property Damage Insurance and Vehicle Liability Insurance: The Contractor shall either require each of the Subcontractors to procure and to maintain subcontractor's public liability and property damage insurance and vehicle liability insurance of the type and in the same amounts specified in the Supplementary General Conditions for the Contractor or insure the activities of the Subcontractors under the Contractor's own policies.

5. Builder's Risk:

   a. This insurance shall be of the "all risks" type, shall be written in completed value form, and shall protect the Contractor, Subcontractors, the Owner, and the Engineer, against risks of damage to buildings, structures, and materials and equipment (including any stored off-Site and while in transit), Contractor's equipment, debris removal and including demolition and contingent loss occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for Engineer's services and expenses required as a result of such insured loss. The amount of such insurance shall be not less than the insurable value of the Work at completion plus equipment. Builder's Risk insurance shall provide for losses to be payable to the Contractor and the Owner, as their interests may appear. This insurance shall contain a provision that in the event of payment for any loss under the coverage provided, the insurance company shall have no rights of recovery against the Contractor, the Owner, and the Engineer. This insurance shall insure against all risks of loss (including earthquake, flood and collapse) and, at the option of the Owner, shall include comprehensive boiler and machinery coverage including coverage for installation and testing.

b. If the Owner finds it necessary to occupy or use a portion or portions of the Project prior to Substantial Completion thereof, such occupancy shall not commence prior to the time mutually agreed to by the Owner and Contractor and to which the insurance company or companies providing the Builder's Risk Insurance have consented by endorsement to the policy or policies.

ARTICLE 6 -- CONTRACTOR'S RESPONSIBILITIES

6.1 COMMUNICATIONS

A. Written communications with the Owner shall be only through or as directed by the Engineer.

6.2 SUPERVISION AND SUPERINTENDENCE

A. The 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. The Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction and all safety precautions and programs incidental thereto. The Contractor shall be responsible to see that the completed Work complies accurately with the Contract Documents.

B. The Contractor shall designate in writing and keep on the Site at all times during the performance of the Work a technically qualified, English-speaking superintendent, who is an employee of the Contractor and who shall not be replaced without written notice to the Owner and the Engineer. The superintendent will be the Contractor's representative at the Site and shall have authority to act on behalf of the Contractor. All communications given to the superintendent shall be as binding as if given to the Contractor.

C. The Contractor's superintendent shall be present at the Site at all times while Work is in progress and shall be available by phone for emergencies 24 hours per day, 7 days per week. Failure to observe this requirement shall be considered suspension of the Work by the Contractor until such time as such superintendent is again present at the Site.

6.3 LABOR, MATERIALS, AND EQUIPMENT

A. The Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. The Contractor shall furnish, erect, maintain, and remove the construction plant and any required temporary works. The Contractor shall at all times maintain good discipline and order at the Site. Except in connection with the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the Site shall be performed during regular working hours, and the Contractor will not permit overtime Work or the performance of Work on Saturday, Sunday, or any federally observed holiday without the Owner's written consent. The Contractor shall apply for this consent through the Engineer in writing a minimum of 24 hours in advance.

B. Except as otherwise provided in this Paragraph, the Contractor shall receive no additional compensation for overtime Work, i.e., Work in excess of 8 hours in any one calendar day or 40 hours in any one calendar week, even though such overtime Work may be required under emergency conditions and may be ordered by the Engineer in writing. Additional

compensation will be paid to the Contractor for overtime Work only in the event extra Work is ordered by the Engineer and the Change Order specifically authorizes the use of overtime Work and then only to such extent as overtime wages are regularly being paid by the Contractor for overtime Work of a similar nature in the same locality.

C. All increased costs of inspection and testing performed during overtime Work by the Contractor which is allowed solely for the convenience of the Contractor shall be borne by the Contractor. The Owner has the authority to deduct the cost of all such inspection and testing from any partial payments otherwise due to the Contractor.

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

E. All materials and equipment incorporated into the Work shall be of specified quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Specifications shall expressly run to the benefit of the Owner. If required by the Engineer, the Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind and quality of materials and equipment. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with the instructions of the applicable Supplier except as otherwise provided in the Contract Documents; but no provisions of any such instructions will be effective to assign to the Owner, Engineer, or any of their consultants, agents, or employees, any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.9 C.

6.4 SCHEDULE

A. The Contractor shall comply with the schedule requirements in the General Requirements.

6.5 SUBSTITUTES OR "OR EQUAL" ITEMS

A. The Contractor shall submit proposed substitutes or "or equal" items in accordance with the provisions of Section 01 60 00 - Products, Materials, Equipment, and Substitutions.

6.6 CONCERNING SUBCONTRACTORS, SUPPLIERS, AND OTHERS

A. The Contractor shall be responsible to the Owner and the Engineer for the acts and omissions of its Subcontractors, Suppliers, and their employees to the same extent as Contractor is responsible for the acts and omissions of its own employees. Nothing contained in this Paragraph shall create any contractual relationship between any Subcontractor and the Owner or the Engineer nor relieve the Contractor of any liability or obligation under the Contract Documents. The Contractor shall include these General Conditions and the Supplementary General Conditions as a part of all its subcontract and supply agreements.

6.7 PERMITS

A. Unless otherwise provided in the Supplementary General Conditions, the Contractor shall obtain and pay for all construction permits and licenses from the agencies having jurisdiction, including the furnishing of insurance and bonds if required by such agencies.

The enforcement of such requirements shall not be made the basis for claims for additional compensation by Contractor. When necessary, the Owner will assist the Contractor, in obtaining such permits and licenses. The Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable at the time of opening of Bids. The Contractor shall pay all charges of Utility owners for inspection or connections to the Work.

6.8 PATENT FEES AND ROYALTIES

A. The 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 the Owner or the Engineer its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed by the Owner in the Contract Documents. The Contractor's indemnification obligation under this Paragraph 6.8 A. for all claims and liabilities arising out of 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 shall be in accordance with Paragraph 6.17 of these General Conditions.

6.9 LAWS AND REGULATIONS

A. The Contractor shall observe and comply with all Laws and Regulations which in any manner affect those engaged or employed on the Work, the materials used in the Work, or the conduct of the Work. If any discrepancy or inconsistency should be discovered between the Contract Documents and any such Laws or Regulations, the Contractor shall report the same in writing to the Engineer. Any particular Law or Regulation specified or referred to elsewhere in the Contract Documents shall not in any way limit the obligation of the Contractor to comply with all other provisions of federal, state, and local laws and regulations. The Contractor's indemnification obligations for all claims or liability arising from violation of any such law, ordinance, code, order, or regulation, whether by Contractor or by its employees, Subcontractors or Suppliers shall be in accordance with Paragraph 6.17 of these General Conditions.

6.10 TAXES

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

6.11 USE OF PREMISES

A. The Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site, the land and areas identified in and permitted by the Contract Documents, and the other land and areas permitted by Laws and Regulations, rights-of-way, permits, and easements. The Contractor shall assume full liability and responsibility for any damage to any such land or area, or to the owner or occupant thereof or of any land or areas contiguous thereto, resulting from the performance of the Work. Should any claim be made against the Owner or the Engineer by any such owner or occupant because of the performance of the Work, the Contractor shall promptly attempt to settle with such other party by agreement or otherwise resolve

the claim through litigation at the Contractor's sole liability expense. The Contractor's indemnification obligations for all claims and liability, arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any such owner or occupant against the Owner, the Engineer, their consultants, subconsultants, and the officers, directors, employees and agents of each and any of them to the extent caused by or based upon the Contractor's performance of the Work shall be in accordance with Paragraph 6.17 of these General Conditions.

6.12 SAFETY AND PROTECTION

A. The Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. The 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 at the Site and other persons and organizations who may be affected thereby;

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 but not limited to trees, shrubs, lawns, walks, pavements, roadways, structures, and Utilities not designated for removal, relocation, or replacement in the course of the performance of the Work.

B. The 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. The Contractor shall notify owners of adjacent property and Utilities when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed or Owner has issued written notification in accordance with Paragraph 14.8 (except as otherwise expressly provided in connection with Substantial Completion).

C. The 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.

D. Materials that contain hazardous substances or mixtures may be required on the Work. A Material Safety Data Sheet shall be made available at the Site by the Contractor for every hazardous product used.

E. Material usage shall strictly conform to OSHA safety requirements and all Manufacturer's warnings and application instructions listed on the Material Safety Data Sheet and on the product container label.

F. The Contractor shall be responsible for the 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.

G. The Contractor shall notify the Engineer in writing if it considers a specified product or its intended use to be unsafe. This notification must be given to the Engineer prior to the

product being ordered, or if provided by some other party, prior to the product being incorporated in the Work.

6.13 EMERGENCIES

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor, without special instruction or authorization from Owner or Engineer, is obligated to immediately 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. 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 Change Order will be issued to document the consequences of such action.

6.14 SUBMITTALS

A. After checking and verifying all field measurements and after complying with applicable procedures specified in the General Requirements, the Contractor shall submit to the Engineer for review all Shop Drawings in accordance with the accepted schedule of Shop Drawing submittals specified in Section 01 33 00 – Submittal Procedures.

B. The Engineer's review will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, generally conform to the Contract Documents and with the design concept of the completed Project.

C. The Contractor shall also submit to the Engineer for review all Samples in accordance with the accepted schedule of Sample submittals specified in Section 01 33 00 – Submittal Procedures.

D. Before submittal of each Shop Drawing or Sample, the Contractor shall have determined and verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar data with respect thereto and reviewed or coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents. The Contractor shall provide submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

6.15 CONTINUING THE WORK

A. No claim, potential claim, dispute, or controversy shall interfere with the progress and performance of the Work, or any changes thereto, and the Contractor shall proceed in all instances with its Work, including any disputed Work, or any changes thereto, and any failure of the Contractor to comply herewith and to proceed with the Work shall be deemed a material breach of the Agreement entitling the Owner to all remedies available under Article 15 of the General Conditions or other provisions of the Contract Documents and applicable law. Except as provided elsewhere in the Contract Documents, the Owner will continue to make undisputed payments in accordance with the Contract Documents.

6.16 CONTRACTOR'S GENERAL WARRANTY AND GUARANTEE

A. Contractor warrants and guarantees that all Work will be in accordance with the Contract Documents and will not be defective. 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, or Suppliers, or any other individual or entity for whom Contractor is responsible;

2. Normal wear and tear under normal usage.

B. 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 (including Contractor’s obligations under the general warranty and guaranty of Paragraph 6.16 A) 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 Completion by the Owner;

4. Use or occupancy of the Work or any part thereof by the Owner;

5. Any acceptance by Owner or any failure to do so;

6. Any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice or acceptability by Engineer pursuant to Paragraph 14.7 B.;

7. Any inspection, test, or approval by others; or

8. Any correction of Defective Work by Owner.

6.17 INDEMNIFICATION

A. To the fullest extent permitted by Laws and Regulations, the Contractor shall indemnify, defend, and hold harmless the Owner, the Engineer, their consultants, subconsultants, and the officers, directors, employees, and agents of each and any of them, against and from all claims and liability arising under, by reason of, related, or incidental to the Contract Documents or any performance of the Work , in any and all situations, including situations involving the concurrent active or passive negligence of any indemnified party, but not from the sole negligence or willful misconduct of the Owner and/or the Engineer. Such indemnification by the Contractor shall include, but not be limited to, the following:

1. Liability or claims resulting directly or indirectly from the negligence or carelessness of the Contractor and its Subcontractors, Suppliers, and the employees, agents, permittees, and invitees of any of them in the performance of the Work, or in guarding or maintaining the same, or from any improper materials, implements, or appliances used in its construction, or by or on account of any act or omission of the Contractor, its employees, or agents;

2. Liability or claims arising directly or indirectly from bodily injury, occupational sickness or disease, or death of the Contractor, and its Subcontractor, Supplier, and the employees, agents, permittees and invitees of any of them engaged in the Work resulting in actions brought by or on behalf of such employees against the Owner and/or the Engineer;

3. Liability or claims arising directly or indirectly from or based on the violation of any Laws or Regulations, whether by the Contractor and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them;

4. Liability or claims arising directly or indirectly from the use or manufacture by the Contractor and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them in the performance of this Agreement of any copyrighted or uncopyrighted composition, secret process, patented or unpatented invention, article, or appliance, unless otherwise specifically stipulated in this Agreement;

5. Liability or claims arising directly or indirectly from the breach of any warranties, whether express or implied, made to the Owner and/or Engineer or any other parties by the Contractor, and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them;

6. Liability or claims arising directly or indirectly from the willful misconduct of the Contractor, and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them;

7. Liability or claims arising directly or indirectly from any breach of the obligations assumed in this Agreement by the Contractor;

8. Liability or claims arising directly or indirectly from, relating to, or resulting from a hazardous condition created by the Contractor, and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them, and;

9. Liability or claims arising directly, or indirectly, or consequentially out of any action, legal or equitable, brought against the Owner, the Engineer, their consultants, subconsultants, and the officers, directors, employees and agents of each or any of them, to the extent caused by the Contractor's and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them use of any premises acquired by permits, rights of way, or easements, the Site, or any land or areas contiguous thereto or its performance of the Work thereon.

B. The Contractor shall reimburse the Owner and the Engineer for all costs and expenses, (including but not limited to fees and charges of engineers, architects, attorneys, and other professionals and court costs including all costs of appeals) incurred by said Owner and Engineer in enforcing the provisions of this Paragraph 6.17.

C. The indemnification obligation under this Paragraph 6.17 shall not be limited in any way by any limitation on the amount or type of insurance carried by Contractor or by the amount or type of damages, compensation, or benefits payable by or for the Contractor or any Subcontractor or other person or organization under workers' compensation acts, disability benefit acts, or other employee benefit acts.

D. Contractor's obligation to defend and indemnify shall not be excused because of Contractor's inability to evaluate liability or because the Contractor evaluated liability and

determined that the Contractor is not liable to the claimant. The Contractor will respond within 30 Days to the tender of any claim for defense and indemnity by the Owner, unless that time has been extended by the Owner. If the Contractor fails to accept or reject the tender of defense in indemnity within 30 Days, in addition to any other remedy authorized by Law, so much of the money due the Contractor under and by virtue of the Contract as shall reasonably be considered necessary by the Owner, may be retained by the Owner until disposition has been made of the claim or suit for damages, or until the Contractor accepts or rejects the tender of defense, whichever occurs first.

E. With respect to third party claims against the Contractor, the Contractor waives any and all rights of any type to express or implied indemnity against the Owner, its directors, officers, employees, or agents.

6.18 CONTRACTOR'S DAILY REPORTS

A. The Contractor shall complete a daily report indicating location worked, total manpower for each construction trade, major equipment on Site, each Subcontractor's manpower and equipment, weather conditions, and other related information involved in the performance of the Work. The daily report shall be submitted to the EngineerEngineer at the conclusion of each Day. The daily report shall comment on the daily progress and status of each major component of the Work. These components will be decided by the Engineer.

ARTICLE 7 -- OTHER WORK

7.1 RELATED WORK AT SITE

A. The Owner may perform other work related to the Project at or adjacent to the Site by the Owner's own forces, have other work performed by utility owners, or let other direct contracts for such other work. The Contractor shall include in its Bid all costs associated with coordinating and connecting its Work with adjoining work performed under other contracts. The Contractor shall be solely responsible for aligning and coordinating its Work with other portions of the Project performed by others.

B. The Contractor shall afford each person who is performing the other work (including the Owner's employees) proper and safe access to the Site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and shall properly coordinate the Work with theirs. The 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. The Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will only cut or alter their work with the written consent of the Engineer and the others whose work will be affected.

C. If the proper execution or results of any part of the Contractor's Work depends upon such other work by another, the Contractor shall inspect and report to the Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for such proper execution and results. The Contractor's failure to report such delays, defects, or deficiencies will constitute an acceptance of the other work as fit and proper for integration with the Contractor's Work except for latent or nonapparent defects and deficiencies in the other work.

7.2 COORDINATION

A. If the Owner contracts with others for the performance of other work at the Site, Owner will have sole authority and responsibility in respect of such coordination unless otherwise provided in the Supplementary General Conditions.

ARTICLE 8 -- OWNER'S RESPONSIBILITIES

8.1 COMMUNICATIONS

A. Except as may be otherwise provided in these General Conditions or the Supplementary General Conditions, the Owner will issue all its communications to the Contractor through the Engineer.

8.2 PAYMENTS

A. The Owner will make payments to the Contractor as provided in Article 14.

8.3 LANDS, EASEMENTS, AND SURVEYS

A. The Owner's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.1 and 4.6.

8.4 REPORTS AND DRAWINGS

A. The Owner will identify and make available to the Contractor copies of reports of physical conditions at the Site and drawings of existing structures which have been utilized in preparing the Contract Documents as set forth in Paragraph 4.2.

8.5 CHANGE ORDERS

A. The Owner will execute Change Orders as indicated in Article 10.

8.6 INSPECTIONS AND TESTS

A. The Owner's responsibility for inspections and tests is set forth in Paragraph 13.3.

8.7 SUSPENSION OF WORK

A. The Owner's right to stop Work or suspend Work is set forth in Paragraphs 13.4 and 15.1.

8.8 TERMINATION OF AGREEMENT

A. The Owner's right to terminate services of the Contractor is set forth in Paragraphs 15.2 and 15.3.

8.9 LIMITATION 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 furnishing or performance of the Work. Owner will not be responsible for Contractor's failure to perform or furnish the Work in accordance with the Contract Documents.

8.10 UNDISCLOSED HAZARDOUS ENVIRONMENTAL CONDITIONS

A. Owner's responsibility in respect to an undisclosed hazardous environmental condition is set forth in Paragraph 4.5.

ARTICLE 9 -- ENGINEER'S STATUS DURING CONSTRUCTION

9.1 OWNER'S REPRESENTATIVE

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

9.2 OBSERVATIONS ON THE SITE

A. The Engineer will make observations on the Site during construction to monitor the progress and quality of the Work and to determine, in general, if the Work is proceeding in accordance with the Contract Documents. The level or frequency of the Engineer's inspections of the quality or quantity of the Work will not relieve the Contractor from any of its obligations or liability for the Work under the Contract Documents or otherwise.

9.3 PROJECT REPRESENTATION

A. The Engineer may furnish a Resident Project Representative to assist in observing the performance of the Work. The duties, responsibilities, and limitations of authority of any such Resident Project Representative will be as provided in the Supplementary General Conditions.

9.4 CLARIFICATIONS

A. The Engineer will issue with reasonable promptness such written Clarifications of the requirements of the Contract Documents as the Engineer may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents.

9.5 AUTHORIZED VARIATIONS IN WORK

A. The Engineer may authorize variations in the Work from the requirements of the Contract Documents. These may be accomplished by a Field Order and will require the Contractor to perform the Work involved in a manner that minimizes the impact to the Work and the Contract Times. If the Contractor believes that a Field Order justifies an increase in the Contract Price or an extension of the Contract Times, the Contractor may make a claim therefor as provided in Article 11 or 12.

9.6 REJECTING DEFECTIVE WORK

A. The Engineer will have authority to reject Defective Work and will also have authority to require special inspection or testing of the Work as provided in Article 13.

9.7 CONTRACTOR SUBMITTALS, CHANGE ORDERS, AND PAYMENTS

A. In accordance with the procedures set forth in the General Requirements, the Engineer will review all Contractor submittals.

B. The Engineer's responsibilities for Change Orders are set forth in Articles 10, 11, and 12.

C. The Engineer's responsibilities for Applications for Payment are set forth in Article 14.

9.8 DECISIONS ON DISPUTES

A. The Engineer will be the initial interpreter of the requirements of the Contract Documents and of the acceptability of the Work thereunder. Claims, disputes, and other matters relating to the acceptability of the Work and interpretation of the requirements of the Contract Documents pertaining to the performance of the Work shall be determined by the Engineer. Any claims in respect to changes in the Contract Price or Contract Times shall be resolved in accordance with the requirements set forth in Articles 10, 11, and 12.

9.9 LIMITATION ON ENGINEER'S RESPONSIBILITIES

A. Neither the Engineer's authority to act under this Article 9 or other provisions of the Contract Documents nor any decision made by the Engineer in good faith either to exercise or not exercise such authority shall give rise to any duty or responsibility of the Engineer to the Contractor, any Subcontractor, any Supplier, any surety for any of them, or any other person or organization performing any of the Work.

B. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "as reviewed," "as approved," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," or "satisfactory," or adjectives of like effect or import are used to describe a requirement, direction, review, or judgment of the Engineer as to the Work, it is intended that such requirement, direction, review, or judgment will be solely to evaluate the Work for compliance with the requirements of the Contract Documents, and conformance with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents, unless there is a specific statement indicating otherwise. The use of any such term or adjective shall not be effective to assign to the 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 Paragraph 9.9 C.

C. The Engineer will not supervise, direct, control, or have authority over or be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of the Contractor to comply with Laws and Regulations applicable to the performance of the Work. The Engineer will not be responsible for the Contractor's failure to perform the Work in accordance with the Contract Documents. The Engineer will not be responsible for the acts or omissions of the Contractor nor of any Subcontractor, Supplier, or any other person or organization performing any of the Work.

ARTICLE 10-- CHANGES IN THE WORK

10.1 GENERAL

A. Without invalidating the Agreement and without notice to any surety, the Owner may at any time or from time to time, order additions, deletions, or revisions in the Work. Such additions, deletions or revisions will be authorized by a Change Order or Field Order. Upon receipt of any such document, Contractor shall promptly proceed to implement the additions, deletions, or revisions in the Work in accordance with the applicable conditions of the Contract Documents.

B. The Contractor shall not be entitled to an increase in the Contract Price nor 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 by Change Order.

C. The Owner and the Contractor shall execute appropriate Change Orders covering:

1. Changes in the Work which are ordered by the Owner pursuant to Paragraph 10.1 A.;

2. Changes required because of acceptance of Defective Work under Paragraph 13.6; and

3. Changes in the Contract Price or Contract Times which are agreed to by the parties under Articles 11 and/or 12, respectively.

D. If notice of any change in the Work is required to be given to a surety, the giving of any such notice shall be the Contractor's responsibility. If the change in the Work affects the Contract Price, the Owner may require an adjustment to the amount of any applicable Bond and the amount of each applicable Bond shall be adjusted accordingly.

E. If the Owner and Contractor agree as to the extent, if any, of an increase in the Contract Price or an extension or shortening of the Contract Times that should be allowed as a result of a Field Order, the Contractor shall proceed so as to minimize the impact on and delays to the Work pending the issuance of a Change Order.

F. If the Owner and the Contractor are unable to agree as to the extent, if any, of an increase in the Contract Price or an extension or shortening of the Contract Times that should be allowed as a result of a Field Order, the Engineer can direct the Contractor to proceed on the basis of time and materials so as to minimize the impact on and delays to the Work, and the Contractor may make a claim as provided in Articles 11 and 12.

G. Owner may from time to time issue requests for additional Work. However, once the Owner has received a price for the additional Work from the Contractor, Owner may or may not issue a Change Order for such additional Work. In the event that Owner does not issue a Change Order for such Work, Contractor has no obligation to perform the Work so requested but not ordered.

10.2 ALLOWABLE QUANTITY VARIATIONS

A. In the event of an increase or decrease in the quantity of any Bid item under a unit price contract, the total amount of Work actually done or materials or equipment furnished will be paid for according to the unit price established for such Work under the Contract Documents, wherever such unit price has been established; provided, that an adjustment in the Contract Price may be made for changes which result in an increase or decrease in excess of 25 percent of the estimated quantity of any unit price bid item of the Work.

B. In the event a part of the Work is to be entirely eliminated and no lump sum or unit price is named in the Contract Documents to cover such eliminated work, the price of the eliminated Work shall be agreed upon by the Owner and the Contractor by Change Order.

ARTICLE 11 -- CHANGE OF CONTRACT PRICE

11.1 GENERAL

A. The Contract Price constitutes the total compensation payable to the Contractor for performing the Work. All duties, responsibilities, and obligations assigned to or undertaken by the Contractor to complete the Work shall be at its expense without change in the Contract Price.

B. The Contract Price may only be changed by a Change Order. The value of any Work covered by a Change Order or of any claim for an increase or decrease in the Contract Price shall be determined in one of the following ways:

1. Where the Work involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the quantities of the items involved.

2. By mutual acceptance of a lump sum, which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.4; or

3. On the basis of the cost of Work (determined as provided in Paragraph 11.3) plus the Contractor's overhead and profit (determined as provided in Paragraph 11.4).

C. Any claim for an increase in the Contract Price shall be based on written notice delivered by the Contractor to the Engineer promptly (but in no event later than 10 Days) after the start of the event giving rise to the claim and shall state the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered within 60 Days after the start of such event (unless the Engineer allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the Contractor's written statement that the amount claimed covers all known amounts (direct, indirect, and consequential) to which the Contractor is entitled as a result of such event. All claims for adjustment in the Contract Price will be determined by the Engineer. No claim for an adjustment in the Contract Price will be valid if not submitted in accordance with this Paragraph 11.1 C.

11.2 COSTS RELATING TO WEATHER

A. The Contractor shall have no claims against the Owner for damages for any injury to work, materials, or equipment, resulting from the action of the elements. If, however, in the opinion of the Engineer, the Contractor has made all reasonable efforts to protect the materials, equipment, and work, the Contractor may be granted a reasonable extension of Contract Times to make proper repairs, renewals, and replacements of the Work, materials, or equipment at Contractor's own cost.

11.3 COST OF WORK (BASED ON TIME AND MATERIALS)

A. **General:** The term "cost of work" means the sum of all costs necessarily incurred and paid by the Contractor for labor, materials, and equipment in the proper performance of extra Work. Except as otherwise may be agreed to in writing by the Owner, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any of the costs itemized in Paragraph 11.5.

B. **Labor:** The costs of labor will be the actual cost for wages prevailing for each craft or type of workers performing the extra Work at the time the extra Work is done, plus employer payments of payroll taxes, workers compensation insurance, liability insurance, health and welfare, pension, vacation, apprenticeship funds, and other direct costs resulting from federal, state or local laws, as well as assessments or benefits required by lawful collective

bargaining agreements. Labor costs for equipment operators and helpers will be paid only when such costs are not included in the invoice for equipment rental. The labor costs for foremen shall be proportioned to all of their assigned Work and only that applicable to extra Work shall be paid. Nondirect labor costs including superintendence shall be considered part of the markup set out in Paragraph 11.4.

C. **Materials**: The cost of materials reported shall be at invoice or lowest current price at which materials are locally available and delivered to the Site in the quantities involved, plus the cost of freight, delivery and storage, subject to the following:

1. All trade discounts and rebates shall accrue to the Owner, and the Contractor shall make provisions so that they may be obtained;

2. For materials secured by other than a direct purchase and direct billing to the purchaser, the cost shall be deemed to be the price paid to the actual supplier as determined by the Engineer. Except for actual costs incurred in the handling of such materials, markup will not be allowed;

3. Payment for materials from sources owned wholly or in part by the purchaser shall not exceed the price paid by the purchaser for similar materials from said sources on extra Work items or the current wholesale price for such materials delivered to the Site, whichever price is lower; and

4. If in the opinion of the Engineer the cost of material is excessive, or the Contractor does not furnish satisfactory evidence of the cost of such material, then the cost shall be deemed to be the lowest current wholesale price for the quantity concerned delivered to the Site less trade discount. The Owner reserves the right to furnish materials for the extra Work and no claim will be allowed by the Contractor for costs and profit on such materials.

D. **Equipment:** The Contractor will be paid for the use of equipment at the rental rate listed for such equipment specified in the Supplementary General Conditions. Such rental rate will be used to compute payments for equipment whether the equipment is under the Contractor's control through direct ownership, leasing, renting, or another method of acquisition. The rental rate to be applied for use of each item of equipment will be the rate resulting in the least total cost to the Owner for the total period of use. If it is deemed necessary by the Contractor to use equipment not listed in the publication specified in the Supplementary General Conditions, an equitable rental rate for the equipment will be established by the Engineer. The Contractor may furnish cost data which might assist the Engineer in the establishment of the rental rate. Payment for equipment shall be subject to the following:

1. All equipment shall, in the opinion of the Engineer, be in good working condition and suitable for the purpose for which the equipment is to be used;

2. Before construction equipment is used on the extra work, the Contractor shall plainly stencil or stamp an identifying number thereon at a conspicuous location, and shall furnish to the Engineer, in duplicate, a description of the equipment and its identifying number;

3. Unless otherwise specified, manufacturer's ratings and manufacturer approved modifications shall be used to classify equipment for the determination of applicable rental rates. Equipment which has no direct power unit shall be

powered by a unit of at least the minimum rating recommended by the manufacturer;

4. Individual pieces of equipment or tools having a replacement value of $500 or less, whether or not consumed by use, will be considered to be small tools and no payment will be made therefore.

E. **Equipment Rental Time:** The rental time to be paid for equipment on the Site will be the time the equipment is in productive operation on the extra Work being performed and, in addition, will include the time required to move the equipment to the location of the extra Work and return it to the original location or to another location requiring no more time than that required to return it to its original location; except, that moving time will not be paid if the equipment is used on other than the extra Work, even though located at the Site of the extra Work. Loading and transporting costs will be allowed, in lieu of moving time, when the equipment is moved by means other than its own power, except that no payment will be made for loading and transporting costs when the equipment is used at the Site of the extra Work on other than the extra Work. Rental time will not be allowed while equipment is inoperative due to breakdowns. The rental time of equipment on the work Site will be computed subject to the following:

1. When hourly rates are listed, any part of an hour less than 30 minutes of operation will be considered to be half-hour of operation, and any part of an hour in excess of 30 minutes will be considered one hour of operation;

2. When daily rates are listed, any part of a day less than 4 hours operation will be considered to be half-day of operation. When owner-operated equipment is used to perform extra Work to be paid for on a time and materials basis, the Contractor will be paid for the equipment and operator, as set forth in Paragraphs 3, 4, and 5, following;

3. Payment for the equipment will be made in accordance with the provisions in Paragraph 11.3 D., herein;

4. Payment for the cost of labor and subsistence or travel allowance will be made at the rates paid by the Contractor to other workers operating similar equipment already on the Site, or in the absence of such labor, established by collective bargaining agreements for the type of workmen and location of the extra Work, whether or not the operator is actually covered by such an agreement. A labor surcharge will be added to the cost of labor described herein in accordance with the provisions of Paragraph 11.3 B., herein, which surcharge shall constitute full compensation for payments imposed by state and federal Laws and all other payments made to or on behalf of workers other than actual wages; and

5. To the direct cost of equipment rental and labor, computed as provided herein, will be added the allowances for equipment rental and labor as provided in Paragraph 11.4, herein.

F. Special Services: Special Work or services are defined as that Work characterized by extraordinary complexity, sophistication, innovation, or a combination of the foregoing attributes which are unique to the construction industry. The Engineer will make estimates for payment for special services and may consider the following:

1. When the Engineer and the Contractor, determine that a special service or Work is required which cannot be performed by the forces of the Contractor or those of any

of its Subcontractors, the special service or Work may be performed by an entity especially skilled in the Work to be performed. After validation of invoices and determination of market values by the Engineer, invoices for special services or Work based upon the current fair market value thereof may be accepted without complete itemization of labor, material, and equipment rental costs;

2. When the Contractor is required to perform Work necessitating special fabrication or machining process in a fabrication or a machine shop facility away from the Site, the charges for that portion of the Work performed at the off-Site facility may, by agreement, be accepted as a special service and accordingly, the invoices for the Work may be accepted without detailed itemization; and

3. All invoices for special services will be adjusted by deducting all trade discounts. In lieu of the allowances for overhead and profit specified in Paragraph 11.4, herein, an allowance of 15 percent will be added to invoices for special services.

G. **Sureties:** All Work performed hereunder shall be subject to all of the provisions of the Contract Documents and the Contractor's sureties shall be bound with reference thereto as under the original Agreement. Copies of all amendments to Bonds or supplemental Bonds shall be submitted to the Owner for review prior to the performance of any Work hereunder.

11.4 CONTRACTOR'S OVERHEAD AND PROFIT

A. Extra Work ordered on the basis of time and materials will be paid for at the actual necessary cost as determined by the Engineer, plus allowances for overhead and profit. The allowance for overhead and profit will include full compensation for superintendence, taxes, field office expense, extended overhead, home office overhead, and all other items of expense or cost not included in the cost of labor, materials, or equipment provided for under Paragraph 11.3. The allowance for overhead and profit will be made in accordance with the following schedule:

Overhead and Profit Allowance	
Labor	15 percent
Materials	10 percent
Equipment	10 percent

To the sum of the costs and markups provided for in this Article, an additional one percent of the sum will be added as compensation for Bonds and insurance.

B. It is understood that labor, materials, and equipment for extra Work may be furnished by the Contractor or by the Subcontractor on behalf of the Contractor. When all or any part of the extra Work is performed by a Subcontractor, the allowance specified herein will be applied to the labor, materials, and equipment costs of the Subcontractor, to which the Contractor may add 5 percent of the Subcontractor's total cost for the extra Work. Regardless of the number of hierarchical tiers of Subcontractors, the 5 percent increase above the Subcontractor's total cost which includes the allowances for overhead and profit specified herein may be applied one time only .

11.5 EXCLUDED COSTS

A. The term "cost of the work" shall not include any of the following:

1. Payroll costs and other compensation of Contractor's officers, executives, proprietors, partners, principals, general 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 a branch office for general administration of the Work all of which are to be considered administrative costs covered by the Contractor's allowance for overhead and profit;

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. Cost of premiums for all Bonds and for all insurance whether or not Contractor is required by the Contract Documents to purchase and maintain the same (except as provided by Paragraph 11.4 above);

5. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of Defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property; and

6. Other overhead or general expense costs of any kind and the cost of any item not specifically and expressly included in Paragraph 11.4.

11.6 CONTRACTOR'S EXTRA WORK REPORT

A. In order to be paid for extra Work, the Contractor must submit a daily extra Work report on the form furnished by the Engineer. The form must be completely filled out based on the provisions of Paragraphs 11.3 through 11.5 and signed by the Contractor and Engineer at the end of each working Day. Failure to complete the form and obtain appropriate signatures by the next working Day after the extra Work of the previous day was completed will result in Contractor's costs for extra Work being disallowed.

ARTICLE 12-- CHANGE OF CONTRACT TIMES

12.1 GENERAL

A. The Contract Times may only be changed by a Change Order. Any claim for an extension of the Contract Times shall be based on written notice delivered by the Contractor to the Engineer promptly (but in no event later than 10 Days) after the start of the event giving rise to the claim and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall be delivered within 30 Days after the start of such event (unless the Engineer allows an additional period of time for the submission of additional or more accurate data in support of the claim) and shall be accompanied by the Contractor's written statement that the adjustment claimed is the entire adjustment to which the Contractor is entitled as a result of said event. All claims for adjustment in the Contract Times will be determined by the Engineer. No claim for an adjustment in the Contract Times will be valid if not submitted in accordance with the requirements of this Paragraph

12.1 A. An increase in Contract Times does not mean that the Contractor is due an increase in Contract Price. Only compensable time extensions will result in an increase in Contract Price.

B. All time limits stated in the Contract Documents are of the essence of the Agreement.

C. When Contractor is prevented from completing any part of the Work within the Contract Times (or Milestones) due to delay beyond the control of Contractor, the Contract Times (or Milestones) will be extended in an amount equal to the time lost on the critical path of the Work due to such delay, if a claim is made therefor as provided in Paragraph 12.1.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner; acts or neglect of those performing other work as contemplated by Article 7; and fires, floods, epidemics, terrorist acts, acts of the public enemy, acts of war, abnormal weather conditions, or acts of God. Delays attributable to and within the control of any Subcontractor or Supplier shall be deemed to be delays within the control of the Contractor.

D. In no event will Owner be liable to Contractor, any Subcontractor, any Supplier, any other person or organization, or to any surety for or employee or agent of any of them, for any increase in the Contract Price or other damages arising out or resulting from the following:

1. Delays caused by or within the control of Contractor; or

2. Delays beyond the control of both Owner and Contractor including but not limited to fires, floods, epidemics, terrorist acts, acts of the public enemy, acts of war, abnormal weather conditions, acts of God, or acts or neglect by those performing other work as contemplated by Article 7.

12.2 EXTENSIONS OF CONTRACT TIMES FOR DELAY DUE TO WEATHER

A. The Contractor's construction schedule shall anticipate delay due to unusually severe weather.

B. Contract Times may be extended by the Engineer because of delays in excess of the anticipated delay. The Contractor shall, within 10 Days of the beginning of any such delay, notify the Engineer in writing and request an extension of Contract Times. The Engineer will ascertain the facts and the extent of the delay and extend the Contract Times when, in its judgement, the findings of the fact justify such an extension.

ARTICLE 13 -- INSPECTIONS AND TESTS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

13.1 NOTICE OF DEFECTIVE WORK

A. Prompt notice of Defective Work known to the Owner or Engineer will be given to the Contractor. All Defective Work, whether or not in place, may be rejected, corrected, or accepted as provided in this Article 13. Defective Work may be rejected even if approved by prior inspection.

13.2 ACCESS TO WORK

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

13.3 INSPECTIONS AND TESTS

A. The Contractor shall give the Engineer not less than 24 hours notice of readiness of the Work for all required inspections, tests, or approvals, and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. The Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. For inspection, tests, or approvals covered by Paragraphs 13.3C. and 13.3D. below;

2. That costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.3H. shall be paid as provided in said Paragraph 13.3H.; and

3. As otherwise provided in the Contract Documents.

C. If Laws and Regulations of any public body having jurisdiction require any Work (or any part thereof) 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 the Engineer the required certificates of inspection or approval.

D. The Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for the Engineer's acceptance of materials or equipment to be incorporated in the Work or acceptance of materials, mix designs, or equipment submitted for approval prior to the Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to the Engineer.

E. The Engineer will make, or have made, such inspections and tests as the Engineer deems necessary to see that the Work is being accomplished in accordance with the requirements of the Contract Documents. Unless otherwise specified in the Supplementary General Conditions, the cost of such inspection and testing will be borne by the Owner. In the event such inspections or tests reveal non-compliance with the requirements of the Contract Documents, the Contractor shall bear the cost of corrective measures deemed necessary by the Engineer, as well as the cost of subsequent reinspection and retesting. Neither observations by the Engineer nor inspections, tests, or approvals by others shall relieve the Contractor from the Contractor's obligation to perform the Work in accordance with the Contract Documents.

F. If any Work (including the work of others) that is to be inspected, tested, or approved is covered without written concurrence of the Engineer, it must, if requested by the Engineer, be uncovered for observation. Such uncovering shall be at the Contractor's expense unless the Contractor has given the Engineer not less than 24 hours notice of the

Contractor's intention to perform such test or to cover the same and the Engineer has not acted with reasonable promptness in response to such notice.

G. If any Work is covered contrary to the written request of the Engineer, it must, if requested by the Engineer, be uncovered for the Engineer's observation and recovered at the Contractor's expense.

H. If the Engineer considers it necessary or advisable that covered Work be observed by the Engineer or inspected or tested by others, the Contractor, at the Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as the Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment. If it is found that such Work is Defective Work, the Contractor shall bear all direct, indirect, and consequential costs and damages of such uncovering, exposure, observation, inspection, and testing and of satisfactory reconstruction, including but not limited to, fees and charges of engineers, architects, attorneys, and other professionals. However, if such Work is not found to be Defective Work, the Contractor will be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, the Contractor may make a claim therefor as provided in Articles 11 and 12.

13.4 OWNER MAY STOP THE WORK

A. If Defective Work is identified, the Owner may order the Contractor to stop performance of the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of the Owner to stop the Work shall not give rise to any duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other party.

13.5 CORRECTION OR REMOVAL OF DEFECTIVE WORK

A. If required by the Engineer, the Contractor shall promptly either correct all Defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by the Engineer, remove it from the Site and replace it with non-defective Work. The Contractor shall bear all direct, indirect, and consequential costs and damages of such correction or removal, including but not limited to fees and charges of engineers, architects, attorneys, and other professionals made necessary thereby.

13.6 ACCEPTANCE OF DEFECTIVE WORK

A. If, instead of requiring correction or removal and replacement of Defective Work, the Owner prefers to accept the Defective Work, the Owner may do so. The Contractor shall bear all direct, indirect, and consequential costs attributable to the Owner's evaluation of and determination to accept such Defective Work. If any such acceptance occurs prior to final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and the Owner shall be entitled to an appropriate decrease in the Contract Price.

13.7 OWNER MAY CORRECT DEFECTIVE WORK

A. If the Contractor fails within a reasonable time after written notice from the Engineer to correct Defective Work, or to remove and replace Defective Work as required by the Engineer in accordance with Paragraph 13.5A., or if the Contractor fails to perform the Work in accordance with the Contract Documents, or if the Contractor fails to comply with

any other provision of the Contract Documents, the Owner may, after 7 Days written notice to the Contractor, correct and remedy any such deficiency.

B. In exercising the rights and remedies under this paragraph, the Owner shall proceed with corrective and remedial action. In connection with such corrective and remedial action, the Owner may exclude the Contractor from all or part of the Site, take possession of all or part of the Work, and suspend the Contractor's services related thereto and incorporate in the Work all materials and equipment for which the Owner has paid the Contractor whether stored at the Site or elsewhere. The Contractor shall provide the Owner, Owner's representatives, Engineer, and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.

C. All direct, indirect, and consequential costs and damages incurred by the Owner in exercising the rights and remedies under this paragraph will be charged against the Contractor and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and the Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, the Owner may make a claim therefor as provided in Article 11. Such claim 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 and all direct, indirect, and consequential damages associated therewith.

D. The Contractor shall not be allowed an extension of Contract Times (or Milestones) 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.

13.8 CORRECTION PERIOD

A. The correction period for Defective Work shall be the longer of:

1. One year after the date of final acceptance;

2. Such time as may be prescribed by Laws and Regulations;

3. Such time as specified by the terms of any applicable special guarantee required by the Contract Documents; or

4. Such time as specified by any specific provision of the Contract Documents.

B. If, during the correction period as defined in Paragraph 13.8A above, any Work is found to be Defective Work, the Owner shall have the same remedies as set forth in Paragraphs 13.5, 13.6, and 13.7 above.

C Where Defective Work (and damage to other work resulting therefrom) has been corrected, removed, or 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.

ARTICLE 14-- PAYMENTS TO CONTRACTOR AND COMPLETION

14.1 SCHEDULE OF VALUES (LUMP SUM PRICE BREAKDOWN)

A. The schedule of values or lump sum price breakdown established as provided in the General Requirements shall serve as the basis for progress payments and shall be incorporated into a form of Application for Payment acceptable to the Engineer.

14.2 UNIT PRICE BID SCHEDULE

A. Progress payments on account of unit price work will be based on the number of units completed as verified by the Engineer in accordance with Section 01 29 00 – Measurement and Payment. The Engineer's determination of quantities shall be final and binding on the parties.

14.3 APPLICATION FOR PROGRESS PAYMENT

A. Unless otherwise prescribed by law, on the 25th of each month, the Contractor shall submit to the Engineer for review, the Application for Payment filled out and signed by the Contractor covering the Work completed as of the date of the Application for Payment and accompanied by such supporting documentation as is required by the Contract Documents.

B. The Application for Payment shall identify, as a subtotal, the amount of the Contractor total earnings to date; plus the value of materials stored at the Site which have not yet been incorporated in the Work; and less a deductive adjustment for materials installed which were not previously incorporated in the Work, but for which payment was allowed under the provisions for payment for materials stored at the Site, but not yet incorporated in the Work.

C. The Application for Payment shall show the payment claimed by the Contractor, from which shall be deducted the amount of retainage specified in the Supplementary General Conditions and the total amount of all previous payments made to the Contractor.

D. The value of materials stored at the Site shall be an amount equal to the specified percent of the value of such materials as set forth in the Supplementary General Conditions. Said amount shall be based upon the value of all acceptable materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing; provided, each such individual item has a value of more than $5,000 and will become a permanent part of the Work. The Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that the Contractor 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 and other arrangements to protect the Owner's interest therein, all of which will be satisfactory to the Owner. At the Owner's request, the Contractor shall execute a security agreement and UCC-1 Financing Statement as a condition of receiving payment for materials stored at another location.

14.4 CONTRACTOR'S WARRANTY OF TITLE

A. The Contractor warrants and guarantees that title to all Work, materials, and equipment covered by an Application for Payment, whether incorporated in the Work or not, will pass to the Owner no later than the time of payment, free and clear of all Liens.

14.5 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

A. The Engineer will, within 7 Days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the application to the Owner, or return the application to the Contractor indicating in writing the Engineer's reasons for refusing to recommend payment. In the latter case, the Contractor may make the necessary corrections and resubmit the application. If the Engineer still disagrees with a

portion of the application, it will submit the application recommending the undisputed portion of the application to the Owner for payment and provide reasons for recommending non-payment of the disputed amount. Thirty Days after presentation of the Application for Payment with the Engineer's recommendation to the Owner, the amount recommended will (subject to the provisions of Paragraph 14.5B.) become due and when due will be paid by the Owner to the Contractor.

B. The Engineer, in its discretion, may refuse to recommend the whole or any part of any payment. Engineer may also refuse to recommend any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:

1. The Work is Defective Work or the completed Work has been damaged requiring correction or replacement.

2. The Contract Price has been reduced by written amendment or Change Order.

3. The Owner has been required to correct Defective Work or complete Work in accordance with Paragraph 13.7.

4. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.1 through 15.4 inclusive.

C. The Owner may refuse to make payment of the full amount recommended by the Engineer because:

1. Claims have been made against Owner on account of Contractor's performance or furnishing of the Work.

2. 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.

3. There are other items entitling Owner to a set-off against the amount recommended, or

4. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.5B. through 14.5C and 15.1 through 15.4 inclusive.

The Owner must give the Contractor immediate written notice (with a copy to the Engineer) stating the reasons for such action and promptly pay the Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor corrects to Owner's satisfaction the reasons for such action.

14.6 SUBSTANTIAL COMPLETION

A. When the Contractor considers the Work ready for its intended use, the Contractor shall notify the Owner and the Engineer in writing that the Work is substantially complete. The Contractor shall attach to this request a list of all Work items that remain to be completed and a request that the Engineer prepare a Notice of Completion. Within a reasonable time thereafter, the Owner, the Contractor, and the Engineer shall make an inspection of the Work to determine the status of completion. If the Engineer does not consider the Work substantially complete, or the list of remaining work items to be comprehensive, the Engineer will notify the Contractor in writing giving the reasons therefor. If the Engineer considers the Work substantially complete, the Engineer will prepare and deliver to the Owner for its execution and recordation the Notice of Completion signed by the Engineer and Contractor, which shall fix the date of Substantial Completion.

14.7 PARTIAL UTILIZATION

A. The Owner shall have the right to utilize or place into service any item of equipment or other usable portion of the Work prior to completion of the Work. Whenever the Owner plans to exercise said right, the Contractor will be notified in writing by the Owner, identifying the specific portion or portions of the Work to be so utilized or otherwise placed into service.

B. It shall be understood by the Contractor that until such written notification is issued, all responsibility for care and maintenance of all of the Work shall be borne by the Contractor. Upon issuance of said written notice of Partial Utilization, the Owner will accept responsibility for the protection and maintenance of all such items or portions of the Work described in the written notice.

C. The Contractor shall retain full responsibility for satisfactory completion of the Work, regardless of whether a portion thereof has been partially utilized by the Owner, and the Contractor's one year correction period shall commence only after the date of Substantial Completion for the Work.

14.8 FINAL APPLICATION FOR PAYMENT

A. After the Contractor has completed all of the remaining Work items referred to in Paragraph 14.6 and delivered all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, marked-up record documents (as provided in the General Requirements), and other documents, all as required by the Contract Documents, and after the Engineer has indicated that the Work is acceptable, the Contractor may make application for final payment following the procedure for progress payments. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents, together with complete and legally effective releases or waivers (satisfactory to the Owner) of all claims arising out of or filed in connection with the Work.

14.9 FINAL PAYMENT AND ACCEPTANCE

A. Upon completion of the Work, including all items of the final punch list of deficiencies and upon completion of final cleaning, the Contractor shall notify the Engineer in writing. Upon receipt of the written notice, the Owner, Contractor, and Engineer will conduct the final inspection to determine the actual conformance of the Work to the requirements of the Contract Documents.

B. Upon confirmation by the Owner and Engineer that a satisfactory final inspection has been conducted, the Contractor shall submit an application for final payment to the Engineer. The request shall include a completed and signed Application for Payment and shall include, but not be limited to, the following documentation:

1. Certified payroll records in accordance with Article 14 of these General Conditions.

2. Final technical manual in accordance with Section 01 33 00 – Submittal Procedures.

3. Final record drawings in accordance with Section 01 33 00 – Submittal Procedures.

4. Final CPM schedule in accordance with Section 01 32 16 – CPM Construction Schedule showing the sequence of Work as actually constructed.

5. Certificates or other evidence of any insurance policy that will expire in the next 30 Days.

6. Conditional waiver and release of Lien upon progress payment forms from all Subcontractors and Suppliers included in the current payment application.

7. Unconditional waiver and release of Lien upon progress payment forms from all Subcontractors and Suppliers included in the previous month’s payment application.

8. An inventory of all spare parts and maintenance materials the Contractor has provided the Owner.

9. As a condition of final payment, the Contractor shall be required to execute a release on the form provided by Owner, releasing the Owner from any and all claims of liability for payment on the Project except for such amounts as may be specifically described and excluded from the release.

C. If, on the basis of the Engineer's observation of the Work during construction and final inspection, and the Engineer's review of the final Application for Payment and accompanying documentation, all as required by the Contract Documents, the Engineer is satisfied that the Work has been completed and the Contractor's other obligations under the Contract Documents have been fulfilled, the Engineer will, within 14 Days after receipt of the final Application for Payment, indicate in writing the Engineer's recommendation of payment and present the application to the Owner for payment.

D. Following receipt of all required submittals and the Engineer’s written statement that the construction is complete, and the Owner accepts the Work, the Owner will file a Notice of Completion.

E. Thirty five Days after recording the Notice of Completion, the Owner will make final payment to the Contractor of the amount remaining after deducting all prior payments and all amounts to be kept or retained under the provisions of the Contract Documents, including the following items:

1. Liquidated damages, as applicable;

2. Amounts withheld by Owner under Paragraph 14.5B. and C. which have not been released; and

3. Two times the value of outstanding items of correction Work or punch list items yet uncompleted or uncorrected, as applicable. All such Work shall be completed or corrected to the satisfaction of the Owner within the time stated on the Notice of Completion, otherwise the Contractor does hereby waive any and all claims to all monies withheld by the Owner to cover the value of all such uncompleted or uncorrected items.

F. As a condition of final payment, the Contractor shall be required to execute a release on the form provided by Owner, releasing the Owner from any and all claims of liability for payment on the Project except for such amounts as may be specifically described and excluded from the release.

14.10 RELEASE OF RETAINAGE AND OTHER DEDUCTIONS

A. After executing the necessary documents to initiate the Lien period, and not more than 45 Days thereafter (based on a 30 Day Lien filing period and 15 Day processing time), the Owner will release to the Contractor the retainage funds withheld pursuant to the Agreement, less any deductions to cover pending claims against the Owner pursuant to Paragraph 14.9E.

B. After filing of the necessary documents to initiate the Lien period, the Contractor shall have 30 Days to complete any outstanding items of correction Work remaining to be completed or corrected as listed on a final punch list made a part of the Notice of Completion. Upon expiration of the time limit referred to in Paragraph 14.10A., the amounts withheld pursuant to the provisions of Paragraph 14.9E. herein, for all remaining Work items will be returned to the Contractor; provided, that said Work has been completed or corrected to the satisfaction of the Owner within said 30 Days. Otherwise, the Contractor does hereby waive any and all claims for all monies withheld by the Owner under this Agreement to cover two times the value of such remaining uncompleted or uncorrected items.

ARTICLE 15 -- SUSPENSION OF WORK AND TERMINATION

15.1 SUSPENSION OF WORK BY OWNER

A. The Owner may, at any time and without cause, suspend the Work or any portion thereof for a period of not more than 90 Days by notice in writing to the Contractor. The Contractor shall resume the Work on receipt of a notice of resumption of Work. The Contractor will be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to any suspension if the Contractor makes an approved claim therefor as provided in Articles 11 and 12.

15.2 TERMINATION OF AGREEMENT BY OWNER FOR DEFAULT

A. In the event of default by the Contractor, the Owner may give seven Days written notice to the Contractor of Owner's intent to terminate the Agreement and provide the Contractor an opportunity to remedy the conditions constituting the default within a specified period of time. It will be considered a default by the Contractor whenever Contractor shall:

1. Declare bankruptcy, become insolvent, or assign its assets for the benefit of its creditors;

2. Disregard or violate the Laws or Regulations of any public body having jurisdiction;

3. Fail to provide materials or workmanship meeting the requirements of the Contract Documents;

4. Disregard or violate provisions of the Contract Documents or Engineer's instructions;

5. Fail to prosecute the Work according to the approved progress schedule;

6. Fail to provide a qualified superintendent, competent workmen, or materials or equipment meeting the requirements of the Contract Documents; or

7. Disregard the authority of the Engineer.

B. If the Contractor fails to remedy the conditions constituting default within the time allowed, the Owner may then issue the notice of termination.

C. In the event the Agreement is terminated in accordance with Paragraph 15.2A., herein, the Owner may take possession of the Work and may complete the Work by whatever method or means the Owner may select. The cost of completing the Work will be deducted from the balance which would have been due the Contractor had the Agreement not been terminated and the Work completed in accordance with the Contract Documents. If such cost exceeds the balance which would have been due, the Contractor shall pay the excess amount to the Owner. If such cost is less than the balance which would have been due, the Contractor shall not have claim to the difference.

15.3 TERMINATION OF AGREEMENT BY OWNER FOR CONVENIENCE

A. Upon seven Days written notice to the Contractor and the Engineer, the Owner may, without cause and without prejudice to any other right or remedy of the Owner, elect to terminate the Agreement. In such case, the Contractor shall be paid (without duplication of any items):

1. For 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 of such Work;

2. For 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;

3. For all reasonable claims, costs, losses, and damages incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. For reasonable expenses directly attributable to termination.

B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.4 TERMINATION OF AGREEMENT BY CONTRACTOR

A. The Contractor may terminate the Agreement upon 14 Days written notice to the Owner, whenever:

1. The Work has been suspended under the provisions of Paragraph 15.1, herein, for more than 90 consecutive Days through no fault or negligence of the Contractor, and notice to resume Work or to terminate the Agreement has not been received from the Owner within this time period; or

2. The Owner should fail to pay the Contractor any monies due in accordance with the terms of the Contract Documents and within 60 Days after presentation to the Owner by the Contractor of a request therefor, unless within said 14 day period the Owner shall have remedied the condition upon which the payment delay was based.

B. In the event of such termination, the Contractor shall have no claims against the Owner except for those claims specifically enumerated in Paragraph 15.3, herein, and as determined in accordance with the requirements of said paragraph.

ARTICLE 16 -- MISCELLANEOUS

16.1 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 delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice. A notice sent by facsimile will be deemed delivered upon receipt. A notice sent by recognized overnight delivery service will be deemed delivered the next business day after the notice is sent to the last business address known to the giver of the notice.

16.2 TITLE TO MATERIALS FOUND ON THE WORK

A. The Owner reserves the right to retain title to all soils, stone, sand, gravel, and other materials developed and obtained from excavations and other operations connected with the Work. Unless otherwise specified in the Contract Documents, neither the Contractor nor any Subcontractor shall have any right, title, or interest in or to any such materials. The Contractor will be permitted to use in the Work, without charge, any such materials which meet the requirements of the Contract Documents.

16.3 RIGHT TO AUDIT

A. If the Contractor submits a claim to the Owner for additional compensation, the Owner shall have the right, as a condition to considering the claim, and as a basis for evaluation of the claim, and until the claim has been settled, to audit the Contractor's books to the extent they are relevant. This right shall include the right to examine books, records, documents, and other evidence and accounting procedures and practices, sufficient to discover and verify all direct and indirect costs of whatever nature claimed to have been incurred or anticipated to be incurred and for which the claim has been submitted. The right to audit shall include the right to inspect the Contractor's plant, or such parts thereof, as may be or have been engaged in the performance of the Work. The Contractor further agrees that the right to audit encompasses all subcontracts and is binding upon

Subcontractors. The rights to examine and inspect herein provided for shall be exercisable through such representatives as the Owner deems desirable during the Contractor's normal business hours at the office of the Contractor. The Contractor shall make available to the Owner for auditing, all relevant accounting records and documents, and other financial data, and upon request, shall submit true copies of requested records to the Owner.

16.4 SURVIVAL OF OBLIGATIONS

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

16.5 CONTROLLING LAW

A. This Agreement is to be governed by the law of the state in which the Project is located. Venue for any action brought for the purpose of enforcing any provision of this Agreement, including without limitation for damages by reason of any alleged breach of any provision of this Agreement or a declaration of rights or obligations under this Agreement, or for any other judicial remedy, shall be brought in the appropriate state court located in the county where the project is located. Contractor agrees to joinder of claims and parties with respect to any matter arising hereunder that may involve the work of another owner, contractor, or consultant.

16.6 SEVERABILITY

A. If any term or provision of this Agreement is declared invalid or unenforceable by any court of lawful jurisdiction, the remaining terms and provisions of the Agreement shall not be affected thereby and shall remain in full force and effect.

16.7 WAIVER

A. The waiver by the Owner or Engineer of any breach or violation of any term, covenant or condition of this Agreement or of any provision, ordinance, or law shall not be deemed to be a waiver of any other term, covenant, condition, ordinance, or law or of any subsequent breach or violation of the same or of any other term, covenant, condition, ordinance, or law. The subsequent payment of any monies or fee by the Owner which may become due hereunder shall not be deemed to be a waiver of any preceding breach or violation by Contractor or any term, covenant, condition of this Agreement or of any applicable law or ordinance.

- END OF GENERAL CONDITIONS -

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SECTION 00 73 13 - SUPPLEMENTARY GENERAL CONDITIONS

PART 1-- GENERAL

These Supplementary General Conditions make additions, deletions, or revisions to the General Conditions as indicated herein. All provisions which are not so added, deleted, or revised remain in full force and effect. Terms used in these Supplementary General Conditions which are defined in the General Conditions have the meanings assigned to them in the General Conditions.

SGC-1 DEFINITIONS

Add the following definitions to Article 1:

Engineer - In accordance with its contract with the Owner, the Engineer is further defined as the firm of Stantec Consulting Services, Inc., located at 2890 E Cottonwood Parkway, Suite 300, Salt Lake City, Utah 84121.

Owner - The Owner is further defined as Magna Water District, located at 3500 S 8885 W, Magna, UT 84044.

SGC-2.2 COPIES OF DOCUMENTS

The Owner shall furnish to the Contractor electronic copies (PDF files) of the Contract Documents. Hard copies may also be purchased at the expense of the Contractor.

SGC-2.4 STARTING THE WORK

Add the following as Paragraphs 2.4C and 2.4D of the General Conditions:

C. The Contractor shall notify the treatment plant staff at least 48 hours in advance of the commencement of Work at any Site.

D. The Contractor shall be responsible for making itself aware of Utility company facilities, and shall be liable for any and all damages stemming from repair or delay costs or any other expenses resulting from the unanticipated discovery of underground Utilities. The Contractor shall be responsible for notifying the Owner at least 48 hours in advance of the commencement of Work at any Site.

SGC-3.4 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

NOT USED

SGC-4.2 REPORTS OF PHYSICAL CONDITIONS

In the preparation of the Contract Documents, the Engineer has relied upon:

A. The following reports of explorations and tests of subsurface conditions at the Site:

1. Geotechnical report dated September 2017 prepared by IGES entitled “Geotechnical Investigation – Magna Wastewater Treatment Plant

Improvements – Chemical Building & Clarifier Project", consisting of 147 pages.

2. Geotechnical report dated March 2018 prepared by IGES entitled "Geotechnical Investigation", consisting of 67 pages.

3. Geotechnical report dated September 2017 prepared by IGES entitled "Geotechnical Investigation – Reuse Facility", consisting of 74 pages.

4. Geotechnical report dated August 2023 prepared by IGES entitled "Geotechnical Investigation – Influent Pump Station & Grit Washing Facility", consisting of 211 pages.

B. The following drawings of physical conditions in or relating to existing surface and subsurface structures (except underground Utilities) which are at or contiguous to the Site:

1. Drawings dated May 2007 prepared by Carollo Engineers entitled "Barton Wellfield WTP", consisting of 224 sheets.

2. Drawings dated August 2010 prepared by Carollo Engineers entitled "Magna WRF Fine Screening Facility", consisting of 75 sheets.

3. Drawings dated July 2020 prepared by Carollo Engineers entitled "Water and Wastewater Treatment Upgrades", consisting of 181 sheets.

C. Copies of these reports and drawings may be examined at the office of 7650 W 2100 S, Magna, UT during regular business hours if said reports and drawings are not bound herein. As provided in Paragraph 4.2 of the General Conditions and as identified and established above, the Contractor may rely upon the accuracy of the technical data contained in such reports and drawings, except for such physical dimensions that can be field verified; however, the interpretation of such technical data, including any interpolation or extrapolation thereof, and opinions contained in such reports and drawings are not to be relied on by the Contractor.

SGC-4.5 HAZARDOUS MATERIALS

NOT USED

SGC-5.1 BONDS

Delete the first sentence of Paragraph 5.1A and add the following:

The Contractor shall furnish a satisfactory Performance Bond in the amount of 100 percent of the Contract Price and a satisfactory Payment Bond in the amount of 100 percent of the Contract Price as security for the faithful performance and payment of all the Contractor's obligations under the Contract Documents.

5.1.D MAINTENANCE AND GUARANTY BOND

The Contractor shall provide a Maintenance and Guaranty Bond in the amount of 100 percent of the Contract Price to provide a guarantee against defects in the Work occurring during the year

following the one year correction period. The Bond shall meet all of the requirements listed in Paragraph 5.1 BONDS, shall be payable to the Owner, and be at the sole cost of the Contractor.

SGC-5.2 INSURANCE

A. The limits of liability for the insurance required by Paragraph 5.2 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations. Limits may be provided by a combination of primary and excess liability policies or through a single policy. If the limits are provided by a combination of primary and excess liability policies, then the excess or umbrella liability coverages shall include commercial general, comprehensive automobile, and employer's liability and shall provide coverage at least as broad as the underlying policies.

1. Workers' Compensation:

State	Statutory
Applicable Federal (e.g. USL&H)	Statutory
Note: If the WORK called for in the Contract Documents involves work in or on any navigable waters, the Contractor shall provide Workers' Compensation coverage which shall include coverage under the Longshore and Harbor Workers' Compensation Act, the Jones Act, Maritime Law, and any other coverage required under Federal or State laws pertaining to workers in or on navigable waters.	
Employer's Liability	
Bodily Injury by Accident	$ 2,000,000 each accident
Bodily Injury by Disease	$ 2,000,000 policy limit
Bodily Injury by Disease	$ 2,000,000 each employee

2. Comprehensive or Commercial General Liability

Combined Single Limit	
Premises/operations	$ 2,000,000 each occurrence
Products/completed/ operations	$ 2,000,000 each occurrence $ 2,000,000 annual aggregate
Personal Injury	$ 2,000,000 each occurrence

a. Policies shall include premises/operations, products, completed operations, independent contractors, explosion, collapse, underground hazards, broad form contractual, personal injury with employment contractual exclusions deleted, and broad form property damage.

b. If policies are written on a Commercial General liability form, the General Aggregate shall be at least two times the each occurrence limit or be written on a "per project" basis.

c. If policies are written on a claims made form, the certificate should so specify and policies shall continue in force for 1 year after completion of the project. The retroactive date of the policy must be no later than the date of the Agreement.

d. If policies are written for split limits, limits shall be equal for bodily injury and property damage liability.

3. Comprehensive Automobile Liability (including owned, hired, and nonowned vehicles):

Combined Single Limit	
Bodily Injury and Property Damage	$ 2,000,000 each accident
If policies are written for split limits, limits shall be equal for bodily injury per person, bodily injury per accident, and property damage	

4. Builder's Risk Insurance:

a. In an amount equal to the replacement cost of the completed value of the project.

b. Any deductibles or self insured retentions shall be in accordance with Paragraph SGC-5.2F or as agreed to by the Owner and Contractor.

B. All policies shall provide that the Contractor agrees to waive all rights of subrogation against the Owner, the Engineer, and their subconsultants, employees, officers and directors, for Work performed under the Agreement. Endorsements shall be provided with certificates of insurance.

C. All policies shall also specify that the insurance provided by the Contractor will be considered primary and not contributory to any other insurance available to the Owner or Engineer.

D. All policies except Workers' Compensation and Builders Risk shall name the Owner, Engineer, their consultants, subconsultants, and their officers, directors, agents and employees as additional insureds. The Builders Risk insurance shall name the Contractor, Owner, and Engineer as named insureds.

E. All policies shall provide for 30 Days notice prior to any cancellation, reduction in coverage, or nonrenewal.

F. The deductible or self insured retention on Comprehensive or Commercial General Liability shall not be greater than $ 100,000. Deductibles on Builder's Risk coverage shall not be greater than $25,000 for flood or $100,000 or 5 percent of the Contract Price, whichever is greater, for earthquake coverage. All deductibles are the responsibility of the Contractor.

SGC-5.2C INSURANCE

NOT USED

SGC-6.6 SUBCONTRACT LIMITATIONS

Add the following as Paragraph 6.6B of the General Conditions:

B. The Contractor shall perform not less than 20 percent of the Work with its own forces (i.e., without subcontracting). The 20 percent requirement shall apply to the Contract Price less the values of Owner-assigned contracts and allowances in the Bid for prenegotiated Work.

SGC-6.7 PERMITS

A. The Contractor shall be responsible for complying with the requirements of all permits acquired by the Owner.

B. Except for the permits specifically set forth in A above, the Contractor shall acquire all permits required by Laws or Regulations, including, without limitation, the following specific permits (if applicable):

1. State permits to construct and/or operate sources of air pollution.

2. Certificates and permits are required for sources such as, but not limited to:

   a. Fuel burning equipment
   b. Gasoline and petroleum distillate storage containers
   c. Land disturbing activities
   d. Processing equipment (sand, gravel, concrete batch plant, etc.)
   e. Odors

3. Permits to construct and/or operating permits for construction should be obtained from:

   Utah Division of Water Quality

4. Stormwater Permit.

5. Permit-Required Confined Space

   The workplace in which the Work is to be performed may contain permit-required confined spaces (permit spaces) as defined 29 CFR 1910.146 and, if so, permit space entry is allowed only through compliance with a confined space entry program meeting the requirements of 29 CFR 1910.146.

6. Encroachment Permit.

SGC-6.17 INDEMNIFICATION

Replace Paragraph 6.17A of the General Conditions with the following:

To the fullest extent permitted by Laws and Regulations, the Contractor shall indemnify, defend, and hold harmless the Owner, the Engineer, their consultants, subconsultants, and the officers, electe officials, appointed officials, directors, employees, and agents of each and any of them, against and from all claims and liability arising under, by reason of, related, or incidental to the Contract Documents or any performance of the Work, in any and all situations, including situations involving the concurrent active or passive negligence of any indemnified party, but not from the sole negligence or willful misconduct of the Owner and/or the Engineer. Such indemnification by the Contractor shall include, but not be limited to, the following:

The Contractor shall also indemnify, defend, and hold harmless Stantec Consulting Services, Inc. and its officers, directors, agents, and employees, against and from all claims and liability arising under or by reason of the Agreement or any performance of the Work, but not from the sole negligence or willful misconduct of Stantec Consulting Services, Inc.

Replace Paragraph 6.17.A.9 of the General Conditions:

Liability or claims arising directly, or indirectly, or consequentially out of any action, legal or equitable, brought against the Owner, the Engineer, their consultants, subconsultants, and the officers, elected officials, appointed officials, directors, employees and agents of each or any of them, to the extent caused by the Contractor's and its Subcontractors, Suppliers, and the employees, agents, permittees, or invitees of any of them use of any premises acquired by permits, rights of way, or easements, the Site, or any land or areas contiguous thereto or its performance of the Work thereon.

Add the following as Paragraph 6.19 of the General Conditions:

SGC-6.19 ASSIGNED CONTRACTS BY THE OWNER

A. The Owner will have executed a procurement contract with a Supplier for early procurement of the following described items to be installed in the Work by the Contractor. Said procurement contract is hereby assigned to the Contractor as a part of the Work of the Agreement. Said assignment of the procurement contract to the Contractor shall be a condition of the contract for the construction of Magna WRF Influent Design Project. As of the date of execution of the Agreement hereunder, all references in the procurement documents to the Owner shall mean the Contractor hereunder.

B. The Contractor shall be wholly responsible under the Agreement for administration of each of said procurement contract, including payment of the Supplier therefor and for all expediting, quality assurance, and delivery. All costs of site storage, erection, installation, safety, security, and protection both prior to and after erection or installation until after final acceptance of the Work by the Owner, shall be the responsibility of the Contractor. No separate payment will be allowed therefor, and all costs shall be included by the Contractor in the lump sum price Bid for the Work.

C. The assignment of said procurement contract shall act to relieve the Owner from all further obligation and liability under the procurement contract, and all rights, duties, and obligations of the Owner under said procurement contract shall become the rights, duties and obligations of the Contractor, including that of inspection at the point of manufacture or fabrication, as applicable.

D. The Contractor shall be wholly responsible for all payments to the Supplier and for expediting, delivery, storage, and installation or erection under the Agreement. The

Contractor shall be responsible for all safety, security, and protection of said procurement items both prior to and after installation until final acceptance by the Owner.

SGC-7.2 COORDINATION

NOT USED

SGC-9.3 PROJECT REPRESENTATION

A. The Resident Project Representative, who is the Engineer's agent, will act as directed by and under the supervision of the Engineer and will confer with the Engineer regarding its actions. The Resident Project Representative's dealings in matters pertaining to the Work shall, in general, be only with the Engineer and the Contractor, and dealings with Subcontractors shall only be through or with the full knowledge of the Contractor. Written communication with the Owner will be only through or as directed by the Engineer.

B. The Resident Project Representative shall have the duties and responsibilities set forth in this paragraph.

1. Review the progress schedule of Shop Drawing submittals and schedule of values prepared by the Contractor and consult with the Engineer concerning their acceptability.

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

3. Serve as the Engineer's liaison with the Contractor, working principally through the Contractor's superintendent and assist said superintendent in understanding the intent of the Contract Documents. Assist the Engineer in serving as the Owner's liaison with the Contractor.

4. Receive Shop Drawings and samples furnished by the Contractor.

5. Conduct on-Site observations of the Work in progress to assist the Engineer in determining if the Work is proceeding in accordance with the Contract Documents.

6. Verify that the tests, equipment, and systems startups and operating and maintenance instruction are conducted as required by the Contract Documents and in presence of the required personnel, and that the Contractor maintains adequate records thereof.

7. Transmit to the Contractor the Engineer's clarifications and interpretations of the Contract Documents.

8. Consider and evaluate the Contractor's suggestions for modifications in the Contract Documents and report them with recommendations to the Engineer.

9. Review applications for payment with the Contractor for compliance with the established procedure for their submittal and forward them with recommendations to the Engineer, noting particularly their relation to the schedule of values, Work

completed, and materials and equipment delivered at the Site but not incorporated in the Work.

10. During the course of the Work, verify that certificates, maintenance and operation manuals, and other data required to be assembled and furnished by the Contractor are applicable to the items actually installed.

11 Before the Engineer prepares a Notice of Completion, as applicable, submit to the Contractor a list of observed items requiring completion or correction.

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

13. Verify that all items on the punch list have been completed or corrected and make recommendations to the Engineer concerning acceptance.

SGC-12.2 WEATHER DELAYS

NOT USED

SGC-14.3C AMOUNT OF RETENTION

Add the following to Paragraph 14.3C of the General Conditions:

Unless otherwise prescribed by law, the Owner may retain a portion of the amount otherwise due to the Contractor, as follows:

1. Retention of 5 percent of each approved progress payment will be held until final payment, after completion of all the Work identified on the final inspection of the project to the Owner's satisfaction.

- END OF SUPPLEMENTARY GENERAL CONDITIONS -

SECTION 01 10 00 – SUMMARY OF WORK

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Work to be performed under this Contract shall consist of furnishing plant, tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The Work shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the Work in good faith shall be provided by the Contractor as though originally so indicated, at no increase in cost to the Owner.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

1.03 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of this Contract includes, but is not limited to, construction of a new influent pump station with three screw pumps, expansion and modifications of the existing intermediate pump station, replacement of grit pumps and chamber equipment, construction of a new grit washing building with two grit washers, and all associated structural, architectural, mechanical, instrumentation, control, electrical, and site work. The Work also includes site piping, earthwork, paving, erosion control, pressure testing, clean-up and any other Work as shown in the Contract Drawings or described in the Technical Specifications. Portions of the Work involve the installation of equipment and materials pre-procured by the Owner (screw pumps and grit washing equipment).

B. The Work is located at the Owner's Water Reclamation Facility, 7650 W 2100 S, Magna, UT 84044.

1.04 CONTRACT METHOD

A. The Work hereunder will be constructed under a single lump sum contract.

1.05 WORK BY OTHERS

A. Where 2 or more contracts are being performed at one time on the same Site or adjacent land in such manner that work under one contract may interfere with work under another, the Owner will determine the sequence and order of the Work in either or both contracts. When the Site of one contract is the necessary or convenient means of access for performance of work under another, the Owner may grant privilege of access or other reasonable privilege to the Contractor so desiring, to the extent, amount, and in manner and at time that the Owner may determine. No Owner determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The Contractor shall conduct its operations so as to cause a minimum of interference with the work of such other contractors and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.

B. Interference With Work On Utilities**:** The Contractor shall cooperate fully with all utility forces of the Owner or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the Work, and shall schedule the Work so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.06 CONTRACTOR USE OF SITE

A. The Contractor's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

B. The Contractor is responsible to ensure that all debris, waste materials and chemicals shall be disposed of in accordance with applicable federal, state and local regulations and shall bear all costs related to same.

C. The Contractor shall conform to the site access and storage requirements per Section 01 55 00 – Site Access and Storage.

1.07 OUTAGE PLAN AND REQUESTS

A. Unless the Contract Documents indicate otherwise, the Contractor shall not remove from service, de-energize, or modify settings for any existing operating tank pipeline, valve, channel, equipment, structure, road, or any other facility without permission from the Engineer and Owner.

B. Where the Work requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the Contractor shall submit a detailed outage plan and schedule for the Engineer’s and Owner’s approval a minimum of 2 weeks in advance of the time that such outage is planned.

C. A completed System Outage Request form (blank furnished by the Engineer) shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of the Contract Documents. The outage plan shall describe the Contractor's method for preventing bypassing of other treatment units; the length of time required to complete said operation; any necessary temporary power, controls, instrumentation or alarms required to maintain control, monitoring, and alarms for the treatment plant processes; and the manpower, plant, and equipment which the Contractor will furnish for proper operation of associated treatment units. All costs for preparing and implementing the outage plans shall be at no increase in cost to the Owner.

D. The Engineer and Owner shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.

E. The Contractor shall provide written confirmation of the shutdown date and time 2 working days prior to the actual shutdown.

1.08 OWNER USE OF THE SITE

A. The Owner may utilize all or part of the existing facilities during the entire period of construction. The Contractor shall cooperate and coordinate with the Owner to facilitate the Owner's operations and to minimize interference with the Contractor's operations at the same time. In any event, the Owner shall be allowed access to the Site during the period of construction.

1.09 PROJECT MEETINGS

A. Preconstruction Conference

1. Prior to the commencement of Work at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the Contractor’s Project Manager, its superintendent, and its subcontractors as the Contractor deems appropriate. Other attendees will be:

   a. Engineer and the Resident Project Representative.

   b. Representatives of Owner.

   c. Governmental representatives as appropriate.

   d. Others as requested by Contractor, Owner, or Engineer.

   e. The Contractor shall bring the preconstruction conference submittals in accordance with Section 01 33 00 – Submittal Procedures.

2. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the Contractor prior to the meeting date. However, the Contractor should be prepared to discuss all of the items listed below.

   a. Status of Contractor's insurance and bonds.

   b. Contractor's tentative schedules.

c. Transmittal, review, and distribution of Contractor's submittals.

d. Processing applications for payment.

e. Maintaining record documents.

f. Critical work sequencing.

g. Field decisions and Change Orders.

h. Use of Site, office and storage areas, security, housekeeping, and Owner's needs.

i. Major equipment deliveries and priorities.

j. Contractor's assignments for safety and first aid.

k. Daily Report Form which the Engineer will furnish.

l. Submittal Transmittal Form which the Engineer will furnish.

3. The Engineer will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.

B. Progress Meetings

1. The Engineer will schedule and hold regular on-Site progress meetings at least weekly and at other times as requested by Contractor or as required by progress of the Work. The Contractor, Engineer, and all subcontractors active on the Site shall attend each meeting. Contractor may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.

2. The Engineer will preside at the progress meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the Work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the Contractor shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 00– CONSTRUCTION RESTRAINTS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Work shall be scheduled, sequenced, and performed in a manner which minimizes disruption to the operation and maintenance of existing facilities.

B. The Contractor shall incorporate the construction and schedule constraints of this Section in preparing the construction schedules required under Section 01 32 16 – CPM Construction Schedule.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 32 16	CPM Construction Schedule
01 50 10	Protection of Existing Facilities

1.03 EXISTING PLANT

A. The Work shall be executed while the existing wastewater treatment plant is in operation. Operation of the existing plant shall not be jeopardized nor shall the efficiency of wastewater treatment be reduced as a result of the execution of the Work.

B. Unless indicated otherwise, temporary pumping, piping, power, lighting, controls, instrumentation, alarms, security devices, and safety devices shall be provided by the Contractor whenever its activity or interruption due to its activity affects the existing facility.

C. The construction constraints in this Section do not include every item affecting the completion of the Work but are intended to describe the sequence of critical events necessary to minimize disruption to the ongoing treatment plant processes and to ensure compliance with UPDES Permit requirements. It shall be understood and agreed by the Contractor that the critical events described are not inclusive and that additional items of Work not included may be required to minimize disruption and ensure compliance. Deviation from or modification of these suggested sequences is permitted if techniques and methods known to the Contractor will result in reducing disruption to the facility operation and maintaining treatment efficiency, and if deviation is approved in advance by the Engineer.

1.04 OPERATION OF PLANT EQUIPMENT

A. Operational functions or shutdown of the existing plant required to facilitate Contractor's operation will be done by the Owner's personnel only.

B. The plant operation and maintenance personnel will cooperate in every way that is practical in order to facilitate Contractor's operation. However, certain shutdown and connections may only be permissible at times other than normal working hours such as nights or weekends. No additional payment will be made to the Contractor for any night, weekend, or holiday premium or overtime payments.

C. If it becomes necessary for the proper operation or maintenance of portions of the plant, the Owner may require the Contractor to reschedule an approved shutdown. The Contractor shall then reschedule its operations so there shall be no conflict with necessary operations or maintenance of the plant. The Contractor shall, within 2 Days, furnish the Engineer a revised outage request and a plan for rescheduling the shutdown in accordance with the requirements of the construction schedule.

1.05 BYPASSING

A. Bypassing of untreated or partially treated sewage to surface waters or drainage courses is prohibited during construction. In the event accidental bypassing is caused by the Contractor's operations, the Owner shall immediately be entitled to employ others to stop the bypassing and costs incurred therefore will be deducted from the Contractor's construction progress payments.

1.06 COMPLIANCE WITH UPDES PERMIT

A. The plant is operating under the terms of a UPDES permit issued by the Utah Department of Environmental Quality. The UPDES permit specifies the water quality limits that the plant must meet prior to discharging its effluent. A copy of the UPDES permit is available for review by the Contractor. In scheduling and performing the Work, the Contractor shall not, directly or indirectly, prevent the plant from achieving the discharge requirements. Penalties imposed on the Owner as a result of any discharge violation caused by the actions of the Contractor or its employees, or subcontractors shall be borne in full by the Contractor, including fines, legal fees, and other expenses to the Owner resulting directly or indirectly from such discharge violations. The Owner may recover such sums by deductions from the construction progress payments.

B. The Contractor shall take necessary precautions to ensure that no damage occurs to the plant facilities, including piping, utilities, roads, and structures, that are to remain in operation and are not to be modified or replaced, in accordance with Section 01 50 10 – Protection of Existing Facilities. Any temporary facilities, materials, equipment, and labor required for the plant to continue to meet the terms of the UPDES permit during construction shall be provided by the Contractor as part of the Work. At the completion of work, such temporary facilities, materials, and equipment shall be removed from the Site as part of the Work.

1.07 OUTAGE REQUESTS

A. Modifications to existing facilities, the construction of new facilities, and the connection of new to existing facilities may require the temporary outage or bypass of existing treatment processes or facilities. In such cases, the Contractor shall coordinate Work with the Engineer as described below. The Contractor shall submit a detailed outage plan and time schedule for construction activities which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment, structure, road, or other facilities from service. Outage requests should be submitted in accordance with Section 01 93 00 and use the Method of Procedure form provided.

B. The outage plans shall be submitted to the Engineer for acceptance a minimum of 2 weeks in advance of the time that such outages are required. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of this Section. The outage plan shall describe the Contractor's method for preventing bypassing of other treatment units; the length of time required to complete the operation; any necessary temporary power, controls, instrumentation, or alarms required to maintain control, monitoring, and alarms for the treatment plant processes; and the manpower, plant, and equipment which the Contractor shall provide in order to ensure proper operation of associated treatment units. Costs for preparing and implementing the outage plans shall be the responsibility of the Contractor as part of the Work.

C. The Contractor shall not begin an alteration affecting existing facilities until specific written approval has been granted by the Engineer in each case.

D. The Engineer will coordinate the Contractor's planned procedure with the treatment facility personnel. The Engineer has the authority to modify any proposed shutdown procedures if such procedures would adversely impact the plant operations.

E. The Engineer shall be notified in writing at least one week in advance of the required outage if the schedule for performing the Work has changed or if revisions to the outage plan are required. The Contractor shall provide written confirmation of the shutdown date and time 2 Days prior to the actual shutdown.

1.08 TEMPORARY CONNECTIONS

A. Making connections to existing facilities or other operations that interfere with the operation of the existing equipment shall be thoroughly planned in advance, and required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall be completed as quickly as possible and with as little delay as possible and shall proceed continuously (24 hours a day and seven days a week) if necessary to complete modifications and/or connections in the minimum time.

B. The cost of any temporary facilities and night, weekend, or holiday activity and overtime payments required during process interruptions shall be included in the Work.

C. Temporary facilities and piping shall be located to minimize interference with Contractor's construction facilities and Owner's operation and maintenance of the wastewater treatment plant. Unless otherwise indicated, each temporary pipeline shall be of the same size as its connection to the existing or permanent facility at the downstream end of the pipeline. Piping materials shall be suitable for the material being conveyed and be as required in the Contract Specifications.

D. When temporary electrical power, controls, instrumentation, or alarms are required for routine continuous operations of existing or new equipment, the Contractor shall provide the necessary equipment and appurtenances. Prior to installing said equipment and appurtenances, Contractor shall furnish a submittal on the proposed components and installation for Engineer's review and approval.

E. A plan showing the size and location of the temporary facilities and piping shall be submitted to the Engineer at the same time as the outage plan required under this Section. Costs for design, provision, operation, and removal of temporary facilities and piping shall be part of the Work.

1.09 CONSTRUCTION SEQUENCING

A. Construction activities shall be scheduled and sequenced to ensure continuous operation of the existing treatment facilities. The Contractor's scheduling shall develop construction sequencing so that the Work will not adversely impact treatment. The Contractor shall be responsible for development of the construction sequencing. In implementing the construction sequencing, the Contractor shall maintain the existing facilities in service until new facilities are constructed and are operational to supplement the existing capacity. When new facilities are operational, the existing facilities may be taken out of service. The following general guidelines shall be used by the Contractor in planning the sequence of construction.

1. Safe working conditions for personnel shall be maintained during rehabilitation, modification, and demolition Work. The foregoing includes at least proper trench excavation, the provision of temporary equipment guards, supports, warning signs, walkways, covers over openings, handrailing, and protection of electrical equipment and power supply.

2. Temporary facilities shall be constructed in accordance with applicable codes and regulations to operate safely and properly.

3. Valves to be temporarily shut off during the Work shall be tagged as such and shall be wired shut with a crimped lead seal and padlocked.

4. Electrical and mechanical equipment shall be similarly shut down.

1.10 PERMITS

A. The Contractor shall abide by the conditions of permits and shall obtain proof of satisfaction of conditions from issuers of permits prior to acceptance of the Work by the Owner.

1.11 SCHEDULE CONSTRAINTS

A. General: It is the Contractor's responsibility to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall Work.

B. The listing of schedule constraints below does not mean that every constraint or special condition has been identified. The list does not substitute for the Contractor's coordination and planning for completion of the Work within the Contract Times.

C. The following constraints affect the construction schedule. See Section 01 93 00 – Maintenance for additional shutdown, bypass, and work sequence requirements.

1. Pre-procured equipment will be assigned to the Contractor as outlined in the specifications. Contractor shall coordinate payment, delivery, storage, and installation.

2. Subsurface utility investigation and relocation required before construction of new Influent Pump Station and Grit Washing Facility.

3. Commissioning of new Influent Pump Station is required before demolition of existing influent pumps in the East Headworks.

4. Demolition of existing influent pumps is required before installation of new intermediate pumps in the East Headworks.

5. Only one of the two existing step screens shall be out of service at any given time while making new piping connection to step screen channel from new Influent Pump Station and demolition of existing influent pumps.

6. Only one of the two grit chambers and pumps shall be out of service at any given time during existing grit equipment replacement in the Headworks Facility.

7. Shutdowns and bypass pumping will be required and must be coordinated with the Owner.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 29 00 - MEASUREMENT AND PAYMENT

PART 1 -- GENERAL

1.1 SUMMARY

A. Measurement and payment for all Work shown or specified herein will be made on a unit or lump sum price basis in accordance with the prices set forth in the Bid for individual items of Work. Contractor shall make a careful assessment when preparing the Bid.

B. The items listed below refer to and are the same pay items listed in the Bid Schedule. They constitute all of the pay items for the completion of the Work. No direct or separate payment will be made for providing miscellaneous temporary or accessory services or all other items not specifically named in specific bid item descriptions and needed for the prosecution of the Work, and all other requirements of the Contract Documents. Compensation for all such services, things and materials shall be included in the prices stipulated for the lump sum and unit price pay items listed herein.

C. The prices stated in the Bid Schedule include all costs and expenses for taxes, labor, equipment, materials, commissions, transportation charges and expenses, patent fees and royalties, labor for handling materials during inspection, together with any and all other costs and expenses for performing and completing the Work as shown on the Drawings and specified herein. The basis of payment for an item at the lump sum or unit price shown in the Bid Schedule shall be in accordance with the description of that item in this Section.

D. Items listed as allowances in the Bid Schedule are to be used and will be paid for only at the written direction and authorization of the Engineer, if agreed to by the Owner. Payment under this Section will be made for permitting fees and hidden utilities and/or existing conflicts beyond the limits indicated or reasonably inferred from the Contract Documents. All materials furnished and installed shall be in accordance with these Specifications. Measurements and payment will be in accordance with the Contract Documents or the terms of the written authorization for the additional Work and will include but not necessarily be limited to, the furnishing, hauling, placing and installing of materials and the furnishing of such manpower and equipment as required to accomplish the Work as directed in writing by the Engineer.

1.2 ALTERATIONS

A. The Owner reserves the right to change the alignment, grade, form, length, dimensions or materials of the Work under the Contract, whenever any conditions or obstructions are met that render such changes desirable or necessary. All such alterations shall be paid for under the total lump sum bid or at a unit price bid for these items of Work, except as follows:

1. In case such alterations make the Work less expensive to the Contractor, a proper deduction shall be made from the Contract Prices and the Contractor shall have no claim on this account for damages or for anticipated profits on the Work that may be dispensed with.

2. In case such alterations make the Work more expensive, a proper addition shall be made to the Contract Prices.

3. Any such deduction or addition shall be determined by the Engineer in accordance with the General Conditions.

1.3 SUBMITTALS

A. Contractor shall submit the following Informational Submittals in conformance with the General Conditions of the Contract:

1. Schedule of Values: Section 01 29 73 – Schedule of Values.

2. Schedule of Estimated Progress Payments: Section 01 29 73 – Schedule of Values

a. Submit with initially acceptable Schedule of Values.

b. Submit adjustments thereto with Applications for Payment.

3. Applications for Payment.

4. Final Application for Payment.

1.4 APPLICATION FOR PAYMENT

A. Transmittal Summary Form: Attach one Summary Form with detailed Application for Payment 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 Engineer.

C. Include accepted Schedule of Values for each portion of Work, the unit price breakdown for the Work to be paid on unit price basis, a listing of equipment by Owner-assigned contracts, a listing of Owner-selected equipment, if applicable, and allowances, as appropriate.

D. Preparation:

1. List each Change Order executed prior to date of submission as separate line item. Totals to equal those shown on the Transmittal Summary Form as applicable.

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 as applicable, and such supporting data as may be requested by Engineer.

1.5 PAYMENT

A. General:

1. Progress payments will be made monthly.

2. The date for Contractor’s submission of monthly Application for Payment shall be established at the Preconstruction Conference.

B. Payment for all the Work shown or specified in Contract Documents is included in the Contract Price. No measurement or payment will be made for individual items.

C. Payment for mobilization:

1. The Contractor's attention is directed to the condition that 75 percent of total mobilization amount will be allowed at the first payment for mobilization and 25 percent will be retained at the final payment for demobilization.

1.6 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for following:

1. Products wasted or disposed of in a manner that is not acceptable.

2. Products determined unacceptable before or after placement.

3. Products not completely unloaded from the transporting vehicle.

4. Products placed beyond the lines and levels of the required Work.

5. Loading, hauling, and disposing of rejected Products.

6. Installation of rejected equipment or materials.

7. Defective Work not accepted by the Owner.

8. Material remaining on hand after completion of Work.

1.7 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Major Equipment Delivered under the following conditions.

1. Shop drawings have been submitted and “Approved.”

2. Operations and Maintenance Manuals have been approved.

3. Up to 80 percent of the equipment value.

4. Provide Manufacturer’s invoice for the equipment.

5. Provide secure location for equipment to the satisfaction of the Owner.

6. Store and maintain equipment according to the Manufacturer’s written instruction. Failure to properly store and maintain the equipment will be grounds for deducting any previous payments for the equipment.

1.8 FINAL PAYMENT

A. 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

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SECTION 01 29 73 – SCHEDULE OF VALUES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. This Section defines the process whereby the Schedule of Values (lump sum price breakdown) shall be developed and incorporated into the cost loading function of the CPM Schedule in accordance with the requirements of Section 01 32 16 – CPM Construction Schedule.

B. Monthly progress payment amounts will be determined from the monthly progress updates of the CPM Schedule activities.

C. Develop the Schedule of Values independent of but simultaneous with the development of the CPM Schedule activities and logic.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 32 16	CPM Construction Schedule
01 10 00	Summary of Work

1.03 PRELIMINARY SCHEDULE OF VALUES

A. Submit a preliminary Schedule of Values for the major components of the Work at the Preconstruction Conference in accordance with the requirements of Section 01 10 00 – Summary of Work.

B. At a minimum, submit proposed values for the following major Work components:

1. Mobilization: Maximum 5 percent of Contract Price;

2. the total value of electrical Work;

3. the total value of instrumentation and control Work;

4. the total value of protective coatings Work;

5. the total value of yard mechanical Work inclusive of excavation, pipe installation, testing and backfill of pipe, and all incidental Work associated with underground pipe installations;

6. the total value of mechanical Work:

   a. exclusive of yard mechanical Work included in Item 5 above, but including piping, valves, equipment, tanks, and appurtenances at new and existing structures;

   b. break down this total value into separate values for each new and existing structure constructed or modified as a part of the Work;

7. the total value of structural reinforced concrete Work:

a. inclusive of excavation, dewatering, subgrade preparation, backfill, and incidental Work for new structures;

b. break down this total value shall be broken down into separate values for each new structure constructed as a part of the Work;

c. miscellaneous and minor concrete Work may be listed as one item in this breakdown;

8. the total value of site civil Work, inclusive of clearing and grubbing, paving, grading and drainage Work, and;

9. the total value of other Work not specifically included in the above items.

C. Review and Revisions

1. The Contractor and Engineer shall meet and jointly review the preliminary Schedule of Values and make any adjustments in value allocations if, in the opinion of the Engineer, these are necessary to establish fair and reasonable allocation of values for the major Work components.

2. Front-end loading will not be accepted.

3. The Engineer may require reallocation of major Work components from items in the above listing if in the opinion of the Engineer such reallocation is necessary.

4. This review and any necessary revisions shall be completed within 15 Days from the date of Notice to Proceed.

1.04 DETAILED SCHEDULE OF VALUES

A. Prepare and submit a detailed Schedule of Values to the Engineer within 30 Days from the date of Notice to Proceed.

B. Base the detailed Schedule of Values on the accepted preliminary Schedule of Values for major Work components.

C. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through cost loading of the CPM Schedule activities, furnish a sufficiently detailed breakdown in order to meet this requirement.

D. The Engineer will be the sole judge of acceptable numbers, details and description of values established.

E. If, in the opinion of the Engineer, a greater number of Schedule of Values items than proposed is necessary, add the additional items so identified by the Engineer.

F. Submit the minimum detail of breakdown of the major Work components as follows; furnish greater detail if requested by the Engineer:

1. Mobilization: no breakdown required;

2. Section 01 32 16 – CPM Construction Schedule: break down by submittal;

3. Break down the electrical Work by structure and yard facilities, as follows:

    a. Break down structures electrical Work into conduit and raceway installation, cable and wire installation, electrical equipment installation, terminations, and lighting; and,

    b. Break down yard facilities electrical Work by duct bank designation and substations;

4. Break down instrumentation and control Work by structure;

5. Protective Coating Work:

    a. Break down protective coating Work by structure and yard area;

    b. Where specific coating Work at structures or yard areas may be critical to performing the Work in order to meet milestone and Contract Times, such Work shall be included as individual pay and Schedule activity items;

6. Yard Piping Work:

    a. Break down into individual pipelines running from and to Contract termination points.

    b. Each pipeline shall be an individual pay item unless otherwise allowed by the Engineer.

7. Break down mechanical Work within each structure in order to identify individual piping systems, equipment installation by equipment name and number, and equipment testing and checkout.

8. Break down concrete structures into excavation, subgrade preparation, and appurtenant pre-foundation Work, concrete foundation construction, slabs on grade, walls/columns, suspended slabs, stairs, and the like (provide sufficiently detailed breakdown in order to accommodate necessary Schedule detail), hydrostatic structure testing, where required, and backfill.

9. Break down civil site Work into individual drainage piping, drainage structures, site concrete, paving, excavation cut and fill, removal of existing pipe, clearing and grubbing, and other items determined to be necessary for the establishment of pay and schedule activity items.

10. Break down pre-commissioning and commissioning based on completion milestones for each.

11. Break down other Work not specifically included in the above items, as necessary for the establishment of pay and schedule activity items.

G. Adjustments and Acceptance

1. The Contractor and Engineer shall meet and jointly review the detailed Schedule of Values within 35 Days from the date of Notice to Proceed, at which time the value allocations and extent of detail shall be reviewed in order to determine if necessary adjustments to the values are required, and to determine if sufficient detail has been proposed in order to allow acceptable cost loading of the CPM Schedule activities.

2. Make necessary adjustments to the value allocation or level of detail, and submit a revised detailed Schedule of Values within 40 Days from the date of Notice to Proceed.

3. Following acceptance of the detailed Schedule of Values, incorporate the values into the cost loading portion of the CPM Schedule.

4. Concurrently develop the CPM activities and logic with the development of the detailed Schedule of Values; however, it shall be necessary to adjust the detailed Schedule of Values to correlate to individual Schedule activities.

5. It is anticipated that instances will occur, due to the independent but simultaneous development of the Schedule of Values and the CPM Schedule activities, where interfacing these 2 documents will require changes to each document.

6. Schedule activities may need to be added to accommodate the detail of the Schedule of Values, and Schedule of Value items may need to be added to accommodate the detail of the CPM Schedule activities.

7. Where such instances arise, propose changes to the Schedule of Values and to the CPM Schedule activities in order to satisfy the CPM Schedule cost loading requirements.

1.05 CROSS-REFERENCE LISTING

A. To assist in the correlation of the Schedule of Values and the CPM Schedule, provide a cross-reference listing to be furnished in 2 parts:

   1. In the first part, list each scheduled activity with the breakdown of the respective valued items making up the total cost of the activity; and,

   2. In the second part, list the valued item with the respective schedule activity or activities that make up the total indicated cost.

B. In the case where a number of schedule items make up the total cost for a valued item (shown in the Schedule of Values), indicate the total cost for each Schedule of Value item.

C. Update and submit these listings in conjunction with the CPM monthly submittals as indicated in Section 01 32 16 – CPM Construction Schedule.

D. Incorporate approved Change Orders reflected in the CPM Schedule into the Schedule of Values as a single unit identified by the Change Order number.

1.06 CHANGES TO SCHEDULE OF VALUES

A. Changes to the CPM Schedule which additional activities not included in the original schedule but included in the original Work (schedule omissions) shall have values assigned as approved by the Engineer.

B. Reduce other activity values in order to provide equal value adjustment increases for added activities, as approved by the Engineer.

C. In the event that the Contractor and Engineer agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 32 16 - CPM CONSTRUCTION SCHEDULE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall schedule the Work in accordance with this Section.

B. Development of the schedule, the cost loading of the schedule, monthly payment requisitions and project status reporting requirements of the Contract shall employ Critical Path Method (CPM) scheduling. The CPM Schedule shall be cost loaded based on the schedule of values as approved by the Engineer in accordance with Section 01 29 73 – Schedule of Values.

C. The CPM schedule and related reports should be prepared electronically.

1.2 DEFINITIONS

A. CPM Scheduling: The term shall be interpreted to be generally as outlined in the Association of General Contractors (AGC) publication, "The Use of CPM in Construction." except that either "i-j" arrow diagrams or precedence diagramming format may be utilized. In the case of conflicts between this Section and the AGC document, this Section shall govern.

B. Float: Unless otherwise indicated herein, float and total float are synonymous. Total float is the period of time measured by the number of Days each non-critical path activity may be delayed before it and its succeeding activities become part of the critical path. If a non-critical path activity is delayed beyond its float period, then that activity becomes part of the critical path and controls the end date of the Work. Thus, delay of a non-critical path activity beyond its float period will cause delay to the project itself.

1.3 CPM SCHEDULE SUBMITTALS

A. Original CPM Schedule Submittal: Within 30 Days after the commencement date stated in the Notice to Proceed, the Contractor shall submit for review by the Engineer an electronic CPM schedule (PDF or Excel). This submittal shall have already been reviewed and approved by the Contractor's Project Manager, superintendent, and estimator prior to submission. The CPM schedule shall describe the activities to be accomplished and their logical relationships and shall show the critical path. Each installation and sitework activity shall be cost loaded.

B. Original CPM Schedule Review Meeting: The Contractor shall, within 40 Days from the commencement date stated in the Notice to Proceed, meet with the Engineer to review the original CPM schedule submittal. The Engineer's review will be limited to conformance with the Contract Documents. However, the review may also include:

1. Clarifications of the design intent.

2. Directions to include activities and information missing from the submittal.

3. Requests to the Contractor to clarify and revise the schedule.

C. Revisions to the Original CPM Schedule: Within 50 Days after the commencement date stated in the Notice to Proceed, the Contractor shall revise the original CPM schedule submittal to address review comments from the original CPM schedule review meeting

and resubmit for the Engineer's review. The Engineer, within 14 Days from the date that the Contractor submitted the revised schedule will either (1) accept the schedule as submitted, or (2) advise the Contractor in writing to review any part or parts of the schedule which either do not meet the requirements or are unsatisfactory for the Engineer to monitor the progress and status of Work or evaluate monthly payment requests by the Contractor. The Engineer may accept the schedule conditional upon the first monthly CPM schedule update correcting deficiencies identified. When the schedule is accepted, it shall be considered as the "Original CPM Construction Schedule" until an updated schedule has been submitted. The Engineer reserves the right to require that the Contractor adjust, add to, or clarify any portion of the schedule which may later be discovered to be insufficient for the monitoring of Work or approval of partial payment requests. No additional compensation will be provided for such adjustments, additions, or clarifications.

D. Acceptance

1. Acceptance of the Contractor's schedule by the Engineer and Owner will be based solely upon compliance with the requirements. By way of the Contractor assigning activity durations and proposing the sequence of the Work, the Contractor agrees to utilize sufficient and necessary management and other resources to perform Work in accordance with the schedule. Upon submittal of a schedule update, the updated schedule shall be considered the "current" project schedule.

2. Submission of the Contractor's progress schedule to the Engineer shall not relieve the Contractor of total responsibility for scheduling, sequencing, and pursuing the Work to comply with the requirements of the Contract Documents, including adverse effects such as delays resulting from ill-timed Work.

E. Monthly Updates and Periodic CPM Schedule Submittals

1. Following acceptance of the Contractor's original CPM schedule, the Contractor shall monitor the progress of the Work and adjust the schedule each month to reflect actual progress and any changes in planned future activities. Each schedule update submittal shall be complete including information requested in the original schedule submittal and be in the schedule report format indicated below. Each update shall continue to show Work activities including those already completed. Completed activities shall accurately depict "as built" information by indicating when the Work was actually started and completed.

2. Neither the submission nor the updating of the Contractor's original schedule submittal nor the submission, updating, change, or revision of any other report, curve, schedule, or narrative submitted by the Contractor, nor the Engineer's review or acceptance of any such report, curve, schedule, or narrative shall have the effect of amending or modifying in any way the Contract Times or milestone dates or of modifying or limiting in any way the Contractor's obligations under the Contract. Only a signed, fully executed Change Order can modify contractual obligations.

1.4 CHANGE ORDERS

A. Upon approval of a Change Order or upon receipt by the Contractor of authorization to proceed with additional WORK, the change shall be reflected in the monthly updates of the CPM Schedule. Whenever the Contractor believes that a Change Order will extend the Contract Times, the sub-network analysis herein shall be submitted with the price proposal for the change. If the Contractor does not submit the sub-network demonstrating

that the change affects the Contract Times, then no subsequent claim for additional time due to the change will be accepted.

1.5 CPM STANDARDS

A. Construction and procurement activities shall be presented in a time-scaled format with a calendar timeline along the entire sheet length. Each activity arrow or node shall be plotted so that the beginning and completion dates of each activity are accurately represented along the calendar timeline. Every activity shall use symbols that clearly distinguish between critical path activities, non-critical activities, and free float for each non-critical activity.

1.6 PROJECT STATUS REPORTING

A. The Contractor shall prepare monthly written narrative reports of the status of the project for submission to the Engineer. Status reports shall include:

1. The status of major project components (percent complete, amount of time ahead or behind schedule) and an explanation of how the project will be brought back on schedule if delays have occurred.

2. The progress made on critical activities indicated on the CPM schedule.

3. Explanations for any lack of Work on critical path activities planned for the last month.

4. Explanations for any schedule changes, including changes to the logic and to activity durations.

5. A list of the critical activities scheduled to be performed in the next 2 months.

6. The status of major material and equipment procurement.

7. The value of materials and equipment properly stored at the Site but not yet incorporated into the Work.

8. Any delays encountered during the reporting period.

9. An assessment of inclement weather delays and impacts to the progress of the Work.

B. The Contractor may include any other information pertinent to the status of the Work. The Contractor shall include additional status information requested by the Engineer.

1.7 INCLEMENT WEATHER PROVISIONS OF THE SCHEDULE

A. The Contractor's schedule shall include at least the number of Days of delay due to unusually severe weather as required by the Supplementary General Conditions.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Wherever submittals are required by the Contract Documents, submit them to the Engineer.

B. Within 14 Days after the date of commencement as stated in the Notice to Proceed, submit the following items for review:

1. Submittal Schedule

a. Submit a preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("or equal") submittals listed in the Bid.

b. Base the schedule of submittals on Contractor's priority, planned construction sequence and schedule, long-lead items, and size of submittal package.

c. Allow time for resubmittals.

2. Submit a list of permits and licenses the Contractor shall obtain, indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 10 00	Summary of Work
01 29 73	Schedule of Values
01 32 16	CPM Construction Schedule
01 60 00	Products, Materials, Equipment, and Substitutions
01 77 00	Project Closeout

1.03 PRECONSTRUCTION CONFERENCE SUBMITTALS

A. At the preconstruction conference of Section 01 10 00 – Summary of Work, submit the following items to the Engineer for review:

1. a revised schedule of Shop Drawings, Samples, and proposed Substitution ("or-equal") submittals listed in the Bid;

2. a list of permits and licenses the Contractor shall obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit;

3. a preliminary schedule of values in accordance with Section 01 29 73 – Schedule of Values;

4. a 60-Day plan of operation in accordance with Section 01 32 16 – CPM Construction Schedule.

1.04 SHOP DRAWINGS

A. Wherever called for in the Contract Documents or where required by the Engineer, provide Shop Drawings in PDF format.

B. Shop Drawings may include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items.

C. Whenever the Contractor is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of an engineer registered in the appropriate branch and in the State of Utah, unless otherwise indicated.

D. Transmittal Form

1. Shop Drawing submittals shall be accompanied by the Engineer's standard submittal transmittal form, a reproducible copy of which is available from the Engineer.

2. A submittal without the form, or where applicable items on the form have not been completed, will be returned for resubmittal.

E. Organization

1. Use a single submittal transmittal form for each technical specification Section or item or class of material or equipment for which a submittal is required.

2. A single submittal covering multiple Sections will not be accepted, unless the primary specification references other Sections for components: For example, if a pump Section references other Sections for the motor, shop-applied protective coating, anchor bolts, local control panel, and variable frequency drive, a single submittal would be accepted, whereas a single submittal covering vertical turbine pumps and horizontal split-case pumps would not be accepted.

3. On the transmittal form, index the components of the submittal.

4. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title, room number, or building name, as applicable.

5. Unless otherwise indicated, match terminology and equipment names and numbers used in the submittals with those used in the Contract Documents.

F. Format

1. Submittals shall be submitted as a PDF document.

2. Number every page in a submittal in sequence.

3. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports.

4. Present a sufficient level of detail for assessment of compliance with the Contract Documents.

5. Numbering

    a. Assign to each submittal a unique number.

    b. Number the submittals sequentially, with the submittal numbers clearly noted on the transmittal.

    c. Assign original submittals a numeric submittal number followed by a letter of the alphabet in order to distinguish between the original submittal and each resubmittal: For example, if submittal "25-A" requires a resubmittal, the first resubmittal will bear the designation "25-B" and the second resubmittal will bear the designation "25-C," and so on.

6. Provide an electronic pdf copy of final approved submittals.

G. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.

H. Engineer's Review

1. Except as otherwise indicated, the Engineer will return each submittal to the Contractor with comments noted thereon, within 30 Days following receipt by the Engineer.

2. It is considered reasonable that the Contractor shall make a complete and acceptable submittal to the Engineer by the first resubmittal on an item.

3. The Owner reserves the right to withhold monies due to the Contractor to cover additional costs of the Engineer's review beyond the first resubmittal.

4. The Engineer's maximum review period for each submittal or resubmittal will be 30 Days; thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 90 Days.

I. If a submittal is returned to the Contractor marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.

J. If a submittal is returned marked "MAKE CORRECTIONS NOTED," the Contractor shall make the corrections on the submittal, but formal revision and resubmission will not be required.

K. Resubmittals

1. If a submittal is returned marked "AMEND-RESUBMIT," the Contractor shall revise the submittal and resubmit.

2. Resubmittal of portions of multi-page or multi-drawing submittals will not be accepted: For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "AMEND-RESUBMIT," the submittal as a whole is deemed "AMEND-RESUBMIT," and 10 drawings are required to be resubmitted.

3. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.

L. Rejected Submittals

1. If a submittal is returned marked "REJECTED-RESUBMIT," it shall mean either that the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed, or is a substitution request not submitted in accordance with Section 01 60 00 – Products, Materials, Equipment, and Substitutions.

2. In the first 2 cases, the Contractor shall prepare a new submittal.

3. In the latter case, the Contractor shall submit the substitution request according to the requirements of Section 01 60 00 – Products, Materials, Equipment, and Substitutions.

4. The resubmittal of rejected portions of a previous submittal will not be accepted.

M. The fabrication of an item may commence only after the Engineer has reviewed the pertinent submittals and returned copies to the Contractor marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

N. Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.

O. Review by Contractor

1. Submittals shall be carefully reviewed by an authorized representative of the Contractor prior to submission to the Engineer.

2. Each submittal shall be dated and signed by the Contractor as being correct and in strict conformance with the Contract Documents.

3. In the case of Shop Drawings, each sheet shall be so dated and signed.

4. Any deviations from the Contract Documents shall be noted on the transmittal sheet.

5. The Engineer will only review submittals that have been so verified by the Contractor.

6. Non-verified submittals will be returned to the Contractor without action taken by the Engineer, and any delays caused thereby shall be the total responsibility of the Contractor.

P. Conformance

1. Corrections or comments made on the Contractor's Shop Drawings during review shall not relieve the Contractor from compliance with Contract Drawings and Specifications.

2. A lack of comments made on the Contractor’s Shop Drawings during review shall not relieve the Contractor from compliance with Contract Drawings and Specifications.

3. Review is for conformance to the design concept and general compliance with the Contract Documents only.

4. The Contractor shall be responsible for confirming and correlating quantities and dimensions, fabrication processes and techniques, coordinating Work with the trades, and satisfactory and safe performance of the Work.

1.05 SAMPLES

A. Quantity

1. The Contractor shall submit the number of samples indicated by the Specifications.

2. If the number is not indicated, submit not less than 3 samples.

3. Where the quantity of each sample is not indicated, submit such quantity as necessary for proper examination and testing by the methods indicated.

B. Identification and Distribution

1. Individually and indelibly label or tag each sample, indicating the salient physical characteristics and the manufacturer's name.

2. Upon acceptance by the Engineer, one set of the samples will be stamped and dated by the Engineer and returned to the Contractor, one set of samples will be retained by the Engineer, and one set shall remain at the Site in the Engineer's field office until completion of the Work.

C. Selection

1. Unless otherwise indicated, the Engineer will select colors and textures from the manufacturer's standard colors and standard materials, products, or equipment lines.

2. If certain samples represent non-standard colors, materials, products, or equipment lines that will require an increase in Contract Times or Price, the Contractor shall clearly state so on the transmittal page of the submittal.

D. The Contractor shall schedule sample submittals such that:

1. Sample submittals for color and texture selection are complete so the Engineer has 45 Days to assemble color panels and select color- and texture-dependent products and materials without delay to the construction schedule; and,

2. After the Engineer selects colors and textures, the Contractor has sufficient time to provide the products or materials without delay to the construction schedule.

3. The Contract Times will not be extended for the Contractor's failure to allow enough review and approval or selection time, failure to submit complete samples requiring color or texture selection, or failure to submit complete or approvable samples.

1.06 TECHNICAL MANUAL

A. The Contractor shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual.

B. The manual shall be written such that it can be used and understood by the Owner's operation and maintenance staff.

C. The Specifier must consider whether the organization of information in the manuals is appropriate for the scope of the Work. If possible during customization, discuss the manual organization with Owner staff and O&M manual specialists.

D. Categories

1. The Technical Manual shall be subdivided first by Specification Section number; second, by equipment item; and last, by "Category." The following "Categories" shall be addressed (as applicable):

a. Category 1 - Equipment Summary

1) Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

2) Form: The Engineer will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the Work. The Contractor shall fill in the relevant information on the form and include it in Part 1.

b. Category 2 - Operational Procedures

1) Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

a) Installation

b) Adjustment

c) Startup

d) Location of controls, special tools, equipment required, or related instrumentation needed for operation

e) Operation procedures

f) Load changes

g) Calibration

h) Shutdown

i) Troubleshooting

j) Disassembly

k) Reassembly

l) Realignment

m) Testing to determine performance efficiency

n) Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices

o) List of all electrical relay settings including alarm and contact settings

c. Category 3 - Preventive Maintenance Procedures

1) Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.

2) Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

d. Category 4 - Parts List

1) Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

2) Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.

e. Category 5 - Wiring Diagrams

1) Diagrams: Category 5 shall include complete internal and connection wiring diagrams for electrical equipment items.

f. Category 6 - Shop Drawings

1) Drawings: This category includes approved shop or fabrication drawings with Engineer comments and corrections incorporated, complete with dimensions.

g. Category 7 - Safety

1) Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

h. Category 8 - Documentation:

1) Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this category.

E. Format

1. Bind each Technical Manual in standard size 3-ring hardcover binders, labeled on the spine and cover with Project name, Owner's project number, Specification Section number, equipment name, and equipment identification number.

2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders in a multi-binder set.

3. Documents in binders shall be 3-hole punched, with no text punched out, and pages larger than 8-1/2 by 11 shall be folded to 8-1/2 by 11 size.

4. Provide a flash drive with electronic files with each final set of Technical Manuals, as follows:

   a. Adobe Acrobat portable document format (PDF) or other software required by the Specifications.

   b. Manufacturer literature in Adobe Acrobat portable document format (PDF).

F. Review Process

1. Furnish draft Technical Manuals electronically for each Specification Section that requires a manual.

2. The Owner and Engineer will review and provide comments back to the Contractor.

3. Contractor shall incorporate comments into the draft and submit 3 identical hard copies and a flash drive (manual in PDF format) of the final manual for acceptance.

G. Schedule

H. Submittal and Corrections

1. The Work under this Contract involves start-up and commissioning of equipment in multiple areas of the facility at independent times within the Project Schedule.

2. The manuals shall be completed for each piece of equipment prior to final acceptance of the equipment by the Owner.

3. Except as otherwise indicated, submit the manuals for review in final form a minimum of 30 Days prior to the start of performance testing for each piece of equipment.

4. Discrepancies found by the Engineer shall be corrected within 30 Days from the Date of written notification by the Engineer.

1.07 SPARE PARTS LIST

A. General

1. Furnish to the Engineer a spare parts list for mechanical, electrical, and instrumentation equipment.

2. The spare parts list shall include those spare parts that each manufacturer recommends to be maintained by the Owner in inventory.

B. Sources and Pricing

1. The spare parts list shall include a current list price of each spare part.

2. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts, to assist the Owner in ordering.

3. For coatings, include local suppliers list.

C. Format

1. Cross-reference the spare parts lists to the equipment numbers designated in the Contract Documents.

2. The spare parts lists shall be in PDF electronic format.

1.08 AS-BUILT DRAWINGS

A. On-Site Drawings Set

1. Maintain one set of Drawings at the Site for the preparation of as-built drawings.

2. On this set, mark every project condition, location, configuration, and any other change or deviation which may differ from the Contract Drawings at the time of award, including buried or concealed construction and utility features that are revealed during the course of construction.

3. Give special attention to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings.

4. Supplement the as-built drawings by any detailed sketches as necessary or as directed, in order to fully indicate the Work as actually constructed.

5. The as-built drawings are the Contractor's representation of as-built conditions, shall include revisions made by addenda and change orders, and shall be maintained up-to-date during the progress of the Work.

6. Use red font for alterations and notes.

7. Notes shall identify relevant Change Orders by number and date.

8. Layout/shop drawings that differ from design drawings shall be included.

B. In the case of those drawings that depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, update the as-built drawings by indicating those portions which are superseded by Change Order drawings or final Shop Drawings, and by including appropriate reference information describing the Change Orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.

C. As-built drawings shall be accessible to the Engineer during the construction period.

D. Final Payment

1. Final payment will not be acted upon until the as-built drawings have been completed and delivered to the Engineer.

2. Up-to-date as-built drawings shall be in the form of hard copy and/or electronic PDFs.

E. Information submitted by the Contractor will be assumed to be correct, and the Contractor shall be responsible for the accuracy of such information.

1.09 QUALITY CONTROL (QC) SUBMITTALS

A. Quality control submittals are defined as those required by the Specifications to present documentary evidence to the Engineer that the Contractor has satisfied certain requirements of the Contract Documents.

B. Unless otherwise indicated, QC submittals shall be submitted:

1. Before delivery and unloading, for the following types of submittals:

a. Manufacturers' installation instructions

b. Manufacturers' and Installers' experience qualifications

c. Ready mix concrete delivery tickets

d. Design calculations

e. Affidavits and manufacturers' certification of compliance with indicated product requirements

f. Laboratory analysis results

g. Factory test reports

2. Within 30 Days of the event documented for the following types of submittals:

a. Manufacturers' field representative certification of proper installation

b. Field measurement

c. Field test reports

d. Receipt of permit

e. Receipt of regulatory approval

C. The Engineer will record the date that a QC submittal was received and review it for compliance with submittal requirements, but the review procedures above for Shop Drawings and samples will not apply.

1.10 CONSTRUCTION PHOTOGRAPHS

A. General

1. Furnish construction photographs showing the progress of the Work.

2. Contractor shall submit pre-construction photos as well as post-construction photos for all project components.

3. Starting when the Work begins and continuing for as long as the Work is in progress, take photos not less than 2 weeks apart, consisting of different subjects or angles or view at different locations of progress on the Site.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 33 17 STRUCTURAL DESIGN, SUPPORT AND ANCHORAGE

PART 1 – GENERAL

1.01 SUMMARY

A. The Contractor shall provide calculations and details for structural and non-structural components, supports, and anchorages as required by the Contract Documents and the 2021 IBC. The Contractor shall furnish and install all such structural and non-structural components, supports, and anchorages in accordance with the calculations and details.

B. The Contractor shall provide calculations and details for structures and non-building structures, supports, and anchorages as required by the Contract Documents and the 2021 IBC. The Contractor shall furnish and install all such structures and non-building structures, supports, and anchorages in accordance with the calculations and details.

C. Where a conflict exists between the requirements of the Contract Documents and the 2021 IBC, the more stringent requirement shall apply.

D. Design parameters used to determine Seismic and Wind design forces shall be as listed herein.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
04 05 19.29	Post Installed Anchors in Masonry
05 05 19	Post Installed Anchors in Concrete

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 IBC. If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

IBC	International Building Code
ASCE 7	American Society of Civil Engineers Standard 7-22 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ACI 318	Building Code Requirements for Structural Concrete (2019 edition)
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary (2020 edition)
ACI 350.3	Code Requirements for Seismic Analysis and Design of Liquid-Containing Concrete Structures and Commentary (2020 edition)
TMS 402/602	Building Code Requirements for Masonry Structures and Specifications (2016 edition)

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00.

B. Calculations and Details.

1. Calculations and details are considered a Deferred Submittal as defined in the IBC.

2. Calculations and details shall be complete, accurate, and in accordance with the requirements of the IBC and ASCE 7 and shall be signed and sealed by a Professional Engineer registered in the State of Utah.

3. Calculations shall be clear and concise and show equipment and other non-structural component anchorage forces and the capacities of the anchorage elements proposed by the Contractor. The calculations shall substantiate a complete load path from the component or equipment being anchored into the supporting structure or foundation.

4. The calculations and details shall demonstrate a complete lateral and vertical load path and shall clearly indicate all forces imposed on the supporting structure.

5. Calculations and details are required for all non-structural components, supports, anchorages, and attachments.

a. Non-structural components shall include all architectural, mechanical, and electrical components, equipment, piping, ductwork, and all other similar or related appurtenances necessary to produce the complete architectural, mechanical, and electrical systems.

6. When the Contract Documents require the Contractor to design structures or structural components, calculations and details for those structures and structural components, and their supports, anchorages, and attachments, are required.

7. When computer generated calculations and analyses are included as part (or as the whole) of the calculations, the calculations shall include, but not be limited to, the following: derivations of all input parameters; clear indication of the applicable load combinations and building code equations; diagrams of all members, geometry, loads, forces, reactions and deflections, for all components and connections; and output results demonstrating all stress, force, deflection and other Contract Document and building code requirements have been satisfied.

8. All calculations associated with anchorage into concrete or masonry shall be done using Strength Level forces and shall be in accordance with the applicable provisions of ACI 318 and TMS 402, respectively.

9. Refer to Part 2 below for additional requirements.

1.04 SEISMIC DESIGN CRITERIA

A. Design Requirements

1. Design Parameters:

a. Risk Category: III.

b. Seismic Design Category: D.

c. Mapped MCE_R, 5% damped spectral response acceleration parameter at short periods: S_S = 1.05.

d. Mapped MCE_R, 5% damped spectral response acceleration parameter at a period of 1-second: S_1 = 0.34.

e. Site Class: D (Default).

f. Design, 5% damped spectral response acceleration parameter at short periods: S_{DS} = 0.82.

g. Design, 5% damped spectral response acceleration parameter at a period of 1-second: S_{D1} = 0.55.

h. Long period transition period: T_L = 8 seconds

i. Response modification coefficient, R: In accordance with ASCE 7, Tables 12.2-1, 12.14-1, 15.4-1 and 15.4-2.

j. Seismic Importance Factor, I: 1.250.

k. Component amplification factor, a_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.

l. Component response modification factor, R_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.

m. Component importance factor, Ip: 1.50

2. The following components are exempted from the seismic design requirements:

a. Exemptions shall be as indicated in ASCE 7 Chapter 13.

1.05 WIND DESIGN CRITERIA

A. Design Requirements

1. Design Parameters:

a. Risk Category: III.

b. Basic 3-second Wind Gust Speed: 110 miles per hour.

c. Exposure Category: C.

d. Topographic Factor, K_{zt}: 1.0.

PART 2 – PRODUCTS

2.01 GENERAL

A. Non-Structural Component Supports and Anchors

1. Unless otherwise indicated, non-structural component supports, anchors, and restrainers shall be adequately designed for all applicable static, dynamic, operational, seismic and wind loads.

    a. Wall-mounted equipment weighing more than 250 pounds or which is within 18-inches of the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel or engineered framing support systems. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

    b. All equipment and all other non-structural components shall be supported and anchored in place by methods that satisfy the building code and the Contract Documents.

    c. All equipment and all other non-structural components shall be supported and anchored in place by methods that satisfy the manufacturer's applicable seismic certification requirements.

2. Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.

B. Non-Building Structures

1. Non-Building Structures shall be designed in accordance with ASCE 7 Chapter 15.

2. Non-Building Structures, foundations, supports, anchors, and restrainers shall be adequately designed for all applicable static, dynamic, operational, seismic and wind loads.

C. Anchors – General

1. Anchor rods shall be cast-in-place unless otherwise noted or approved by the Engineer.

2. Anchor rods shall be in accordance with Section 05 50 00.

3. Adhesives and epoxies for post-installed anchors in concrete or masonry shall be in accordance with Section 05 05 19 or 04 05 19.29, respectively.

4. Grouts for anchor rods shall be in accordance with Section 03 60 00.

5. The Contractor shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the calculations and details.

6. Anchor rod calculations shall clearly show that the capacity of the anchor and the capacity of the concrete that the anchor is embedded in are adequate to resist all applicable load combinations, including seismic and wind loads.

    a. The design of anchors resisting seismic forces shall satisfy the ductility requirements stated in the IBC, ASCE 7, ACI 318, and TMS 402.

7. Reduction factors associated with edge distance, embed length, grout and base plate thickness, and rod spacing shall all be considered and based on the actual dimensions of the concrete or masonry that resists the anchorage forces.

8. Where anchorage is required into or through equipment pads, the following requirements shall apply unless otherwise approved by the Engineer:

    a. For tensile forces, the embed length and associated concrete failure zone shall be provided entirely within the structural slab. No portion of the equipment pad may be considered as effective in resisting tensile forces.

    b. For shear forces, the edge distance and associated concrete failure zone shall be provided entirely within the equipment pad. No portion of the structural slab may be considered as effective in resisting shear forces.

9. Anchor rod details shall include required rod diameter, embed, spacing, and edge distances.

10. Where additional reinforcement is required to satisfy anchorage requirements, such reinforcement shall be included in the anchorage details, and shall be furnished and installed by the Contractor.

D. Mechanical and Electrical Equipment Foundations

1. Equipment foundations are indicated on Drawings. The Contractor, through the equipment manufacturer, shall verify the size and weight of the equipment foundation to ensure compatibility with equipment.

2. Equipment foundation dimensions shall be coordinated with the equipment base geometry and the edge distance and embed requirements of the equipment anchorage calculations.

E. Mechanical and Electrical Equipment (Housekeeping) Pads

1. General

    a. Equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on concrete equipment pads, unless otherwise indicated. The top surface of the equipment pads shall be level, unless otherwise indicated, or otherwise required by the equipment Manufacturer.

    b. Equipment pads shall be sized to accommodate the bearing and anchorage requirements of the equipment, subject to the constraints listed below.

    c. Final geometry of the equipment pads shall not result in a condition that violates applicable building code provisions, including but not limited to the provisions of the National Electric Code.

2. Mechanical Equipment Pads

    a. Mechanical equipment pad heights shall be coordinated with process equipment and piping elevation requirements. Where no such elevation constraints exist, the equipment pad height shall be as shown on the drawings, or as indicated below when no specific height is provided.

1) Equipment pads for mechanical equipment shall be 5 inches in thickness (maximum) at the front of the equipment.

b. Mechanical equipment pads shall extend not more than 2 inches beyond the front, back, and sides of the equipment, except as indicated below, unless otherwise shown on the drawings.

1) Where necessary to meet seismic or wind anchorage requirements, the pads may be extended beyond the 2 inch limit indicated above. The pads shall extend not more than 10 inches beyond the front, back, and sides of the equipment.

3. Electrical Equipment Pads

a. Electrical equipment pads shall be 3.5 inches tall (maximum) at the front of the equipment.

b. Electrical equipment pads shall extend not more than 2 inches beyond the front, back, and sides of the equipment, except as indicated below, unless otherwise shown on the drawings.

1) Where necessary to meet seismic anchorage requirements, the pads may be extended beyond the 2 inch limit indicated above. The pads shall extend not more than 10 inches beyond the front, back, and sides of the equipment.

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 35 53 – SITE SECURITY

PART 1 -- GENERAL

1.01 SECURITY PROGRAM

A. The Contractor shall:

1. Protect Work, existing premises, and Owner's operations from theft, vandalism, and unauthorized entry.

2. Initiate program in coordination with Owner's existing security system at mobilization.

3. Maintain program throughout construction period.

1.02 ENTRY CONTROL

A. The Contractor shall:

1. Restrict entry of persons and vehicles into Site and existing facilities.

2. Allow entry only to authorized persons with proper identification.

3. Maintain log of workmen and visitors and make log available to Owner on request.

4. Coordinate access of Owner's personnel to Site in coordination with Owner's security forces.

B. The Owner will control the entrance of persons and vehicles to those related to the Owner's operations.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 42 13 – ABBREVIATIONS OF INSTITUTIONS

PART 1 -- GENERAL

1.01 GENERAL

A. Wherever in these Specifications references are made to the standards, specifications, or other published data of the various international, national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of the Specifications, the following acronyms or abbreviations which may appear shall have the meanings indicated herein.

1.02 ABBREVIATIONS

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABMA	American Bearing Manufacturer's Association – ABMA
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
AF&PA	American Forest and Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	The Asphalt Institute
AIA	American Institute of Architects
AIHA	American Industrial Hygiene Association
AIIM	Association for Information and Image Management
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMA	Acoustical Material Association

AMCA	Air Movement and Control Association International, Inc
ANS	American Nuclear Society
ANSI	American National Standards Institute, Inc.
APA	The Engineered Wood Association
API	American Petroleum Institute
APWA	American Public Works Association
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society of Nondestructive Testing
ASQ	American Society for Quality
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWCI	American Wire Cloth Institute
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BBC	Basic Building Code, Building Officials and Code Administrators International
BHMA	Builders Hardware Manufacturer's Association
CABO	Council of American Building Officials
CDA	Copper Development Association
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association

CLFMI	Chain Link Fence Manufacturer's Institute
CLPCA	California Lathing and Plastering Contractors Association
CMAA	A division/section of the Material Handling Industry of America
CPG	Compressed Gas Association
CRSI	Concrete Reinforcing Steel Institute
DCDMA	Diamond Core Drilling Manufacturer's Association
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
EI	Energy Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
ETL	Electrical Test Laboratories
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
FEMA	Federal Emergency Management Association
FHWA	Federal Highway Administration
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute, Hydraulic Institute
HSWA	Federal Hazardous and Solid Waste Amendments
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
ICBO	International Conference of Building Officials
ICC	International Code Council
ICC-ES	International Code Council Evaluation Service
ICCEC	Electrical Code
ICEA	Insulated Cable Engineers Association
IECC	International Energy Conservation Code

IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFC	International Fire Code
IFGC	International Fuel Gas Code
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code, Association Connecting Electronic Industries
IRC	International Residential Code
ISA	Instrument Society of Automation
ISDI	Insulated Steel Door Institute
ISEA	Industrial Safety Equipment Association
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
ITU-T	Telecommunications Standardization Sector of the International Telecommunications Union
LPI	Lightning Protection Institute
LRQA	Lloyd’s Register Quality Assurance
MBMA	Metal Building Manufacturer's Association
MIL	Military Standards (DoD)
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers
DASMA	Door and Access Systems Manufacturers Association International
NACE	National Association of Corrosion Engineers
NAPF	National Association of Pipe Fabricators
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors
NCCLS	National Committee for Clinical Laboratory Standards

NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association or National Fluid Power Association
NISO	National Information Standards Organization
NIST	National Institute of Standards and Technology
NLGI	National Lubricating Grease Institute
NRCA	National Roofing Contractors Association
NSF	National Sanitation Foundation
NWWDA	National Wood Window and Door Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PPI	Plastic Pipe Institute
RCRA	Resource Conservation and Recovery Act
RIS	Redwood Inspection Service, a division of the California Redwood Association, CRA
RMA	Rubber Manufacturers Association
RVIA	Recreational Vehicle Industry Association
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SDI	Steel Door Institute, Steel Deck Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPFA	Steel Plate Fabricator’s Association
SPIB	Southern Pine Inspection Bureau

SSBC	Southern Standard Building Code, Southern Building Code Congress
SSPC	Society for Protective Coating
SSPWC	Standard Specifications for Public Works Construction
STLE	Society of Tribologists and Lubricating Engineers
TAPPI	Technical Association of the Worldwide Pulp, Paper, and Converting Industry
TFI	The Fertilizer Institute
TIA	Telecommunications Industries Association
TPI	Truss Plate Institute
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
USEPA	United States of America Environmental Protection Agency
WCLIB	West Coast Lumber Inspection Bureau
WDMA	National Window and Door Manufacturers Association
WEF	Water Environment Federation
WI	Woodwork Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 19 – REFERENCE STANDARDS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Titles of Sections and Paragraphs: Titles and subtitles accompanying specification sections and paragraphs are for convenience and reference only and do not form a part of the Specifications.

B. Applicable Publications: Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is indicated, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the Contract is advertised for Bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth in the Specifications or shown on the Drawings will be waived because of any provision of or omission from said standards or requirements.

C. Specialists, Assignments: In certain instances, specification text requires (or implies) that specific Work is to be assigned to specialists or expert entities who must be engaged to perform that Work. Such assignments shall be recognized as special requirements over which the Contractor has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the Work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of Work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of Contract requirements remains with the Contractor.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The Contractor shall construct the Work in accordance with the Contract Documents and the referenced portions of those referenced codes, standards, and specifications.

B. Reference Standards

International Conference of Building Officials (ICBO)	
	Uniform Building Code
Southern Building Code Congress International	
National Building Code of Building Officials and Code Administrators International (BOCA)	
International Building Code of the International Code Council (ICC)	
International Association of Plumbing and Mechanical Officials (IAPMO)	
National Electric Code (NEC)	
National Fire Protection Association (NFPA)	
Occupational Safety and Health Administration (OSHA)	

Title 29, Part 1926,	Construction Safety and Health Regulations, Code of Federal Regulations
Title 29, Part 1910,	Occupational Safety and Health Standards, Code of Federal Regulations
Standard Specifications for Public Works Construction (SSWPC)	

C. References to "Building Code" or "Uniform Building Code" shall mean Uniform Building Code of the International Conference of Building Officials (ICBO). References to “Building Code” or “Standard Building Code” shall mean the Standard Building Code of the Southern Building Code Congress International. References to “Building Code” or “National Building Code” shall mean the National Building Code of Building Officials and Code Administrators International (BOCA). References to "Building Code" or International Building Code" shall mean International Building Code of the International Code Council (ICC) as amended by the local jurisdiction. Similarly, references to "Mechanical Code" or "Uniform Mechanical Code," "Plumbing Code" or "Uniform Plumbing Code," "Fire Code" or "Uniform Fire Code," shall mean Uniform Mechanical Code, Uniform Plumbing Code and Uniform Fire Code of the International Association of Plumbing and Mechanical Officials (IAPMO) as amended by the local jurisdiction. "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of the codes as approved by the Municipal Code and used by the local agency as of the date that the Work is advertised for Bids shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

D. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and direction prior to ordering or providing any materials or furnishing labor. The Contractor shall bid for the most stringent requirements.

E. References to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

F. References to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. Applicable Standard Specifications: References in the Contract Documents to "Standard Specifications" or SSPWC shall mean the Standard Specifications for Public Works Construction.

1.03 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. The Contractor shall be responsible that all Work included in the Contract Documents, regardless if indicated or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other federal, state, and local regulations governing the storage and conveyance of hazardous materials, including petroleum products.

B. Where no specific regulations exist and the Owner has not waived the requirement in writing, chemical, hazardous, and petroleum product piping and storage in underground locations shall be double containment piping and tanks or be installed in separate concrete trenches and vaults with an approved lining that cannot be penetrated by the chemicals.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 45 00 – QUALITY CONTROL

PART 1 -- GENERAL

1.01 DEFINITION

A. Specific quality control requirements for the Work are indicated throughout the Contract Documents. The requirements of this Section are primarily related to performance of the Work beyond furnishing of manufactured products. The term "Quality Control" includes inspection, sampling and testing, and associated requirements.

1.02 INSPECTION AT PLACE OF MANUFACTURE

A. Unless otherwise indicated, all products, materials, and equipment shall be subject to inspection by the Engineer at the place of manufacture.

B. The presence of the Engineer at the place of manufacturer, however, shall not relieve the Contractor of the responsibility for providing products, materials, and equipment which comply with all requirements of the Contract Documents. Compliance is a duty of the Contractor and said duty shall not be avoided by any act or omission on the part of the Engineer.

1.03 SAMPLING AND TESTING

A. Unless otherwise indicated, all sampling and testing will be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered; however, the Owner reserves the right to use any generally-accepted system of sampling and testing which, in the opinion of the Engineer will assure the Owner that the quality of the workmanship is in full accord with the Contract Documents.

B. Any waiver by the Owner of any specific testing or other quality assurance measures, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the testing or other quality assurance requirements originally indicated, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial Work, shall not be construed as a waiver of any requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, the Engineer reserves the right to make independent investigations and tests, and failure of any portion of the Work to meet any of the requirements of the Contract Documents, shall be reasonable cause for the Engineer to require the removal or correction and reconstruction of any such Work in accordance with the General Conditions.

1.04 INSPECTION AND TESTING SERVICE

A. Inspection and testing laboratory service shall comply with the following:

1. Unless indicated otherwise by the Technical Specifications, the Owner will appoint, employ, and pay for services of an independent firm to perform inspection and testing or will perform inspection and testing itself.

2. The Owner or independent firm will perform inspections, testings, and other services as required by the Engineer under Paragraph 1.3C above.

3. Reports of testing, regardless of whether the testing was the Owner's or the Contractor's responsibility, will be submitted to the Engineer, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

4. The Contractor shall cooperate with the Owner or independent firm and furnish samples of materials, design mix, equipment, tools, storage, and assistance as requested.

5. The Contractor shall notify Engineer 72 hours prior to the expected time for operations requiring inspection and laboratory testing services.

6. Retesting required because of non-conformance to requirements shall be performed by the same independent firm on instructions by the Engineer. The Contractor shall bear all costs from such retesting.

7. For samples and tests required for Contractor's use, the Contractor shall make arrangements with an independent firm for payment and scheduling of testing. The cost of sampling and testing for the Contractor's use shall be the Contractor's responsibility.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Inspection: The Contractor shall inspect materials or equipment upon the arrival on the job site and immediately prior to installation and reject damaged and defective items.

B. Measurements: The Contractor shall verify measurements and dimensions of the Work, as an integral step of starting each installation.

C. Manufacturer's Instructions: Where installations include manufactured products, the Contractor shall comply with manufacturer's applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in Contract Documents.

END OF SECTION

SECTION 01 50 10 – PROTECTION OF EXISTING FACILITIES

PART 1 -- GENERAL

1.01 GENERAL

A. The Contractor shall protect all existing utilities and improvements not designated for removal and shall restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than prior to such damage or temporary relocation, all in accordance with the Contract Documents.

1.02 RIGHTS-OF-WAY

A. The Contractor shall not do any Work that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure, nor shall the Contractor enter upon the rights-of-way involved until notified that the Owner has secured authority from the proper party.

B. After authority has been obtained, the Contractor shall give said party due notice of its intention to begin work, if required by said party, and shall remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, or replace the same.

1.03 PROTECTION OF SURVEY AND STREET OR ROADWAY MARKERS

A. The Contractor shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by the Contractor shall be restored after street or roadway resurfacing has been completed.

1.04 RESTORATION OF PAVEMENT

A. General: All paved areas including asphaltic concrete berms cut or damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing the permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement. Temporary and permanent pavement shall conform to the requirements of the affected pavement owner. Pavements which are subject to partial removal shall be neatly saw cut in straight lines.

B. Temporary Resurfacing: Wherever required by the public authorities having jurisdiction, the Contractor shall place temporary surfacing promptly after backfilling and shall maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.

C. Permanent Resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, the Contractor shall saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.

D. Restoration of Sidewalks or Private Driveways: Wherever sidewalks or private roads have been removed for purposes of construction, the Contractor shall place suitable temporary sidewalks or roadways promptly after backfilling and shall maintain them in satisfactory condition for the period of time fixed by the authorities having jurisdiction over the affected portions. If no such period of time is so fixed, the Contractor shall maintain said temporary sidewalks or roadways until the final restoration thereof has been made.

1.05 EXISTING UTILITIES AND IMPROVEMENTS

A. General: The Contractor shall protect underground Utilities and other improvements which may be impaired during construction operations, regardless of whether or not the Utilities are indicated on the Drawings. The Contractor shall take all possible precautions for the protection of unforeseen Utility lines to provide for uninterrupted service and to provide such special protection as may be necessary. Utilities and other improvements which are adjacent but not included within the limits of an excavation required for performance of the Work shall be protected, supported, and maintained by the Contractor at his expense.

B. Except where the Drawings indicate Utilities have been field located during design or certain Utility locations shall be exposed as part of the Work, the Contractor shall be responsible for exploratory excavations as it deems necessary to determine the exact locations and depths of Utilities which may interfere with its work. All such exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the Contractor's progress. When such exploratory excavations show the Utility location as shown on the Drawings to be in error, the Contractor shall so notify the Owner.

C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the Utility.

D. Utilities to be Moved: In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the Contractor, be notified by the Owner to move such property within a specified reasonable time. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall notify the Owner a sufficient time in advance for the necessary measures to be taken to prevent interruption of service.

E. Utilities to be Removed: Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, the Contractor shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to the Engineer and the Owner of the facility. In cases of temporary removal or relocation, restoration to the former location shall be accomplished by the Contractor in a manner that will restore or replace the Utility or improvement to its former locations and to as good or better condition than found prior to removal.

F. Utilities that Do Not Require Removal or Moving:

1. Utilities which are adjacent to but not included within the limits of an excavation required for performance of the Work shall be protected, supported, and maintained by the Contractor at no additional cost to the Owner.

2. Utilities within the limits of the Work which can be supported and maintained in service and which do not require removal and rebuilding shall be thus supported by the Contractor at his expense, including cost of repair due to damage caused by the Contractor operations.

    a. Supports for water and gas mains, sewers, conduits, and similar utilities shall be constructed of timber or other acceptable materials; shall be supported from undisturbed foundations and shall be sufficiently substantial to ensure protection against settlement when pipe trenches or other excavations are backfilled. In all cases where permits or inspection fees are required by utilities in connection with changes to or temporary support of their conduits, the Contractor shall secure such permits and pay all permit and inspection fees.

    b. The Contractor shall assume full responsibility for maintaining all public service utilities in operation and shall support and protect or remove and rebuild them at his own expense. Such services shall not be interrupted without permission of the owner of the public service utilities.

G. Owner's Right of Access: The right is reserved to the Owner and to the owners of public utilities and franchises to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the Work of this Contract.

H. Underground Utilities Indicated: Existing Utility lines that are indicated or the locations of which are made known to the Contractor prior to excavation and that are to be retained, and all Utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced by the Contractor, unless otherwise repaired by the owner of the damaged Utility. If the owner of the damaged facility performs its own repairs, the Contractor shall reimburse said owner for the costs of repair.

I. Underground Utilities Not Indicated: In the event that the Contractor damages existing Utility lines that are not indicated or the locations of which are not made known to the Contractor prior to excavation, a verbal report of such damage shall be made within 24 hours to the Owner and a written report thereof shall be made promptly thereafter. If the Owner is not immediately available, the Contractor shall notify the Utility owner of the damage. If directed by the Owner, repairs shall be made by the Contractor under the provisions for changes and extra Work contained in Articles 10, 11, and 12 of the General Conditions.

J. Costs of locating and repairing damage and removing or relocating such Utility facilities not indicated in the Contract Documents, and for equipment on the project which was actually working on that portion of the Work which was interrupted or idled by removal or relocation of such Utility facilities, and which was necessarily idled during such work will be paid for as extra work in accordance with the provisions of Articles 10, 11, and 12 of the General Conditions.

K. Approval of Repairs: All repairs to a damaged Utility or improvement are subject to inspection and approval by an authorized representative of the Utility or improvement owner before being concealed by backfill or other work.

L. Maintaining in Service: Unless indicated otherwise, oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Owner are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. The Contractor shall be responsible for and shall repair all damage due to its operations, and the provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

1.06 TREES OR SHRUBS WITHIN STREET RIGHTS-OF-WAY AND PROJECT LIMITS

A. General: Except where trees or shrubs are indicated to be removed, the Contractor shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or owner. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by a certified tree specialist under permit from the jurisdictional agency and/or the Owner and paid for by the Contractor. Tree trimming and replacement shall be accomplished in accordance with the following paragraphs.

B. Trimming: Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. Cuts over 1 1/2 inches (38 mm) in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other material injurious to the life of the tree.

C. Replacement: The Contractor shall immediately notify the jurisdictional agency and the Owner if any tree or shrub is damaged by the Contractor's operations. If, the jurisdictional agency or the Owner's licensed arborist, determines that the damage is such that replacement is necessary, the Contractor shall replace the tree or shrub at its own expense. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a smaller size, the Contractor shall pay to the owner of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or Owner. The size of the tree or shrub shall be approved by the Owner. Planting of replacement trees and shrubs shall be in accordance with the recommendations of the nursery furnishing the plants.

1.07 LAWN AREAS

A. Lawn or landscaped areas damaged during construction shall be repaired to match the pre-construction condition to the satisfaction of the Owner.

1.08 NOTIFICATION BY THE CONTRACTOR

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the Contractor shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than 3 business days nor more than 7 business days prior to excavation so that a representative of said owners or agencies can be present during such work if they so desire. The Contractor shall also notify the regional notification center at least 2 days, but no more than 14 days, prior to such excavation.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 51 00 – TEMPORARY UTILITIES

PART 1 -- GENERAL

1.01 SUMMARY

A. The types of utility services required for general temporary use at the Site include but are not limited to the following:

1. Water service (potable for certain uses)

2. Storm sewer

3. Sanitary sewer

4. Electric power service

5. Heating and cooling

B. The Contractor shall provide the specified temporary utilities required in order to execute the Work expeditiously. Remove the temporary utilities from the Site upon completion of the Work unless specified otherwise.

1.02 JOB CONDITIONS

A. Scheduled Uses: The Contractor, in conjunction with establishing the progress schedule, shall establish a schedule for implementation and termination of service for each temporary utility at the earliest feasible time, and when approved by the Owner, change over from temporary utility service to permanent service.

1.03 PERMITTING

A. The Contractor shall make necessary applications to authorities having jurisdiction, obtain required permits, and pay all fees and related charges.

1.04 TEMPORARY USE OF OWNER'S FACILITIES

A. Permanent systems shall not be used without the written permission of the Owner.

B. If written permission is obtained to use existing heating systems or other systems temporarily before completion, entirely change lubricants, filters and other accessory items upon completion of the Work. Extend warranties to ensure that The Owner receives coverage for the full warranty period, as specified.

C. Temporary or trial usage of any mechanical machinery, apparatus, equipment or any other work or materials by the Owner supplied under the Work before final acceptance by the Owner is not to be construed as evidence of acceptance. The Owner shall have the privilege of such temporary and trial usage as soon as the Contractor claims that the Work is complete.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. The Contractor shall provide either new or used materials and equipment, that are in substantially undamaged condition and without significant deterioration and which are recognized in the construction industry by compliance with appropriate standards, as being suitable for intended use in each case. Where a portion of temporary utility is provided by utility company, the Contractor shall provide the remaining portion with matching and compatible materials and equipment and shall comply with recommendations of the utility company.

PART 3 -- EXECUTION

3.01 INSTALLATION OF TEMPORARY UTILITY SERVICES

A. General: Wherever feasible, the Contractor shall engage the utility company to install temporary service to the Site, or as a minimum, to make connection to existing utility service; locate services where they will not interfere with Work, including installation of permanent utility services; and maintain temporary services as installed for required period of use; and relocate, modify or extend as necessary from time to time during that period as required to accommodate the Work.

B. The Contractor shall pay all costs for installation, maintenance, consumption, and removal of temporary utilities.

C. Approval of Electrical Connections: Temporary connections for electricity shall be subject to approval of the power company representative and shall be removed in like manner at the Contractor's expense prior to final acceptance of the Work.

D. Separation of Circuits: Circuits used for power purposes shall be separate from lighting circuits.

E. Construction Wiring: Wiring for temporary electric light and power shall be properly installed and maintained and shall be securely fastened in place. Electrical facilities shall conform to the requirements of the local jurisdiction having authority and Subpart K of the OSHA Safety and Health Standards for Construction.

3.02 INSTALLATION OF POWER DISTRIBUTION SYSTEM

A. Power: The Contractor shall provide power required for its operations under the Contract and shall provide and maintain temporary power lines required to perform the Work in a safe and satisfactory manner. The Contractor shall arrange with the utility company to extend electric service to the Project Work Site, connect temporary service in a manner directed by the utility company officials, and provide separate meter for metering of power used by all entities authorized to be at or perform Work at the Project Work Site.

B. Temporary Power Distribution: The Contractor shall provide a weatherproof, grounded, temporary power distribution system sufficient for performance of the entire Work, including temporary electrical heating where indicated, operation of test equipment and test operation of building equipment and systems which cannot be delayed until permanent power connections are operable, temporary operation of other temporary facilities, including permanent equipment and systems which must be placed in operation prior to use of permanent power connections (pumps, HVAC equipment, elevators, and similar equipment), and power for temporary operation of existing facilities (if any) at the Site during change-over to new permanent power system. Provide circuits of adequate size and proper power characteristics for each use; run circuit wiring generally overhead, and rise vertically in locations where it will be least exposed to possible damage from construction operations and will result in minimal interference with performance of the Work; provide rigid steel conduit or equivalent raceways for wiring which must be exposed on grade, floors, decks, or other exposures to damage or abuse.

3.03 INSTALLATION OF LIGHTING

A. Construction Lighting: Work conducted at night or under conditions of deficient daylight shall be suitably lighted in accordance with local lighting ordinances (specific lumnes for a distance or radius) and to afford adequate facilities for inspection and safe working conditions. Lighting shall be provided and maintained adequately to safely perform the Work. Contractor shall provide a general, weatherproof, grounded temporary lighting system in every area of construction as soon as overhead floor/roof deck structure has been installed to provide sufficient illumination for safe working and traffic conditions. Run circuit wiring generally overhead and rise vertically in locations where it will be least exposed to possible damage from construction operations on grade, floors, decks, or other areas of possible damage or abuse.

B. Light pollution off the Site shall be avoided and the construction lighting impact off the Site shall be addressed in the Construction Management plan in accordance with the local lighting ordinance.

3.04 WATER SUPPLY

A. Water for construction (non-potable) purposes is available on site. The Contractor shall not make connection to or draw water from any fire hydrant or pipeline without first obtaining permission from the Owner.

3.05 INSTALLATION OF SANITARY FACILITIES

A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of Contractor's employees and visitors. Toilets at construction sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction.

B. Sanitary and Other Organic Wastes: The Contractor shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of away from the Site in accordance with laws and regulations pertaining thereto.

C. Contractor shall provide toileting consumables and maintain sanitation facilities in a clean condition for the duration of the Work.

3.06 INSTALLATION OF HEATING AND COOLING

A. Temporary Heating and Cooling: Provide temporary heating and cooling system required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

B. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

C. Temporary heating and cooling systems shall be paid for by the Contractor.

3.07 OPERATIONS AND TERMINATIONS

A. Inspections: Prior to placing temporary utility services into use, the Contractor shall inspect and test each service and arrange for governing authorities' required inspection and tests and obtain required certifications and permits for use thereof.

B. Protection: The Contractor shall maintain distinct markers for underground lines and protect from damage during excavating operations.

C. Termination and Removal: When need for a temporary utility service or a substantial portion thereof has ended, or when its service has been replaced by use of permanent services, or not later than time of substantial completion, the Contractor shall promptly remove installation unless requested by the Owner to retain it for a longer period. The Contractor shall complete and restore Work which may have been delayed or affected by installation and use of temporary utility, including repairs to construction and grades and restoration and cleaning of exposed surfaces.

D. Removal of Water Connections: Before final acceptance of the Work on the project, temporary connections and piping installed by the Contractor shall be entirely removed and affected improvements shall be restored to original condition in accordance with the preconstruction video and photographs, to the satisfaction of the Owner and to the agency owning the affected utility.

END OF SECTION

SECTION 01 55 00 – SITE ACCESS AND STORAGE

PART 1 -- GENERAL

1.01 ROAD LIMITATIONS

A. The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the Work.

1.02 CONTRACTOR'S WORK AND STORAGE AREA

A. The Owner will designate and arrange for the Contractor's use, a portion of the property adjacent to the Work for its exclusive use during the term of the Contract as a storage and shop area for its construction operations on the Work. At completion of Work, the Contractor shall return this area to its original condition, including grading and landscaping.

B. The Contractor shall make its own arrangements for any necessary off-Site storage or shop areas necessary for the proper execution of the Work.

1.03 PARKING

A. The Contractor shall:

1. Provide temporary parking areas for the Engineer and its employees in areas designated by the Owner.

2. Traffic and parking areas shall be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. The Contractor shall repair breaks, potholes, low areas which collect standing water, and other deficiencies.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 57 19 – TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 -- GENERAL

1.01 DUST ABATEMENT

A. The Contractor shall prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity of the Site. The Contractor shall be responsible for any damage resulting from dust originating from its operations. Dust abatement measures shall be continued until the Contractor is relieved of further responsibility by the Engineer.

B. Storage Piles: Enclose, cover, water (as needed), or apply non-toxic soil binders according to manufacturer's specifications on material piles (i.e., gravel, sand, dirt) with a silt content of 5 percent or greater.

C. Active Areas of Site: Water active construction areas and unpaved roads as needed and as requested by Engineer.

D. Inactive Areas of Site: Apply non-toxic soil stabilizers according to manufacturer's specifications to inactive construction areas, or water as needed to maintain adequate dust control.

E. Vehicle Loads: Cover or maintain at least 2-feet of freeboard vertical distance between the top of the load and the top of the trailer sides on trucks hauling dirt, sand, soil, or other loose materials off of the Site.

F. Roads: When there is visible track-out onto a paved public road, install wheel washers where the vehicles exit and enter onto the paved roads and wash the undercarriage of trucks and any equipment leaving the Site on each trip. Sweep the paved street at the end of each shift with mobile water spray pick-up broom-type street sweeper as necessary or as directed.

G. Vehicle Speeds: If watering of unpaved roads is not sufficient to control dust, reduce vehicle speeds to 15 mph or less on such roads.

1.02 SEDIMENTATION ABATEMENT

A. The Contractor shall be responsible for collecting, storing, hauling, and disposing of spoil, silt, and waste materials in compliance with applicable federal, state, and local rules and regulations and the Contract Documents.

B. Install and maintain erosion and sediment control measures, such as swales, grade stabilization structures, berms, dikes, waterways, filter fabric fences, and sediment basins.

C. Filter fabric barrier systems, if used, shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.

D. Remove and dispose of sediment deposits at the designated spoil area. If a spoil area is not indicated, dispose of sediment off-Site at a location not in or adjacent to a stream or floodplain. Sediment to be placed at the spoil area should be spread evenly, compacted, and stabilized. Sediment shall not be allowed to flush into a stream or drainage way.

E. Maintain erosion and sediment control measures until final acceptance or until requested by the Engineer to remove it.

1.03 STORMWATER POLLUTION PREVENTION

A. Contractor shall minimize stormwater pollution from the Site in accordance with the city, county, and/or state requirements.

1.04 RUBBISH CONTROL

A. During the progress of the Work, the Contractor shall keep the Site and other areas for which it is responsible in a neat and clean condition and free from any accumulation of rubbish. The Contractor shall dispose of rubbish and waste materials of any nature and shall establish regular intervals of collection and disposal of such materials and waste. The Contractor shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of rubbish and surplus materials shall be off the Site in accordance with local codes and ordinances governing locations and methods of disposal and in conformance with applicable safety laws and the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

1.05 SANITATION

A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets shall conform to the requirements of Part 1926 of the OSHA Standards for Construction.

B. Sanitary and Other Organic Wastes: The Contractor shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of away from the Site in a manner satisfactory to the Engineer and in accordance with Laws and Regulations pertaining thereto.

1.06 CHEMICALS

A. Chemicals used on the Work or furnished for facility operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer. In addition, see the requirements set forth in the General Conditions.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 58 13 – TEMPORARY PROJECT SIGNAGE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide one project identification sign, complete, in accordance with the Contract Documents.

B. The Owner will obtain a sign permit, if one is required, at no cost to the Contractor.

PART 2 -- PRODUCTS

2.01 SIGN CONSTRUCTION

A. Size, location, and supports for the project sign shall be proposed by the Contractor and approved by the Owner.

2.02 SIGN CONTENT

A. Sign content shall be approved by the Owner.

PART 3 -- EXECUTION

3.01 SIGN LOCATION

A. The project sign shall be located on the Site at such a location so as to be highly visible and not obstruct pedestrian or vehicular traffic.

3.02 REMOVAL

A. Remove the project sign upon preparation of the Notice of Completion.

END OF SECTION

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SECTION 01 60 00 – PRODUCTS, MATERIALS, EQUIPMENT, AND SUBSTITUTIONS

PART 1 -- GENERAL

1.01 DEFINITIONS

A. The word "Products," as used in the Contract Documents, is defined to include purchased items for incorporation into the Work, regardless of whether specifically purchased for the project or taken from Contractor's stock of previously purchased products. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form Work. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items). Definitions in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.

B. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying, and erection of the Work.

1.02 QUALITY ASSURANCE

A. Source Limitations: To the greatest extent possible for each unit of Work, the Contractor shall provide products, materials, and equipment of a singular generic kind from a single source.

B. Compatibility of Options: Where more than one choice is available as options for Contractor's selection of a product, material, or equipment, the Contractor shall select an option which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material and equipment selections.

1.03 PRODUCT DELIVERY AND STORAGE

A. The Contractor shall deliver and store the Work in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft. Delivery schedules shall be controlled to minimize long-term storage of products at the Site and overcrowding of construction spaces. In particular, the Contractor shall ensure coordination to ensure minimum holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

1.04 TRANSPORTATION AND HANDLING

A. Products shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.

B. The Contractor shall provide equipment and personnel to handle products, materials, and equipment, including those furnished by Owner, by methods to prevent soiling and damage.

C. The Contractor shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

1.05 STORAGE AND PROTECTION

A. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.

B. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.

C. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.

D. Storage shall be arranged to provide access for inspection. The Contractor shall periodically inspect to assure products are undamaged and are maintained under required conditions.

E. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

1.06 MAINTENANCE OF PRODUCTS IN STORAGE

A. Stored products shall be periodically inspected on a scheduled basis. The Contractor shall maintain a log of inspections and shall make the log available on request.

B. The Contractor shall comply with manufacturer's product storage requirements and recommendations.

C. The Contractor shall maintain manufacturer-required environmental conditions continuously.

D. The Contractor shall ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.

E. For mechanical and electrical equipment, the Contractor shall provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.

F. Products shall be serviced on a regularly scheduled basis, and a log of services shall be maintained and submitted as a record document prior to final acceptance by the Owner in accordance with the Contract Documents.

1.07 PROPOSED SUBSTITUTIONS OR "OR-EQUAL" ITEM

A. Whenever materials or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular manufacturer, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or equal" indicating that a substitution is permitted, materials or equipment of other manufacturers may be accepted if sufficient information is submitted by the Contractor to allow the Engineer to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:

1. The burden of proof as to the type, function, and quality of any such substitution product, material or equipment shall be upon the Contractor.

2. The Engineer will be the sole judge as to the type, function, and quality of any such substitution and the Engineer's decision shall be final.

3. The Engineer may require the Contractor to furnish additional data about the proposed substitution.

4. The Owner may require the Contractor to furnish a special performance guarantee or other surety with respect to any substitution.

5. Acceptance by the Engineer of a substitution item proposed by the Contractor shall not relieve the Contractor of the responsibility for full compliance with the Contract Documents and for adequacy of the substitution.

6. The Contractor shall pay all costs of implementing accepted substitutions, including redesign and changes to Work necessary to accommodate the substitution.

B. The procedure for review by the Engineer will include the following:

1. If the Contractor wishes to provide a substitution item, the Contractor shall make written application to the Engineer on the "Substitution Request Form."

2. Unless otherwise provided by law or authorized in writing by the Engineer, the "Substitution Request Form(s)" shall be submitted within the 35-day period after award of the Contract.

3. Wherever a proposed substitution item has not been submitted within said 35-day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by the Engineer, the Contractor shall provide the material or equipment indicated in the Contract Documents.

4. The Contractor shall certify by signing the form that the list of paragraphs on the form are correct for the proposed substitution.

5. The Engineer will evaluate each proposed substitution within a reasonable period of time.

6. As applicable, no shop drawing submittals shall be made for a substitution item nor shall any substitution item be ordered, installed, or utilized without the Engineer's prior written acceptance of the Contractor's "Substitution Request Form."

7. The Engineer will record the time required by the Engineer in evaluating substitutions proposed by the Contractor and in making changes by the Contractor in the Contract Documents occasioned thereby.

C. The Contractor's application shall address the following factors which will be considered by the Engineer in evaluating the proposed substitution:

1. Whether the evaluation and acceptance of the proposed substitution will prejudice the Contractor's achievement of Substantial Completion on time.

2. Whether acceptance of the substitution for use in the Work will require a change in any of the Contract Documents to adapt the design to the proposed substitution.

3. Whether incorporation or use of the substitution in connection with the Work is subject to payment of any license fee or royalty.

4. Whether all variations of the proposed substitution from the items originally specified are identified.

5. Whether available maintenance, repair, and replacement service are indicated. The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.

6. Whether an itemized estimate is included of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.

7. Whether the proposed substitute item meets or exceeds the experience and/or equivalency requirements listed in the appropriate technical specifications.

D. Without any increase in cost to the Owner, the Contractor shall be responsible for and pay all costs in connection with proposed substitutions and of inspections and testing of equipment or materials submitted for review prior to the Contractor's purchase thereof for incorporation in the Work, whether or not the Engineer accepts the proposed substitution or proposed equipment or material. The Contractor shall reimburse the Owner for the charges of the Engineer for evaluating each proposed substitution.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 71 13 – MOBILIZATION

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Contractor shall mobilize as required for the proper performance and completion of the Work and in accordance with the Contract Documents.

B. Mobilization shall include at least the following items:

1. Moving onto the Site of Contractor's plant and equipment necessary for the first month of operations.

2. Installing temporary construction power, wiring, and lighting facilities.

3. Developing construction water supply.

4. Providing field offices for the Contractor, complete with furnishings, equipment, and utility services.

5. Providing on-Site communication facilities.

6. Providing on-Site sanitary facilities and potable water facilities.

7. Arranging for and erection of Contractor's Work and storage yards.

8. Constructing and implementing security features and requirements complying with Section 01 35 53 – Site Security.

9. Obtaining required permits.

10. Having OSHA required notices and establishing safety programs.

11. Submitting initial submittals.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 35 53	Site Security

1.03 PAYMENT FOR MOBILIZATION

A. The Contractor's attention is directed to the condition that 5 percent of the Contract Price will be deducted from any money due the Contractor as progress payments until mobilization items listed above have been completed. The aforementioned amount will be retained by the Owner as the agreed, estimated value of completing the mobilization items listed. Any such retention of money for failure to complete such mobilization items shall be in addition to the retention from any payments due to the Contractor in accordance with Article 14 of the General Conditions.

B. As soon as practicable after receipt of the Notice to Proceed, the Contractor shall submit a breakdown to the Engineer for approval, which shall show the estimated value of each major component of mobilization. When approved by the Engineer, the breakdown will be the basis for initial progress payments in which mobilization is included.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 74 20 - GRAVITY PIPING TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall perform all pipeline flushing and testing, complete, for gravity piping systems or other yard piping systems as required in the Contract Drawings, and as specified herein; in accordance with the requirements of the Contract Documents.

B. The Contractor shall be responsible for providing and conveying flushing water to the point of usage and also for disposal, as required, of water used in the flushing operations.

C. For the purpose of this specification, gravity piping, sewer or gravity sewer piping refers to all pipes with flows that are driven by gravity in an open channel flow condition and convey liquids associated with the treatment plant processes and byproducts (e.g. plant drain, raw sewage, etc).

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ASTM F1417	Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
ASTM C924	Standard Practice for Testing Concrete Pipe Sewer Line by Low-Pressure Air Test Method
ASTM C1244	Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill
UNI-B-6	Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.3 CONTRACTOR SUBMITTALS

A. The Contractor's proposed plans for testing, and for water conveyance, control, and disposal, shall be submitted in writing. The Contractor shall also submit minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. Temporary valves, plugs, bulkheads, and other air pressure testing and water control equipment and materials shall be provided by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to pipeline structure and future function. Air test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the Contractor's expense prior to the leakage test, if required by the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. All testing operations shall be performed in the presence of the Engineer.

B. All water required for cleaning and testing of the sewer pipes shall be furnished by the Contractor.

3.2 CLEANING

A. Do not allow dirt, grease, mud, groundwater, tools, equipment and all other foreign matter to enter the pipe at any point during construction.

B. All pipes shall be completely flushed at a rate with water velocities no less than 4.0 feet per second for pipes up to 12 inches in diameter and 3.0 feet per second for all other pipes. For large diameter pipes, alternate methods, including pigging, or cleaning the pipe may be proposed by the Contractor, subject to the approval of the Engineer, provided proposed method will provide a clean pipe equivalent to flushing as determined by the Engineer.

C. No debris, rubbish, dirt, rocks, or other foreign material shall be permitted to enter downstream sections of the pipeline or system.

D. Furnish, install and permanently remove all cross-connections, piping, valving, ports, etc required to complete the cleaning process. Obtain approval of the Engineer prior to adding any components to the pipeline.

3.3 TESTING OF PIPING

A. General: All gravity sewer pipes and service laterals shall be air tested and mainlines shall be checked for deflection, as specified. All manholes, vaults and boxes directly conveying flows shall be tested for leakage, as specified. Manholes and piping shall be tested following backfill placement. All leakage tests shall be completed and approved prior to the placement of permanent surfacing. When leakage exceeds the amount allowed by the Specifications, the Contractor shall locate the leaks and make the necessary repairs or replacements required to eliminate the leakage. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

B. Leakage Tests: Gravity sewer systems shall be tested for leakage as follows:

1. Air Pressure Test - Gravity sewers shall be air pressure tested in accordance with UNI-B 6 and/or ASTM F1417 as outlined below.

a. The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the Engineer.

b. The Contractor may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of lateral connection sewers. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

c. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the main sewer line and the upper ends of all lateral connection sewers. Prior to any air pressure testing, all pipe plugs shall be

checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

d. Test pressure shall be 4.0 psig, unless groundwater elevation exceeds the invert elevation of the pipe. Where the normal groundwater elevation exceeds the invert elevation of the new pipe, the test pressure shall be adjusted for back pressure created by the groundwater. The new test pressure shall be determined by:

$$P_t = 4.0 + \frac{H}{2.35} \leq 9.0 \text{ psig}$$

e. Where P_t is the new test pressure and H is the difference in feet between the groundwater elevation and the lowest invert elevation of the pipe being tested. In no case shall the test pressure exceed 9.0 psig or the maximum pressure allowed by the pipe manufacturer.

f. After a manhole to manhole reach of pipe has been backfilled and cleaned, and the pneumatic plugs are checked, the plugs shall be placed in the line at each manhole and inflated to manufacturer's recommended inflation pressure. Low pressure air shall be introduced into this sealed line until the internal air pressure reaches test pressure. At least two minutes shall be allowed for the air pressure to stabilize. After the stabilization period minimum pressure (at the beginning of test time shall be test pressure minus 0.5 psig), the air hose from the control panel to the air supply shall be disconnected.

g. For pipe diameters 4"-36", the portion of line being tested shall be termed "Acceptable" if the allocated line pressure decreases less than 1.0 psi in the time shown for the given diameters and lengths in Table 1.

h. For pipe diameters greater than 36", the portion of line being tested shall be termed "Acceptable", if the allocation line pressure decreases less than 0.5 psi in the time shown for the given diameters and lengths in Table 2.

i. Required test times for lines consisting of multiple pipe diameters shall be determined in accordance with UNI-B-6 and or ASTM F1417.

j. If the installation fails to meet these requirements, the Contractor shall determine the source of leakage. He shall perform a leak location test and then repair or replace all defective materials and/or workmanship. This work shall be completed at no additional cost to the Owner.

Table 1
Low Pressure Air Test Times for 1.0 PSig Pressure Drop

Pipe Diameter (in.)	Minimum Time for 1.0 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
4	03:47	597	.380 L
6	05:40	398	.854 L
8	07:33	298	1.520 L
10	09:27	239	2.374 L

12	11:20	199	3.418 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
21	19:50	114	10.470 L
24	22:40	99	13.674 L
27	25:30	88	17.306 L
30	28:20	80	21.366 L
33	31:10	72	25.852 L
36	34:00	66	30.768 L

Table 2
Low Pressure Air Test Times for 0.5 PSIg Pressure Drop

Pipe Diameter (in.)	Minimum Time for 0.5 PSIg Pressure Drop (min:sec)	Pipe Length for Minimum Time (ft.)	Test Time for Pipe Length in Excess of Minimum (sec.)
42	19:50	57	20.939 L
48	22:40	50	27.349 L
54	25:30	44	34.614 L
60	28:30	40	42.733 L
66	31:10	36	51.707 L
72	34:00	33	61.535 L
78	36:50	31	72.219 L
84	39:40	28	83.756 L
90	42:30	27	96.149 L
96	45:20	25	

C. Deflection Test: All flexible and semi-rigid main line pipe shall be tested for deflection, joint displacement, or other obstruction by passing a rigid mandrel through the pipe by hand, not less than 30 days after completion of the trench backfill, but prior to permanent surfacing. The mandrel shall be a full circle, solid cylinder, or a rigid, non-adjustable, odd-numbered leg (9 leg minimum) steel cylinder, approved by the Engineer as to design and manufacture. The circular cross section of the mandrel shall have a diameter of at least 95 percent of the specified average inside pipe diameter of the pipe and the minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. Obstructions encountered by the mandrel shall be corrected by the Contractor.

D. Video Inspection: After the sewer pipe has been installed and cleaned; and the trench has been backfilled, the sewer pipe shall be visually inspected by video camera to locate defects in the sewer pipe. Video Inspection shall be performed by an independent testing agency acceptable to the Owner. All sewer pipes shall be video inspected.

1. Notify the Engineer, 48 hours prior to any televised inspections.

2. The inspection shall be in digital video format, saved to an electronic media and shall be given to the Engineer for review and final records.

3. The Contractor shall ensure safe access to each manhole as required by the testing agency.

4. Video equipment shall include a pipe inspection video camera with the following capabilities: panorama tilt, radial viewing, pans plus and minus 75 degrees, rotates 360 degrees, and has optical zoom from 6 or less inches to infinity. Equipment shall produce a high quality, full color video image.

5. Video equipment shall be equipped with a device that can accurately measure the depth of any ponding encountered in the pipe. Measuring device shall be clearly visible in the video image.

6. The video equipment shall have an accurate footage counter accurate to within 1 foot per 500 foot of pipe. Footage shall be continuously displayed on the video at all times.

7. Pipelines shall be cleaned and flushed immediately prior to video inspection. Pipelines that were cleaned and flushed more than 24 hours prior to video inspection shall be cleaned and flushed again. All dirt/debris, including pipe grease, in the line which could cover a defect shall be removed.

8. Jetting of the lines in conjunction with the video inspection is prohibited.

9. If during the video inspection, foreign material which prohibits an acceptable video inspection is discovered the line shall be cleaned and video inspected again.

10. The video camera shall travel through the pipe at a maximum rate of travel of 30 feet per minute. Video shall be continuous for each pipe segment between manholes or other access points.

11. The video camera shall pause at each tee, lateral or other connection and the camera shall be rotated and tilted to provide an image of the branch for inspection. The image shall remain clear and in focus at all times while zooming to the full extent of the camera. The camera operator shall stop at each fitting and change in pipe type and complete a 360 degree view of the fitting at a rate slow enough to identify any defects.

12. Glare shall be avoided and shall not interfere with viewing the pipe segment.

13. Provide DVDs or CDs with labels indicating project number, segment number, date televised, date submitted, starting manhole number, ending manhole number, pipe diameter, pipe length and street name.

14. Lines to be video inspected shall be flushed within 24 hours prior to beginning of inspection.

15. The video inspection shall be used to identify defective construction such as sags, debris, separated joints, etc. Any Work not conforming to the Specifications or Drawings shall be promptly removed, replaced and retested at no cost to the Owner. The Engineer shall make all final determinations if the severity of the defect constitutes failure and requires subsequent removal or repair of the segment in question.

    a. Conditions identified by the video inspection that require removal and replacement or, but are not limited to:

        1) Alignment (Vertical or Horizontal) is outside the specified limits.

        2) Water ponds in any section with depths equal to or greater than 2 times the grade tolerance specified in the Contract Documents.

        3) Pipe section with visible defects, such as: open joints, pinched gaskets, cracked barrels or bells, leaks, or other defects as determined by the Engineer.

3.4 TESTING OF MANHOLES AND OTHER APPURTENANT STRUCTURES

A. Manholes and other structures

1. Vacuum tests shall be conducted on the newly constructed manholes. Preliminary manhole testing may take place following construction after all connections are made, and before backfilling. Test results derived from this test will allow time for necessary repairs to be completed before further construction proceeds and hinders such repairs. Final tests must be performed after the manhole has been backfilled.

B. Procedures

1. Plug all manhole entrances and exits other than the manhole top access using suitably sized pneumatic or mechanical pipeline plugs and follow all manufacturer's recommendations and warnings for proper and safe installation of such plugs. Plugs should be inserted a minimum of 6 inches beyond manhole wall. Make sure such plugs are properly rated for the pressures required for the test. The standard test of 10 inches Hg. (mercury) is equivalent to approximately 5 PSIG (.3 bar) backpressure. Unless such plugs are mechanically restrained, it is recommended that the plugs are used with a minimum two times (2x) safety factor or a minimum of 10 PSIG (0.7 bar) backpressure usage rating.

2. Close vacuum inlet/outlet ball valve and monitor vacuum for specified test period (see table). If vacuum does not drop in excess of 1" Hg., manhole is considered acceptable and the manhole passes the test. If manhole fails the test, complete necessary repairs and repeat test procedures until satisfactory results are obtained.

Minimum Test Times for Various Manhole Diameters

Depth, Feet	Diameter, Inches												
	48	54	60	66	72	78	84	90	96	102	108	114	120
	Time, Seconds												
8	20	23	26	29	33	35	38	41	45	48	51	54	57
10	25	29	33	36	41	44	48	52	56	60	63	67	71
12	30	35	39	43	49	53	57	62	67	71	76	81	85
14	35	41	46	51	57	62	67	72	78	83	89	94	100
16	40	46	52	58	67	70	76	83	89	95	101	108	114
18	45	52	59	65	73	79	86	93	100	107	114	121	128
20	50	53	65	72	81	88	95	103	111	119	126	135	142
22	55	64	72	79	89	97	105	114	122	131	139	148	156
24	59	64	78	87	97	106	114	124	133	143	152	161	170
26	64	75	84	94	105	114	124	134	144	155	164	175	185
28	69	81	91	101	113	123	133	145	155	167	177	188	199
30	74	87	98	108	121	132	143	155	166	178	189	202	213

3. The values listed above are taken from ASTM Specification C1244-93 "Standard Test Method for Concrete Manholes by the Negative Air Pressure (Vacuum) Test."

4. Repeat the above test procedure after backfilling manhole for final acceptance test.

5. Manholes shall be watertight. All joints, penetrations, etc., shall be sealed watertight prior to acceptance of manhole.

END OF SECTION

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SECTION 01 75 00 – EQUIPMENT TESTING AND PLANT STARTUP

PART 1 - GENERAL

1.1 THE SUMMARY

A. Plant startup is prerequisite to satisfactory completion of the contract requirements and shall be completed within the Contract Times.

B. Conduct all test, check out, startup, and related requirements indicated in the Contract Documents and provide documentation of same to the Engineer prior to requesting Substantial Completion from the Engineer. Where manufacturer onsite inspections are required before startup, the manufacturer shall furnish a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup.

C. Startup of a treatment plant is a highly complex operation requiring the combined expertise of the Contractor, Subcontractors, the Engineer, and the Owner. The Contractor shall be responsible for coordinating all parties for a successful startup: the Engineer and Owner will be available for technical and operational advice prior to and during startup.

D. General requirements for startup activities are included in this Section. More specific requirements may also be included in other portions of the Contract Documents.

E. Temporary facilities may be necessary. If so, Contractor shall design, provide, operate, and later decommission them.

F. During startup, product water shall be wasted to receiving points as directed by the Engineer and Owner.

1.2 DEFINITIONS

A. Startup is defined as testing, demonstrations, and other activities as required to achieve Substantial Completion. Startup includes pre-commissioning and commissioning activities, manufacturer's services, certifications of readiness for testing, and troubleshooting, checkout, and shakedown activities.

B. Pre-commissioning is the systematic demonstration through testing and extended operation that major equipment and auxiliary systems, including related components, sub-systems, and systems operate properly and consistent with their intended function. Pre-commissioning involves balancing, adjustments, calibration, loop checks, and loop validation. Pre-commissioning shall simulate shutdown conditions, failure conditions, power fail and restart, bypass conditions, and failure resets. Pre-commissioning will not be considered complete until successful results and documentation of tests and manufacturer's certifications required by the Contract Documents are submitted and accepted by the Engineer. Pre-commissioning of all portions of the Work shall be successfully completed prior to starting Commissioning.

C. Commissioning is the verification that the complete Work functions on an extended basis in full conformance with the Contract requirements.

1.3 SUBMITTALS

A. Schedule: The schedule for startup shall be submitted under Section 01 32 16 – CPM Construction Schedule.

B. Startup Plan: Not less than 60 Days prior to startup, submit for review a detailed Startup Plan. The Contractor shall revise the Plan as necessary based on review comments. The Plan shall include:

1. Schedules for manufacturers' equipment certifications

2. Schedules for submitting final Technical Manuals

3. Schedule for training the Owner's personnel

4. Description of temporary facilities and schedule for installation and decommissioning them

5. List of Owner and Contractor-furnished supplies

6. Detailed schedule of operations to achieve successful pre-commissioning and commissioning.

7. Checklists and data forms for each item of equipment

8. Address coordination with the Owner's staff

9. Designate a representative of the Contractor who has the authority to act in matters relating to startup and has experience in testing wastewater treatment facilities. The Plan shall also designate the roles and responsibilities of any Subcontractors that may be involved in startup activities.

10. Safety, startup, and testing procedures and proposed inspection and certification forms and records.

11. Interconnection of new to existing facilities

    a. Date and time frame of proposed shutdown or interconnection, including sequence of events and activities to be conducted.

    b. A detailed description of sequences and activities for the planned shutdown and interconnection.

    c. Staff, equipment, and materials that will be at the Site before commencing the shutdown.

    d. Other provisions so that interconnection, testing, and startup will be completed within the planned time.

12. Hydrostatic testing of water-holding structures and pipelines and other potable water equipment. Schedule and plan shall indicate source of water, testing and disinfection sequence, disinfection procedures, and the disposal of the water following disinfection.

C. System Outage Requests: Request for shutdown of existing systems as necessary to test or start up new facilities.

D. Records and Documentation

1. Where required by the specifications, submit equipment installation certifications under those Sections.

2. Records of startup as indicated below.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MALFUNCTIONS

A. During the extended operational demonstrations, all components, subsystems, systems, and equipment must properly run continuously 24 hours per day at rates indicated by the Engineer throughout the test period. Unless indicated otherwise, if any item fails or malfunctions during the test, the item shall be repaired and the test restarted at time zero with no credit given for the operating time before the failure or malfunction. Malfunctions satisfying all 3 of the following conditions will allow the demonstration period to resume at the elapsed time when the malfunction started:

1. Malfunction did not cause any interruption of the continuous operation of any other components, subsystems, systems, and equipment.

2. Malfunction was corrected without causing or requiring any components, subsystems, systems, and equipment to cease operations.

3. Malfunction was corrected within one hour of the time the malfunction was detected (the one hour period includes the time required to locate the cause of the malfunction, beginning upon Contractor’s notification from the Engineer that a malfunction has occurred and ending when the item is corrected and the system is successfully placed back into operation).

B. The Contractor shall arrange for manufacturer's representatives to visit the Site as often as necessary to correct malfunctions.

3.2 PREREQUISITES

A. Pre-commissioning and commissioning activities shall be scheduled according to Section 01 32 16 – CPM Construction Schedule. The 7 Day demonstration and the 8 Day demonstration shall start prior to midday on a Monday, Tuesday, or Wednesday. Testing periods shall not include holidays, based on the Owner's calendar.

B. The following shall be completed before pre-commissioning begins.

1. All Technical Manual information required by the Contract Documents has been submitted.

2. Safety equipment, emergency shower and eyewash units, fire extinguishers, gas detectors, protective guards and shields, emergency repair kits, safety chains, handrails, gratings, safety signs, and valve and piping identification required by the

Contract Documents are provided. Devices and equipment shall be fully functional, adjusted, and tested.

3. Manufacturer's certifications of proper installation have been accepted.

4. Leakage tests, electrical tests, and adjustments have been completed.

5. The Engineer has approved the Startup Plan.

6. Temporary facilities are functional, adjusted, and ready for use.

7. Individual instrumentation loops (analog, status, alarm, and control) have been verified functionally.

8. Pressure switches, flow switches, timing relays, level switches, vibration switches, temperature switches, RTD monitors, pressure regulating valves, and other control devices to the settings determined by the Engineer or the equipment manufacturer have been adjusted for accuracy.

9. Individual interlocks between the field-mounted control devices and the motor control circuits, control circuits of variable-speed controllers, and packaged system controls have been verified.

3.3 GENERAL

A. Supplies

1. The Contractor shall furnish:

a. Fuel

b. Oil and grease

c. Other necessary materials not listed for the Owner to furnish

2. The Owner will furnish:

a. Water

b. Power

B. Startup Records: The Contractor shall maintain the following during testing and startup and submit originals to Engineer:

1. Lubrication and service records for each mechanical and electrical equipment item

2. Hours of daily operation for each mechanical and electrical equipment item

3. Equipment alignment and vibration measurement records

4. Logs of electrical measurements and tests

5. Instrumentation calibration and testing logs

6. Testing and validation of SCADA inputs, outputs, logic functions, status indications, and alarms

7. Factory and field equipment settings

8. Log of problems encountered and remedial action taken

9. Other records, logs, and checklists as required by the Contract Documents

3.4 PRE-COMMISSIONING

A. After individual equipment items and subsystems have been tested and certified as required by the Technical Specifications, tests of systems comprised of single or multiple equipment items with appurtenant equipment and instruments and controls shall be conducted. Items of equipment shall be tested as part of a system to the maximum extent possible.

B. Subject to the malfunction criteria above, each system shall be demonstrated for a continuous, 7 Day, 24 hour/day period. If any system malfunctions, the item or equipment shall be repaired and the test restarted at time zero with no credit given for the elapsed time before the malfunction.

C. The Contractor shall demonstrate the manual and automatic modes of operation to verify proper control sequences, software interlocks, proper operation of software logic and controllers, etc. System testing shall include the use of water or other process media, as applicable, to simulate the actual conditions of operation.

D. Systems testing activities shall follow the detailed procedures and checklists in the Testing and Startup Plan. Completion of systems shall be documented by a report.

E. The Contractor shall demonstrate utility, safety equipment, and other support systems before whole process systems.

F. Furnish the Engineer at least 10 Days written notice confirming the start of pre-commissioning. The Owner's staff will observe pre-commissioning.

3.5 COMMISSIONING

A. The Contractor shall start up the plant and operate it without malfunction for a continuous 8 Day, 24 hour/day period. The Engineer will determine the operational parameters.

B. Defects that appear shall be promptly corrected. Time lost for wiring corrections, control point settings, or other reasons that interrupt the test may, at the judgement of the Engineer, be cause for extending the demonstration an equal amount of time.

C. Commissioning shall not begin until leakage tests, instrumentation tests and adjustments, electrical tests and adjustments, equipment field tests, and system tests have been completed to the satisfaction of the Engineer.

D. The Owner shall operate and make process modifications during the startup. The Contractor shall assist the Owner as directed by the Owner.

E. During commissioning, the Contractor shall:

1. Lubricate and maintain equipment in accordance with the manufacturers' recommendations.

2. Clean or replace strainers, screens, and filter elements.

END OF SECTION

SECTION 01 77 00 – PROJECT CLOSEOUT

PART 1 -- GENERAL

1.01 FINAL CLEANUP

A. The Contractor shall promptly remove from the vicinity of the completed Work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the Work by the Owner will be withheld until the Contractor has satisfactorily performed the final cleanup of the Site.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

1.03 CLOSEOUT TIMETABLE

A. The Contractor shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the Owner, the Engineer, and their authorized representatives sufficient time to schedule attendance at such activities.

1.04 FINAL SUBMITTALS

A. The Contractor, prior to requesting final payment, shall obtain and submit the following items to the Engineer for transmittal to the Owner:

1. Written guarantees, where required.
2. Technical Manuals and instructions.
3. New permanent cylinders and key blanks for all locks.
4. Maintenance stock items; spare parts; special tools.
5. Completed record drawings.
6. Bonds for roofing, maintenance, etc., as required.
7. Certificates of inspection and acceptance by local governing agencies having jurisdiction.

B. Evidence of payment and release of liens in accordance with conditions of the Contract.

C. Consent of Surety to final payment.

D. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.

1.05 MAINTENANCE AND GUARANTEE

A. The Contractor shall comply with the maintenance and guarantee requirements contained in the General Conditions.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the Contractor which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the Contractor shall have obtained a statement in writing from the affected private owner or public agency releasing the Owner from further responsibility in connection with such repair or resurfacing.

C. The Contractor shall make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly, the Owner reserves the right to do the Work and the Contractor and its surety shall be liable to the Owner for the cost thereof.

1.06 BOND

A. The Contractor shall provide a bond to guarantee performance of the provisions contained in Paragraph "Maintenance and Guarantee" above and the General Conditions.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 79 00 - OWNER STAFF TRAINING

PART 1 - GENERAL

1.1 THE SUMMARY

A. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary to train Owner's personnel on the equipment, products, and systems furnished under this Contract. Owner training is a prerequisite to satisfactory completion of the Contract requirements and shall be completed within the Contract Time.

B. The minimum onsite training requirements for various plant components are described in various sections of the specifications.

C. Except where otherwise indicated, all costs for training shall be the responsibility of the Contractor.

1.2 SUBMITTALS

A. Training Schedule: Schedule for training the Owner's personnel shall be submitted with the detailed Testing and Startup Plan required by Section 01 75 00 – Equipment Testing and Plant Startup.

B. Resumes of instructors.

C. The training lesson plan and materials shall be submitted to the Engineer for review at not less than 3 weeks prior to the provision of training.

D. Approved operation and maintenance manuals shall be available at least 30 days prior to the scheduled date for the individual training session.

E. Training classes shall be scheduled a minimum of four (4) weeks in advance of the date of the first class to allow Owner staffing arrangements to take place. The Contractor shall schedule training classes within the period 8:00 a.m. to 5:00 p.m. Monday through Thursday.

F. Training classes shall be organized in conjunction with the Startup Systems, as defined in Section 01 75 00 – Testing and Plant Startup. Each training class shall consist of a classroom portion and a field tour portion. Each training class shall include:

1. Safety to be conducted by the plant safety officer.

2. Overview of the startup system.

3. Training on each item of equipment within the startup system, conducted by the Equipment Manufacturer's representative.

4. Training on the mechanical piping system within the startup system, conducted by the Contractor's mechanical superintendent.

5. Training on the power distribution system within the startup system, conducted by the Contractor's electrical superintendent.

6. Training on the instrumentation and control systems within the startup system, conducted by the Contractor's I&C System Supplier.

7. Training on the SCADA control system within the startup system, conducted by the Owner's system integrator.

G. Class Agenda: A class agenda shall be prepared by the Contractor and submitted to the Engineer with the training schedule. The agenda shall include a listing of subjects to be discussed, time estimated for each subject, a list of documentation to be used and provided to support training, the proposed route of the field tours, and the instructor(s) name and qualifications. Agendas shall include an allocation of time for all components of the training session, including time for Owner staff to ask questions and discuss the subject matter. The Owner may request that particular subjects are emphasized, and the agenda shall be adjusted to accommodate these requests. Copies of the agenda shall be distributed to each student at the beginning of each training class.

H. Within ten (10) days after the completion of each training session, the Contractor shall submit the following:

1. A sign-in sheet of all personnel that attended the training session.

2. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

3. A flash drive containing the above information.

1.3 INSTRUCTOR QUALIFICATIONS

A. Instructors shall be completely knowledgeable in the products and systems for which they are providing training and shall be experienced in conducting classes. Sales representatives are not considered qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.

B. Instructor shall have at least two years of experience in providing training certified by the Manufacturer.

C. If, in the opinion of the Owner, the Instructor did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor at the Contractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this Contract.

2.2 TRAINING AIDS

A. Each instructor is encouraged to use audio-visual devices, P&IDs, models, charts, or other means to effectively increase the transfer of knowledge. The instructor conducting the training shall furnish all such equipment (televisions, CD/DVD recorder/player, projectors, screens easels, etc.), models, and charts for each class. It shall be the responsibility of the instructor to confirm in advance that the classroom will be appropriate for the types of audio-visual equipment to be employed.

2.3 LOCATION

A. Training sessions shall take place at a mutually agreeable location at or nearby the project site.

2.4 FORMAT AND CONTENT

A. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization

a. Review catalog, parts lists, drawings, etc., which have been previously provided for the Owner’s files and operation and maintenance manuals.

b. Inspection on how the equipment has been installed. Demonstrate the operation of the unit and describe how all parts of the equipment meet the requirement of the Specifications.

c. Answer questions.

2. Safety

a. Using material previously provided, review safety features of the equipment.

b. Discuss proper precautions when working around equipment.

3. Operation

a. Using material previously provided, review reference literature.

b. Explain all modes of operation (including emergency).

c. Check out Owner's personnel on proper use of the equipment.

4. Preventive Maintenance

a. Using material previously provided, review preventive maintenance (PM) lists including:

1) Reference material.

2) Daily, weekly, monthly, quarterly, semiannual, and annual PM activities.

b. Demonstrate how to perform Preventive Maintenance procedures.

c. Demonstrate to the Owner's personnel what to look for as indicators of potential equipment problems.

5. Corrective Maintenance

a. Identify possible problems.

b. Demonstrate how to perform repairs. Point out special problems.

c. Open up equipment and demonstrate O & M procedures, where practical.

6. Parts

a. Demonstrate the use of previously provided parts list and order parts.

b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives

a. Identify local vendors where to order parts: name, address, telephone.

b. Service problems:

1) Identify contacts local contacts.

2) Identify emergency contacts.

8. Operation and Maintenance Manuals

a. Review any other material submitted.

b. Update material, as required.

PART 3 - EXECUTION

3.1 GENERAL

A. The objective of the training included under this Section shall be to convey the knowledge needed by the Owner's operations, maintenance, and engineering staff to safely operate, maintain, and repair the equipment and systems furnished under this Contract.

B. Owner personnel who will participate in this training have existing full-time work assignments and this training is an additional assigned work task. Owner's staff work schedules regularly shift, as the plant is operated on an around-the-clock basis.

C. Training shall be tailored to suit the skills and job classifications of the personnel attending the classes e.g., plant manager, plant operator, maintenance technical, electrician, etc.

D. Minimum onsite training requirements for plant components are described in various sections of the Specifications. For the purpose of the times given in individual Specification sections, a workday is defined as an eight (8) hour day at the site, excluding travel time.

E. Training shall be scheduled as a separate trip from equipment inspection, startup, and field adjustment. Training shall not be done until the manufacturer certifies that the equipment is operable as specified.

F. Specific Training Objectives: The training shall include a review of the equipment and drives, including internal parts, as prepared at the factory. The training shall include safety, removal, inspection, cleaning, operation and maintenance of the equipment such as startup, normal operation and shutdown procedures, step-by-step troubleshooting

procedures with all necessary test equipment, and emergency or abnormal operation procedures. Training shall include preventive maintenance and long-term maintenance procedures, special tools necessary, and a discussion of recommended spare parts.

3.2 TRAINING CLASSES

A. A maximum of one (1) class per day shall be held on consecutive days unless otherwise approved by the Owner. Multiple classes may be scheduled if the class duration is shorter than four (4) hours. Times shall be scheduled at the discretion of the Owner.

B. Class Length: Each class shall be subdivided into two (2) to six (6) hour modules, or as appropriate for the subject matter being discussed.

C. Number of Students: It is estimated that five (5) to ten (10) persons will attend each training class. The Owner will determine the actual number of students. Provide training materials for all attendees.

D. Cancellation of Classes: If a class must be canceled because the equipment is not ready for operation, etc. the Contractor shall notify the Owner at least one (1) week in advance. The Contractor shall coordinate with the Owner to reschedule the training.

3.3 TRAINING AIDS

A. Training Aids: Each instructor is encouraged to use audio-visual devices, P&IDs, models, charts, etc. to increase the transfer of knowledge. The Contractor shall provide all such equipment (televisions, videocassette recorder/player, projectors, screens, easels, models, charts, etc.) for each class. It shall be the responsibility of the Contractor to confirm in advance that the training room set-up will be appropriate for the types of audiovisual equipment to be employed.

B. Classroom Documentation: If training is being completed on equipment, systems, or products for which a Technical Manual is required, the draft Technical Manual shall have been returned by the Engineer with a status of “No Exceptions Taken” or “Make Corrections Noted” before the training class is scheduled. The approved Technical Manual shall be used during the classroom instruction. Supplemental documentation handouts shall be provided by the organization conducting the training as required to the support instruction.

3.4 DOCUMENTATION OF TRAINING

A. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

1. As a minimum, classroom equipment training for operations personnel will include:

a. Identify and discuss safety items and procedures.

b. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.

c. Purpose and plant function of the equipment.

d. A working knowledge of the operating theory of the equipment.

e. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.

f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.

g. Operator detection, without test instruments, of specific equipment trouble symptoms.

h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:

a. Identify and review safety items and perform safety procedures.

b. Identify location of equipment and review the purpose.

c. Identifying piping and flow options.

d. Identifying valves and their purpose.

e. Identifying instrumentation:

f. Location of primary element.

g. Location of instrument readout.

h. Discuss purpose, basic operation, calibration, maintenance, troubleshooting, repair, and information interpretation.

i. Discuss, demonstrate, and perform standard operating procedures and round checks.

j. Discuss and perform the preventative maintenance activities.

k. Discuss and perform start-up and shutdown procedures.

l. Perform the required equipment exercise procedures.

m. Perform routine disassembly and assembly of equipment if applicable.

3. Classroom equipment training for the maintenance and repair personnel will include:

a. Safety procedures.

b. Theory of operation.

c. Description and function of equipment.

d. Start-up and shutdown procedures.

e. Normal and major repair procedures.

f. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.

g. Routine and long-term calibration procedures.

h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

i. Hands-on equipment training for maintenance and repair personnel shall include:

    1) Locate and identify equipment components.

    2) Review the equipment function and theory of operation.

    3) Review normal repair procedures.

    4) Perform start-up and shutdown procedures.

    5) Review and perform the safety procedures.

    6) Perform Owner-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

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SECTION 01 93 00 - MAINTENANCE

PART 1 - GENERAL

1.1 DESCRIPTION

A. The intent of these specifications is to have the Contractor schedule and perform the Work in a manner such the Owner can keep the existing treatment plant facilities in continuous dependable operation. It is required as a part of this Contract that the Contractor adhere to the constraints listed in this Section.

B. The Contractor shall:

1. Perform all construction necessary to complete connections and tie-ins (shutdowns) to existing facilities.

2. Keep existing facilities in operation unless otherwise specifically permitted in the specifications and approved by the Owner.

3. Perform all construction activities so as to avoid interference with operations of the facility and the work of others.

1.2 ACCESS

A. Contractor shall not interfere with access to any of the existing operating facilities.

1.3 CONTRACTOR CONSTRAINTS

A. Any temporary work, facilities, roads, walks, protection of existing structures, piping, blind flanges, valves, equipment, etc. that may be required within the Contractor's work limits to maintain continuous and dependable plant operation shall be furnished by the Contractor at the director of the Engineer at no extra cost to the Owner.

B. The Contractor shall schedule the Work in such a manner so that each plant is maintained in continuous operation. All short-term system or partial systems shutdowns shall be approved by the Owner. If, in the opinion of the Engineer, a shutdown is not required in order for the Contractor to perform the Work, the Contractor shall utilize alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times suitable to the Owner. Owner shall be provided a minimum of 1-week notice of Contractor's need for system shutdowns.

C. Shutdowns shall not begin until all required materials are on-hand and ready for installation. At a time approved by the Owner the shutdown period will commence and the Contractor shall proceed with the Work continuously, start to finish, until the Work is completed and the system is tested and ready for operation. If the Contractor completes all required Work before the specified shutdown period has ended the Owner may immediately place the existing system back in service.

D. The Owner shall have the authority to order Work stopped or prohibited which would, in its opinion, unreasonably result in stopping the necessary functions of the plant operations.

E. All operations of existing valves and gates required for the Work shall be done by the Owner. Owner does not guarantee the valves stop logs, gates. etc., are/will be 100

percent water/gas tight.

F. Insofar as possible, all equipment shall be tested and in operating condition before the final tie-ins are made to connect new equipment to the existing facility.

G. The Owner reserves the right to cancel scheduled shutdown(s) if conditions warrant. Delays to the Contractor caused by cancellations will be considered in evaluation requests for time extensions. The Contractor shall not be entitled to damages, intangibles for overhead cost(s), or anticipated profit arising from such cancellations.

1.4 SUBMITTALS

A. Contractor shall prepare and submit for approval a Method of Procedure (MOP) using the document provided at the end of this Section for any interruption to plant operations as outlined in the list below. The MOP must include a detailed plan and schedule of each proposed shutdown detailing all work, materials, sizing calculations, equipment connection(s), and redundancy measures.

1. Shutdowns, diversions, bypass pumping, and tie-ins to the existing facility

2. Process start-up activities

3. Power interruption and tie-ins

4. Switch over between temporary and permanent facilities, equipment, piping, and electrical and instrumentation systems.

5. Process constraints requiring interruption of operating process or utilities.

B. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.

C. Submit baseline schedule with proposed MOPs.

D. Submit MOP log at construction progress meetings.

E. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilities proper operation of the WRF and compliance with the effluent discharge criteria.

F. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.5 WORK SEQUENCE

A. The following is a summary of work which requires bypasses, shutdowns, and coordination. The list does not purport to include all Work necessary and it may be modified to suit existing conditions which are encountered. It shall be used as a guide to prepare the construction schedule and the shutdown schedule.

1. General shutdown requirements:

a. Shutdown periods are indicated in 24-hour calendar days, or number of hours.

b. Simultaneous shutdowns of more than one plant will not be permitted.

c. The Contractor shall submit a plan consisting of a construction sequence, time schedule, details of labor, equipment and material available for work to be performed during each shutdown to the Engineer for approval. The plan shall demonstrate ability to meet the time limitations.

d. Insofar as possible, all equipment to be incorporated into existing facilities, shall be ready for operation before the existing facilities are shutdown. Particular attention must be paid to the identification of all wiring required to transfer the total operational monitoring and control to the new equipment. The Contractor shall identify the conduit and wiring required to ensure the prior work specified for each shutdown will be complete and that the re-start of equipment will not be delayed.

e. If the Work, during shutdown periods, is not done satisfactorily, or as planned, or within the time required or approved by the Engineer, the Engineer may order the Contractor to work a 24-hour, 7-day week work schedule with a full crew, or he may order the Contractor to place the facility back in service and reschedule the shutdown or, he may order the Work required to place the facility back in service done with other forces. If the work is done by the other forces, the Owner's costs will be deducted from the amounts due to the Contractor. In no case shall the Owner be required to make additional payments for overtime work or redoing the work due to the Contractor's failure to complete the work in the allotted time.

f. The list of work required to be performed during and prior to the specific shutdown period may not be complete. The Contractor shall schedule all work requiring a shutdown of a specific facility during the scheduled shutdown period.

2. Bypass requirements:

a. General

1) Provide all necessary labor, tools, fuel, materials, and supervision to provide temporary bypass pumping and flow control in accordance with the requirements of this Section.

2) Operate and maintain bypass pumping facilities, including, but not limited to, pumps, piping, valves, controls, and monitoring until the involved portion(s) of the Work have been completed to the satisfaction of the Engineer.

3) Bypassing wastewater in a way that assures no wastewater is allowed to leak outside of the bypass system or plant facilities. If leakage does occur, pay all fines and reimburse the Owner for all costs associated with the cleanup of the leakage, as well as costs associated with legal actions.

4) Accept responsibility for any release of wastewater and for penalties associated with bypass pumping activities, including commissioning, operating, and decommissioning of bypass pumping facilities.

5) Coordinate the placement of bypass piping and pumping equipment with the Owner.

6) The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities shall be the sole responsibility of the Contractor.

7) Except as otherwise specified or authorized in writing, no interruption of wastewater flow shall be permitted throughout the duration of the project. Contractor is responsible for all wastewater overflows during construction of this work and bypass operations.

8) Take precautions to prevent any potential of spillage of wastewater from entering the stormwater system.

9) Temporary bypass pumping operation limited to the months, times, or seasons indicated, unless approved in writing by the Engineer. Continuous operation for 24 hours per day and 7 days per week is anticipated.

10) Continuously monitor temporary bypass pumping.

11) Provide qualified operators continuously during operation of the bypass systems.

12) Provide pumps, piping, and accessories of adequate capacity and size to handle the range of wastewater flows outlined in this Section.

13) Piping, fittings, and all accessories shall withstand 1.5 times the maximum pressure, including surge.

14) Have standby pump(s) on site to provide 100 percent redundancy of the bypass system design flow. The redundant pump(s) shall be plumbed, fueled, and ready for operation at all times.

15) Maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

16) Notify the Owner a minimum of 7 days prior to the Work and notify the Engineer at least 24 hours prior to bypassing or diverting flow in any of the pipelines or laterals.

3. Bypass pumping needs:

   a. The following are descriptions of events where the Engineer and Owner believe bypass pumping will be necessary to make tie-ins or provide access to process areas for construction activities. The bypass pumping events are numbered in the list below for convenience. The numbering does not necessarily indicate the order in which the bypass pumping events must occur.

   b. Bypass #1 - Main Trunkline

1) Description: Bypass pumping is required to divert flows while installing the temporary 30-inch reinforced concrete pipe from the stub on the existing main west trunkline manhole (MH) to the existing main east trunkline MH. It is recommended that this bypass occur between the existing main west trunkline MH and existing MH located on 2100 S just south of the existing sludge drying beds. Once complete, a plug shall be placed in the 30-inch north branch of the existing main west trunkline to divert all flows to the WRF from the existing main east trunkline MH.

2) Associated Drawings: C-111

3) Estimated Flows: 0.5-3.0 MGD

4) Estimated Duration: 2-4 days

c. Bypass #2 - Main Trunkline

1) Description: Once the new influent pump station has been constructed and is operable, bypass pumping is required to divert flows from the west while installing the 30-inch pipe between the existing main west trunkline MH to the new MH-8. It is recommended that this bypass occur between an existing MH on 2100 S, west of the Admin Building, and the existing east trunkline MH.

2) Associated Drawings: C-111

3) Estimated Flows: 0.5-3.0 MGD

4) Estimated Duration: 2-4 days

d. Bypass #3 - Main Trunkline

1) Description: After the new influent pump station has been constructed and is operable, bypass pumping is required to divert flows from the east while installing the new MH-10. It is recommended that this bypass occur between the existing main west trunkline MH and existing MH located on 2100 S just south of the existing sludge drying beds. Once complete, flows from both the east and west trunkline MHs will flow into the new influent pump station wet well.

2) Associated Drawings: C-111

3) Estimated Flows: 0.5-3.0 MGD

4) Estimated Duration: 2-4 days

e. Bypass #4 - SS Line from RV Dump Station, Admin & Operations Buildings

1) Description: Bypass pumping is required to divert flows during installation of the new MH-4 on the east side of the Operations Building. It is recommended that this bypass occur between the existing MH located northwest of the Maintenance Shed and the existing main west trunkline MH. Once complete, Bypass #5 will need to occur.

2) Associated Drawings: C-111

3) Estimated Flows: 0-0.1 MGD (during this time no waste flows will be permitted in the existing Operations Building)

4) Estimated Duration: 2-4 days

f. Bypass #5 - SS Line from RV Dump Station, Admin & Operations Buildings

1) Description: Bypass pumping is required to divert all sanitary sewer (SS) flows from the RV Dump Station, Admin & Operations Buildings while the new influent pump station is constructed. It is recommended that this bypass occur between the new MH-4 and the existing main west trunkline MH. This bypass will be completed when the new influent pump station is finished and operable.

2) Associated Drawings: C-111

3) Estimated Flows: 0-0.2 MGD

4) Estimated Duration: 365 days

g. Bypass #6 - Plant Drain System

1) Description: Bypass pumping is required to divert all plant drain flows from the north end of the WRF while the new influent pump station is constructed. This bypass will be completed when the new influent pump station is finished and operable. It is recommended that this bypass occur between the existing MH in the rock mulch south of the existing primary tank and to one of the following locations:

a) The blind flange for the existing 14-inch SS line that leads to the head of the East Headworks Building. This will require fittings to connect to the existing piping.
b) The existing main west trunkline MH.
c) The existing main distribution box between the West and East Headworks Buildings. This will likely limit traffic around the distribution box during construction.

2) Associated Drawings: C-110, C-111

3) Estimated Flows: 0.2-1.0 MGD

4) Estimated Duration: 365 days

h. Bypass #7 - East Headworks Building

1) Description: Bypass pumping is required to divert all fine screen effluent flows to the head of the oxidation ditches while modifications are made to the Intermediate Pump Station. It is recommended that this bypass occur between the fine screen effluent channel and the oxidation ditch distribution structure. It is recommended that installation of the new 16-inch primary influent (PI) piping occurs during the Intermediate Pump Station work as this piping will be isolated during this bypass and is

critical to WRF operations once the Intermediate Pump Station is complete.

2) Associated Drawings: C-109, C-110, C-111, 3DD101, 3DD102, 3D-101, 3D-102, 3D-301, 3D-302

3) Estimated Flows: 0.5-6.0 MGD

4) Estimated Duration: 25-30 days

4. Proposed work sequence for major project elements:

a. Mobilization.

b. Subsurface utility investigation and relocation required before construction of new Influent Pump Station and Grit Washing Facility.

c. Commence excavation and construction of new Grit Washing Facility, including installation of new piping. Connection of new piping to existing facilities will happen later in the sequence.

d. Commence excavation and construction of new Influent Pump Station, including installation of new piping. Connection of new piping to existing facilities will happen later in the sequence.

e. While new Influent Pump Station is being constructed:

1) Add new 24-inch RS piping connection from new Influent Pump Station to existing screen channel (see Drawing 3D-103). Demolish existing 14-inch RS piping to make new connection (see Drawing 3DD101). While making the new 24-inch connection, the east step screen channel will need to be isolated and all flow from existing influent pumps shall be directed through the west step screen channel.

2) Contractor has the option to replace existing grit pump and grit chamber equipment in the east channel while the flow is diverted to the west side for the piping connections work described above. West grit chamber to remain in operation during this work.

3) Modify and add new drain piping (and manholes) from the RV Dump Station, Admin & Operations Building (Bypass #4 and #5 required).

4) Modify and add new drain piping (and manholes) at the north end of the WRF (Bypass #6 required).

f. Once new Influent Pump Station is constructed, install new manholes and 30-inch sanitary sewer piping that will flow into the new Influent Pump Station wet well (Bypass #2 and #3 required).

g. Commission and put new Influent Pump Station in operation.

h. Intermediate Pump Station modifications and installation of new 16-inch PI piping to oxidation ditch distribution structure. Bypass flow from fine screen effluent channel to oxidation ditch distribution structure during this work

(Bypass #7).

1) Demolish existing influent pumps in East Headworks (Bypass #7 required). All flow from new Influent Pump Station shall be directed through east step screen channel while decommissioning existing influent pump station.

2) Contractor may choose to replace existing grit chamber equipment and modify grit pump discharge piping in the west channel while flow is diverted to the east channel for the work described above. East grit chamber to remain in operation during this work.

i. Replacement of the grit chamber equipment in both east and west channels of the East Headworks must occur before start-up of the new Grit Washing Facility if it wasn't done in conjunction with the shutdown activities listed above.

j. Once new Grit Washing Facility is constructed, make new grit piping connections in the yard from the grit discharge in East Headworks to Grit Washing Facility. Bypass may be avoided if one grit connection to new grit washer in Grit Washing Facility is installed while other grit connection continues to existing grit washer in the West Headworks.

k. Complete new rock mulch, civil site improvements and demobilize from job site.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

APPENDIX A
"Method of Procedure" (MOP)
Instructions and Forms

Definition and Purpose

"Method of Procedure" (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

MOP Process Summary

WHO	STEP	TIMING
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	7 days prior to Preconstruction Scheduling Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	7 days prior to work
Contractor	6. Complete Readiness Checklist.	5 days prior to work
Contractor	7. Complete Safety Checklist.	Just prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

MOP Process Detail

STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

STEP 3. Submits MOP.

Contractor completes the MOP Form and submit 3 copies for approval to the Owner's Project Manager (OPM).

STEP 4. Reviews MOP.

OPM distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in contract documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer and Contractor.

STEP 6. Complete Readiness Checklist.

Contractor verifies everything is ready for the work.

STEP 7. Complete Safety Checklist.

Contractor ensures safety.

STEP 8. Complete work.

Contractor complete work.

STEP 9. Update MOP Log and Progress Schedules.

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

METHOD OF PROCEDURE (MOP) FORM

Owner: _____ Date: _____

Contractor: _____ Project No.: _____

Project Name: _____ Submittal No.: _____

Submittal Title: _____ Spec/Dwg. Reference: _____

MOP #	Task Title *(Provide <10 word title)*:	Submittal Date: *(No later than 28 days prior to work)*

SCHEDULE OF WORK ACTIVITY START: *(Date/Time)* END: (Date/Time)

REQUESTOR:

PRIMARY POINT OF CONTACT:	PHONE/PAGER:
SECONDARY POINT OF CONTACT:	PHONE/PAGER:

NOTIFY	☐	Control Room, Phone	☐	Security, Phone	

BUILDING:	LOCATION OF WORK FLOOR/LEVEL:

DESCRIPTION OF WORK: *(Provide sufficient details on process isolation, work sequencing, and safety (i.e., control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)*

Task Summary: _____

Processes Affected: _____

Trades Affected: _____

WORK PLAN:

Work Sequencing: _____

Process Isolation: _____

Spill Prevention Plan: _____

Contingency Plans: _____

CRITICAL EQUIPMENT/TOOLS: *(pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)*

☐	Acoustic Ceiling/or Walls Access	☐	Excavation Permit	☐	Lock Out/Tag Out
☐	Chemical Use Approval	☐	Fire Sprinkler Impairment	☐	Life Safety Systems
☐	Confined Space Permit	☐	Flammable Materials	☐	Roof Protocol
☐	Critical Lift Plan	☐	Flush / Discharge	☐	Work After Dark
☐	Energized Electrical Work	☐	High Pressure Test	☐	
☐	Elect. Panel Schedules	☐	Hot Work/Open Flame	☐	

EXISTING SERVICE(S) AT RISK:

☐	Breathing Air	☐	Elect Normal	☐	Process Access	☐	Telephones
☐	Chemical Distribution	☐	Fire Protection	☐	Safety Showers	☐	UPS
☐	City Water	☐	HVAC	☐	SCADA	☐	VAX/DATA
☐	Communication	☐	Inert Gas	☐	Security	☐	
☐	Domestic Drain	☐	Instrument - Air	☐	Solvent Drain	☐	
☐	Elect-Bus Duct	☐	Life Safety System	☐	Specialty Gases	☐	
☐	Elect Emergency	☐	Natural Gas	☐	Storm Drain	☐	

REVIEWER'S INSTRUCTIONS / COMMENTS: _____

☐ PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:

	Full Name (printed)	Signature	Phone	Date
Submitted By				
System Owner				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				

READINESS CHECKLIST
(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____
2. Review work plan: _____
3. Review contingency plan: _____

SAFETY CHECKLIST
(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
   a. Emergency exits: _____
   b. Emergency shower and eyewash: _____
   c. Telephones and phone numbers: _____
   d. Shut-off valve: _____
   e. Electrical disconnects: _____
2. Inspect work area:
   a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. MSDS (Material Safety Data Sheets)
   a. Understand the chemicals and substances in the area you are working in by reading the MSDS.
4. Lockout/Tagout Procedure:
   a. Lockout/Tagout energy sources before beginning work.
   b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
   c. Make sure the lines are depressurized.
5. Overhead work:
   a. Use appropriate personal protective equipment; i.e. safety harness, lifeline, etc.
   b. Select appropriate tie-off points; i.e. structurally adequate, not a pipe or conduit, etc.
   c. Spotter assigned and in position.
   d. Pipe rack access; i.e. check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
   a. Shepherd's hook
   b. ARC flash protection
   c. Fire extinguisher
   d. Other _____
7. Accidents:
   a. Should accidents occur do not shut-off and do not attempt to correct the situation, unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review start-up documents:
   a. In the event the system is shutdown, the Control Center should have a working knowledge of the start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
   a. Do not obstruct evacuation routes.
   b. Take time to survey the area for evacuation routes.

Method of Procedure (MOP) Log
Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (yes/no)
001					
002					
003					

SECTION 01 95 00 – BID ALLOWANCES

PART 1 -- GENERAL

1.1 SUMMARY

A. Listing of allowance items to be included in the Contractor's bid as outlined in Section 00 41 00 - Bid Forms.
   1. Allowance amounts are shown for key pieces of equipment, materials, or services needed for completion of the Work.

1.2 ALLOWANCE AMOUNTS

A. Contractor shall include the following allowance amounts in the contract for furnishing products only:

1.	Two (2) Smith & Loveless Model 7.0B PISTA V-Force™ Grit CHAMBERs™, see adder in Appendix C	$ 150,000.00
2.	SKM Engineering (SCADA and Integration), see Appendix D	$ 220,000.00
3.	Owner's Contingency for Subsurface Utility Conflicts	$ 30,000.00
	Total Allowance Amount:	$ 400,000.00

1.3 COSTS INCLUDED AND EXCLUDED IN ALLOWANCES

A. Costs included in allowances for furnishing products only:
   1. Net cost of product.
   2. Delivery and unloading at site.

B. Costs to be included in Contractor's Bid Price, but not included in allowances for furnishing products only:
   1. Handling at site, including uncrating and storage.
   2. Protection from elements, theft, and damage.
   3. Labor, installation, testing, and finishing.
   4. Other expenses required to complete installation.
   5. Overhead and profit.
   6. Applicable taxes.

1.4 DUTIES OF CONTRACTOR IN PROVIDING PRODUCTS BY ALLOWANCE

A. Advise Engineer at least 60 days in advance of purchase date necessary to avoid impacts to Progress Schedule.

B. Obtain proposals from suppliers, including:
   1. Quantity.
   2. Complete description of product and services provided under allowance.
   3. Unit cost.
   4. Total amount of purchase.
   5. Taxes and delivery charges.

C. Submit proposals for Owner and Engineer review.

D. On notification of selection, enter into purchase agreement with designated supplier.

E. Arrange for delivery and unloading.

F. Install products in accordance with Contract Documents.

1.5 ADJUSTMENT OF COSTS

A. When actual cost is more or less than amount of allowance, Contract Price will be adjusted by Change Order.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 95 10 – BID ALTERNATES

PART 1 -- GENERAL

1.1 SUMMARY

A. Identification and description of Bid Alternate Items as shown on the Bid Form in Section 00 41 00.

1.2 PROCEDURES

A. Alternates will be exercised at Owner's option.

B. Coordinate related work and modify surrounding work as required to complete the Work, including changes under Alternates accepted by Owner in Notice of Award.

1.3 ALTERNATES

A. Bid Alternate A – Replacement of Existing Intermediate Pumps:
   1. Remove and replace the three existing intermediate pumps (PMP-301, PMP-302, and PMP-302) with three new pumps in accordance with the requirements of Section 43 25 06.
   2. Related drawings:
      a. The following drawings are related to the work described in this Section.
         - 3DD101
         - 3D-101
         - 3D-102
         - 3D-302
      b. This list of Related Drawings is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 02 22 00 - SITE CONDITIONS SURVEYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements to document conditions of the Project Site and adjacent properties before construction begins and after completion of the Work. Methods include still photographs, digital video recordings, and topographic surveys.

1.2 SUBMITTALS

A. Submit all photographs, digital videos, and topographic survey data of the preconstruction conditions to Engineer for record purposes prior to, but not more than three weeks before, commencement of any construction activities.

1.3 CLOSEOUT SUBMITTALS

A. Complete and submit all digital videos, still photographs, mapping, and survey data of the postconstruction conditions to Engineer prior to final inspection by Owner and Engineer.

B. Provide postconstruction survey data to Engineer as follows:

1. Submit topographic mapping for each site hereinbefore identified for topographic mapping and surveys as a separate electronic map (drawing) in AutoCAD Release 2018, or later.

2. Also submit each AutoCAD site map in hard copy plot format (six copies).

3. Engineer will review hardcopy plots for accuracy relative to the specified requirements.

4. Amend mapping files, as required, based on review of the hardcopy plots by Engineer.

5. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of 1"=20' horizontal and 2-foot contour intervals as specified for National Map Accuracy Standards.

6. All electronic mapping files shall be three-dimensional.

7. Submit lists of survey points for all topographic surveys in ASCII text file format.

8. Provide mapping and points files on one or more compact discs in a format acceptable to Engineer.

C. If required by Engineer or Owner, submit up to six copies of the survey data.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Conduct thorough preconstruction and postconstruction Site conditions surveys of the entire Project. Site conditions surveys shall consist of photographs, digital video recordings, and topographic mapping. Provide and submit sufficient photographs, supplemented by digital video, to Engineer to resolve any damage claims, which may arise due to the construction of this Project. Develop topographic mapping using the Project coordinates and referenced to the Project base lines and benchmarks. Mapping shall be adequate to ascertain preconstruction and postconstruction conditions (including elevations) of all public and private property within and adjacent to the construction limits.

B. Digital video or photographic surveys shall include, but not be limited to, all access roads used to transport material or equipment to and from the Site and elevation of roadways, drives, walks, and buildings. Use spot elevation surveys to document the elevation on abutting roadways, drives, and walks, taken at approximately 20-foot intervals and at the point of juncture with any structure to which they are attached or otherwise influenced by the Work. In addition, take elevations of all building slabs along the Project route. Provide topographic mapping as specified herein.

C. Digital video recordings required as part of this Section and by Section 31 10 00 – Site Preparation and Restoration and Section 31 30 00 - Earthwork may be combined into a single set of media provided the requirements for videos specified in both Sections are met.

D. As a minimum, note preconstruction and postconstruction conditions and perform digital video surveys of the following:

1. Areas used to access the Site or haul materials and equipment to the Site.

2. The access road, both original and relocated locations and ultimately to the Site.

3. All Work areas, including, but not limited to, access corridors, disposal areas, and staging areas.

4. Any work completed by other contractors at the Site that will be impacted or otherwise affected by Work of this Project.

E. Supplement digital video surveys with still photographs and spot elevation surveys as required to document the original condition and location of existing features and facilities.

F. Provide digital video records in DVD-R format.

G. Conduct topographic mapping to document the post-construction topography of the following Sites.

1. Magna Water Reclamation Facility

END OF SECTION

SECTION 02 41 00 – DEMOLITION

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required for demolitions of existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

1.02 COORDINATION

A. The Contractor shall carefully coordinate the Work in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The Work as indicated is not all-inclusive, and the Contractor shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with sequencing requirements in Section 01 14 00 - Construction Restraints.

B. The Contractor shall note that the Drawings used to indicate demolition and reconstruction are based on survey of surface features, record information, site photographs, and other provided information describing the existing facilities. The record information has been reproduced in the Drawings to show existing conditions and to clarify the scope of Work. The information provided may not be complete or accurate. The Contractor shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of Work, and the extent of auxiliary utilities.

C. While demolition and reconstruction are being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the Contractor's employees and the Owner's personnel at the plant. The Contractor shall remove such protection when reconstruction activities are complete, or as Work progresses, or when requested by the Engineer.

D. The Contractor shall be responsible for acquiring appropriate necessary permits for the work. Copies of the permits shall be submitted to the Owner prior to commencement of demolition.

1.03 CONTRACTOR SUBMITTALS

A. A demolition plan shall be submitted to the Engineer for review. The demolition plan shall detail demolition and reconstruction activities and procedures, including operational sequences, in accordance with Section 01 33 00 – Submittal Procedures. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation.

B. The demolition plan shall include identification of items to be salvaged or relocated. A storage plan for salvaged items shall be included.

C. The Engineer's review shall be limited to a review of the scope and intent of demolition as required by the contract documents. The Contractor shall be responsible for the means and methods to ensure the work is conducted in a safe and proper manner. The Engineer's review of the demolition plan shall in no way alleviate the Contractor from this responsibility.

D. Protection:

1. Perform all demolition and removal Work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.

2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways.

3. Erect and maintain barriers, lights, sidewalk sheds, and other necessary protective devices.

4. Repair damage to facilities to remain, or to any property belonging to the Owner or occupants of the facilities.

E. Scheduling:

1. Carry out operations to avoid interference with Owner's operations and Work in the existing facilities.

F. Notification:

1. At least 48 hours prior to commencement of a demolition or removal activity, notify the Engineer in writing of the proposed schedule. The Owner will inspect the existing equipment and mark for identification those items which are to remain the property of the Owner. Do not start removals without the permission of the Engineer.

G. Explosives:

1. Do not bring explosives onto site.

2. The use of explosives will not be permitted.

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 14 00	Construction Restraints
01 33 00	Submittal Procedures
01 50 10	Protection of Existing Facilities
09 96 00	High Performance Coatings
31 30 00	Earthwork

1.05 DEMOLITION

A. Existing pavement, structures, equipment, piping, valves, ductwork, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the Work shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the Contractor.

1.06 SALVAGE

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances indicated to be salvaged shall be removed without any degradation in condition from that prior to removal. Salvaged items shall be stockpiled and protected on the Site at a location chosen by the Engineer. The Contractor shall be responsible to properly safeguard the salvaged items against damage and loss during removal and handling.

1.07 RELOCATION

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances to be relocated shall be removed without any degradation in condition from that prior to removal. The Contractor shall be responsible to properly safeguard the relocated items against damage and loss during removal, handling, storage, and installation in the new location.

B. Items to be relocated include:

Item	**Description**
Plant Drain Flow Meter	Relocate Parshall flow meter from existing manhole and install in new MH-5.

1.08 ABANDONMENT

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances to be abandoned shall be prepared by the Contractor as indicated.

1.09 REHABILITATION

A. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation Work disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.

B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

C. In buildings with reconstruction Work, the Contractor shall not use any Owner equipment (e.g., bridge cranes and monorails) unless authorized in advance in writing by the Engineer. Such authorization shall be subject to documentation by the Contractor of the proposed load on the equipment and be subject to Owner requirements for usage on operating and maintenance needs. Any damage to a crane shall be repaired or replaced to the Engineer's satisfaction.

1.10 DISPOSAL

A. The Contractor shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 -- PRODUCTS – [NOT USED]

PART 3 -- EXECUTION

3.01 GENERAL

A. The Contractor shall coordinate demolition and reconstruction Work with the Owner and Engineer. Unless otherwise indicated, the Contractor shall be responsible for the sequence of activities. Work shall be performed in accordance with applicable safety rules and regulations.

B. The Contractor shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.

C. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the Work activities to the extent indicated. If reconstruction beyond the scope indicated is required, the Contractor shall obtain approval from the Engineer prior to commencing.

3.02 PROTECTION OF EXISTING FACILITIES

A. Before beginning any reconstruction, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to reconstruction shall be protected and maintained in accordance with Section 01 50 10 - Protection of Existing Facilities. Damaged existing facilities shall be repaired to the previous condition or replaced.

B. Persons shall be afforded safe passages around areas of demolition.

C. Structural elements shall not be overloaded. The Contractor shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of Work performed under this Section. The Contractor shall remove temporary protection when the Work is complete or when so authorized by the Engineer.

D. The Contractor shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment or material.

E. The Contractor shall promptly repair damages caused to adjacent facilities by demolition operations at no cost to the Owner.

3.03 DEMOLITION, SALVAGE, AND RELOCATION

A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The Contractor shall verify the scope of the Work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01 14 00 - Construction Restraints. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. Equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Damage to the existing structure shall be repaired as indicated.

2. Exposed piping including vents, drains, and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2-in. Resultant openings in the structure shall be repaired as indicated.

3. Electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.

4. Exposed electrical conduits and associated wiring shall be removed. Resultant openings in structures shall be repaired as indicated.

5. Connections to embedded electrical conduits shall be removed a minimum of 2-in inside the finished surface of the existing structure. Wiring shall be removed, and the resulting openings shall be repaired as indicated.

6. Associated instrumentation devices shall be removed.

7. Auxiliary utility support systems shall be removed.

8. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.

9. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.

10. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth which will not interfere with new construction, but not less than 36-in below existing ground surface or future ground surface, whichever is lower.

11. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 30 00 – Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.

12. When existing pipe is removed, the Contractor shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.

13. When existing piping is removed from existing structures, the Contractor shall fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to view, the grout shall be recessed approximately 1/2-in and the recessed area filled with cement mortar grout.

14. Electrical reconstruction shall be conducted by the Contractor in a safe and proper manner to avoid injury from electrical shock to the Owner's and Contractor's personnel. Electrical equipment to be shut off for an extended period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections which are energized or could become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.

B. The Contractor shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The Contractor shall inform the Engineer in writing a minimum of 5 Days prior to the functional testing in order for the Owner and Engineer to witness the test. If, in the opinion of the Engineer, the relocated equipment does not function in a satisfactory manner, the Contractor shall make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the Owner.

3.04 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the Contractor shall remove the abandoned pipe for a distance of 5 ft from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-in diameter or greater shall be completely filled with sand or flowable fill prior to closure of the piping ends.

3.05 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by Work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by its construction activities.

B. Where new rectangular openings are to be installed in concrete or concrete masonry walls or floors, the Contractor shall score the edges of each opening (both sides of wall or floor slab) by saw-cutting clean straight lines to a minimum depth of 1-in and then chipping out the concrete. Alternately, the sides of the opening (not the corners) may be formed by saw cutting completely through the slab or wall. Saw cuts deeper than 1-in (or the depth of cover over existing reinforcing steel, whichever is less) shall not be allowed to extend beyond the limits of the opening. Corners shall be made square and true by a combination of core drilling and chipping or grinding. Necessary precautions shall be taken during removal of concrete to prevent debris from falling into or entering adjacent tanks in service or from damaging adjacent equipment or piping. Saw cuts allowed to extend beyond the opening shall be repaired by filling with non-shrink grout. The concrete around any exposed reinforcement steel shall be chipped back and exposed reinforcement steel cut a minimum of 2-in from the finished face of the new opening and be painted with epoxy paint containing a corrosion inhibitor. The inside face of the new opening shall be grouted with a non-shrink grout to fill any voids and cover the exposed aggregate and shall be trowel-finished to provide a plumb and square opening.

C. Where new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as indicated or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to provide watertightness around openings so formed. The boxes or cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.

D. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-in. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.

E. In locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed approximately ½-in and the recessed area filled with cement mortar grout.

F. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

G. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads, bases associated with equipment, supports, and appurtenances shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2-in below finished grade and be painted with epoxy paint. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1 ½-in, and concrete within the scored lines removed to a depth of 1 ½-in (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

H. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete. Existing reinforcement not to be retained shall be cut-off as follows:

    1. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.

    2. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2-in below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.

I. Where existing handrailing is removed, post embedment's and anchors shall be removed, and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.

J. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 96 00 – High Performance Coatings to match the original painting and coating with a compatible system. Surfaces of equipment items that are to be relocated shall be prepared and be coated in accordance with Section 09 96 00 – High Performance Coatings.

3.06 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities that shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.07 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The Contractor shall comply with government regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.08 CLEANING

A. During and upon completion of Work, the Contractor shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by Work in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as requested by the Engineer or directed by governing authorities, and adjacent areas shall be returned to condition existing prior to start of Work.

C. The Contractor shall clean and sweep the street and road daily.

END OF SECTION

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SECTION 03 01 30 - CONCRETE REPAIR AND REHABILITATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide all materials and equipment necessary to accomplish the Work.

B. Repair damage to concrete and concrete surfaces which results from the removal of embedded items, from construction activities, or which existed previously in structures indicated to be repaired.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ACI 201.1R-08	Guide for Conducting a Visual Inspection of Concrete in Service
ACI 546R-14	Concrete Repair Guide
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systemes Used with Concrete by Slant Shear
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic cement Mortars (Using 2-in Cube Specimens)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit Shop Drawings for strengthening required around new openings.

2. Submit detailed drawings showing proposed methods for supporting existing structures, equipment, and piping during demolition and repair activities.

C. Concrete Repair Products and Procedures

1. Submit a comprehensive plan for each repair method indicated within this Section, the plan shall including the following:

a. Manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each product.

b. Curing products and procedures for each repair method for which curing is recommended by the manufacturer.

1.4 QUALIFICATIONS OF CONCRETE RESTORATION FIRMS

A. The concrete restoration Work shall be performed by an experienced firm customarily engaged in performing similar repair work on cast-in-place concrete structures.

B. The restoration firm shall have completed at least 5 similar projects in the last 5 years.

C. The restoration firm shall be certified by the manufacturer of the repair materials.

1.5 QUALITY ASSURANCE

A. Field Tests of Cement Based Mortars and Grouts

1. The Engineer may take compression test specimens during construction from the first placement of each type of mortar or grout, and at intervals thereafter as selected by the Engineer in order to ensure continued compliance with the indicated requirements.

2. The Contractor shall assist the Engineer in obtaining specimens for testing.

3. The compression tests and fabrication of specimens for repair mortar and non-shrink grout will be performed as specified in ASTM C 109.

4. A set of 5 specimens will be made for testing at 7 days, 28 days, and additional time periods as appropriate.

5. Any material, already placed, which fails to meet the indicated performance requirements is subject to removal and replacement as part of the Work.

6. The cost of laboratory tests on mortar and grout will be paid by the Owner, but the Contractor shall be responsible for the cost of any additional tests and investigation on the Work that does not meet the indicated requirements.

7. The Contractor shall supply all necessary materials for fabricating the test specimens.

B. Repair Concrete: Repair concrete shall be tested as required in Section 03 31 00 – Cast-in-Place Concrete.

C. Epoxy Grout: Epoxy grout shall be tested as required in Section 03 60 00 – Grouting.

D. Construction Tolerances: Construction tolerances shall comply with the requirements of Section 03 31 00 – Cast-in-Place Concrete, except as otherwise indicated.

PART 2 -- PRODUCTS

2.1 REPAIR MORTAR

A. Provide repair mortar as a pre-packaged, 2-component, polymer-modified, cementious, non-sag mortar, specifically formulated for the repair of surface defects.

B. Provide the mortar with a penetrating corrosion inhibitor.

C. Repair mortar shall have the following properties:

Physical Property	Value	ASTM Standard
Compressive Strength (min.) at 7 days 7000 psig at 28 days 2200 psig	6000 psig 7000 psig	C-109
Bond Strength (min.) 98% C-666 at 28 days	2200 psig	C-882 (modified)
Freeze/Thaw resistance (min.) 300 cycles	98 percent	C-666

D. Provide a minimum repair thickness of ¼ inch, unless otherwise indicated.

E. Repair Mortar shall be **SikaTop 123 Plus**, by **Sika Corporation**, or equal.

2.2 NON-SHRINK GROUT

A. Provide non-shrink grout conforming to the requirements of Section 03 60 00 – Grouting.

2.3 CONCRETE MATERIALS

A. Cement

1. Use Type II Portland cement unless otherwise indicated.

2. Where repairs are to be made on wall surfaces open to view and above normal water surface elevations, blend white Portland cement with the Type II cement as needed in order to match the color of the adjacent existing concrete surface.

B. Structural Repair Grout

1. Where required, provide structural repair grout meeting the requirements of Section 03 60 00 – Grouting.

2. Provide a minimum repair thickness of 3 inches.

C. Cement Grout

1. Provide cement grout that meets the requirements of Section 03 60 00 – Grouting.

2. Provide a minimum repair thickness of one inch.

D. Miscellaneous Materials**:** For concrete construction materials not covered specifically in this Section, conform to the requirements of Section 03 31 00 – Cast-in-Place Concrete.

2.4 AGGREGATE

A. Obtain the written permission of the manufacturer and Engineer before using aggregate to extend repair mortar and grout products.

B. If allowed and unless otherwise indicated, provide aggregate consisting of 3/8-inch clean, washed gravel or crushed stone as required in Section 03 31 00 – Cast-in-Place Concrete.

2.5 BONDING AGENT AND ANTI-CORROSION COATING

A. Provide a bonding agent that is a solvent-free, moisture-tolerant, epoxy-modified, cementitious product, specifically formulated as a bonding agent and anti-corrosion coating.

B. Bonding Agent shall be **Armatec 110 EpoCem**, by **Sika Corporation**, or equal.

2.6 EPOXY GROUT

A. Provide an epoxy grout conforming to the requirements of Section 03 60 00 – Grouting.

2.7 EPOXY RESIN

A. Use epoxy resin for structural crack repair.

B. For crack injection, provide a 2-component, moisture-tolerant, low-viscosity, high-strength epoxy resin adhesive that is specially formulated for that usage.

C. Provide a minimum bond strength of 2900 psi when tested per ASTM C 882 at 14 days, moist cured.

D. Epoxy Resin shall be **Sikadur 35, Hi-Mod LV**, by **Sika Corporation**, **KEMKO 068 LoVis IR**, by **ChemCo Systems, Inc.**, or equal.

2.8 PROTECTIVE COATING

A. Waterproofing

1. Provide a 2-component, polymer-modified, cementitious waterproofing and protective slurry mortar for concrete.

2. Apply the material in 2 coats, with a coverage of 40 sq ft/gal/coat.

3. Waterproofing shall be **Sika Top Seal 107**, by **Sika Corporation**, or equal.

2.9 FORMWORK

A. Where needed, provide formwork that meets the requirements of Section 03 11 00 – Concrete Forming.

2.10 REINFORCEMENT STEEL

A. Where required, provide reinforcing steel that meets the requirements of Section 03 21 00 – Reinforcement Steel.

2.11 POLYURETHANE SEALANT

A. Provide a 2-part polyurethane, gun-grade sealant.

B. Polyurethane Sealant shall be **Sikaflex – 2C**, by **Sika Corporation**, or equal.

2.12 POLYURETHANE CHEMICAL GROUT

A. Use polyurethane chemical grout for non-structural crack repair.

B. Polyurethane Chemical Grout shall be **SikaFix HH**, by **Sika Corporation**, **Flex LV PURe**, by **WR Grace/De Neef**, **Flex SLV PURe**, by **WR Grace/De Neef**, or equal.

2.13 EXPANSION JOINTS

A. Provide an expansion joint system for repair of the existing expansion joints, consisting of a Hypalon sealing strip and an epoxy adhesive in order to provide a watertight seal.

B. Expansion Joint System shall be **Sikadur Combiflex**, by **Sika Corporation**, or equal.

2.14 HYDROPHILIC WATERSTOP

A. Provide hydrophilic waterstop of the type which expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

B. Provide hydrophilic waterstop that is bentonite-free, and manufactured from chloroprene rubber and modified chloroprene rubber with hydrophilic properties.

C. Hydrophilic Waterstop shall be **Hydrotite RSS-040 P**, by **Greenstreak Group, Inc.**, **KM 4mm String**, by **Adeka Ultra Seal**, or equal.

2.15 HIGH STRENGTH EPOXY GEL

A. High-Strength Epoxy Gel for crack surface sealing shall be **Denepox Rapidgel**, by **WR Grace/De Neef**, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Repairs

1. Repair techniques will be reviewed during the pre-construction meeting between the Contractor, Engineer, and Owner.

2. The Contractor shall be familiar with the cause of deteriorated concrete and shall choose the right equipment, repair materials and techniques to be used for each particular repair.

3. Choose repair materials to match the adjacent concrete surface in color and texture.

4. Apply repair materials in strict accordance with the manufacturer’s printed instructions, including temperature and moisture requirements throughout application and curing.

5. Protect adjacent portions of the structure, including all valves, pipes, mechanical equipment, and filter media from debris generated by repair activities.

6. For portions of the structure that are not identified to be repaired, maintain in their original condition.

B. Structural Stability

1. Use caution not to weaken the structural capacity of a beam, column, wall, slab, walkway, or other concrete member during concrete removal.

2. For severely deteriorated concrete members, consult with the Engineer before removing a major portion of any structural member.

3. Shoring may be required in order to support the structure and to protect workers.

C. Provide off-site disposal of debris generated as a result of repair procedures.

D. Provide concrete construction procedures not specifically addressed in this Section in accordance with the requirements of Section 03 31 00 – Cast-in-Place Concrete.

3.2 REPAIR SEQUENCING

A. Unless otherwise indicated, perform concrete repairs in the following sequence, with no activity in an area being started until previous activities in that area have been completed, including curing, cleanup, and the like:

1. removal of equipment, miscellaneous metals, and other surface features that would interfere with the repair;

2. removal of concrete sections which require complete replacement;

3. surface preparation hydroblasting over the entire area to be repaired;

4. embedded metal repair;

5. crack repair;

6. filter trough to wall connection repair;

7. spalled and delaminated concrete repair;

8. scaled concrete;

9. pop-out repair, and repair of other surface damage, deterioration, or defects;

10. patching of holes in concrete;

11. replacement of concrete sections which require complete replacement;

12. new construction;

13. application of protective coatings;

14. expansion joint repair; and,

15. installation of traffic topping.

B. For areas which require combinations of spalled and delaminated concrete repair, scaled concrete, and pop-out repair, perform these repairs at the same time.

C. Limit the size of the repair area in order to permit the repairs to be performed together, without sacrificing the quality of the individual repairs.

3.3 EMBEDDED METAL REPAIR

A. Unless otherwise indicated, repair anchor bolts and other embedded metal, except rebar, that are exposed at the concrete surface and are showing signs of corrosion, as follows:

1. Cut off or otherwise remove corroded metal fastened at the surface;

2. Burn back embedded metals to a depth of at least 1.5 inches beyond the surface of sound concrete;

3. Chip away unsound concrete around the embedded metal.

4. Apply epoxy grout to the repair area until level with the surface of the surrounding sound concrete.

B. Unless otherwise indicated, repair embedded rebar that is exposed at the concrete surface following the procedures outlined in the appropriate concrete repair subsection, below.

3.4 CRACK REPAIR

A. Structural Cracks – Structural Cracks are defined as follows:

1. All cracks where reinforcing steel is passing across the crack, including erratic cracks, and cracks at construction joints.

2. Cracks identified by the Engineer as structural cracks

3. Repair structural cracks with epoxy resin.

B. Non Structural Cracks – Non Structural Cracks are defined as follows:

1. Cracks occurring at flexible joints, contraction joints or expansion joints.

2. Cracks identified by the Engineer as non structural cracks.

3. Repair non-structural cracks with polyurethane chemical grout.

C. Efflorescence

1. Prior to the crack repair, clean efflorescence from the cracks and the surrounding area.

2. Clean the efflorescence by light hydro-blasting or scrubbing.

D. Pressure Injection: Pressure Injection to be performed prior to leak testing and roof membrane installation.

1. General

a. The indicated repair materials have been selected to minimize the loss of material during the injection process. The areas selected for crack repair are to be identified by the Contractor, Engineer or Construction Manager and be determined prior to leak tests and roof membrane installation. The injection of cracks may also be required as a result of the leak test.

b. In order to avoid excessive loss of injected material at the lower exposed portions of the cracks, space the injection ports a distance no greater than the thickness of the wall being repaired.

2. Open through thickness structural cracks are to be repaired to deliver a water tight hydraulic structure passing the specified leakage test. All 3 foot long minimum or greater through thickness cracks greater than a minimum 15 mil thickness in the walls are to be injected unless they do not accept grout. All 2 foot long minimum through thickness cracks greater than 10 mil thickness in the foundation, water conduits, floor slabs and roof are to be injected unless they do not accept grout. Perform structural crack repairs by pressure injection in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

a. Remove unsound and foreign materials from the crack in a manner that does not trap debris in the crack and prevent the flow of repair materials.

b. Remove any contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air.

c. Install the injection ports in accordance with the manufacturer's directions.

d. Sealing

1) Seal the surface in order to keep the pressure injecting materials from leaking out before it has set or gelled.

2) Seal a surface by brushing an epoxy over the surface of the crack and allowing it to harden, or use high injection pressures to cut-out the cracks in a 'V' shape, fill with an epoxy, and strike off flush with the surface.

3) Surface patching or sealant shall be performed where needed to provide for complete penetration of the injected polyurethane grout and to prevent wastage. Seal surface of crack with fast setting hydraulic cement or high strength epoxy gel. The floor surface along the cracks shall be cleaned and all wasted grout and surface seal material shall be completely removed from the concrete surface following completion of the repair work

e. Inject the repair materials, with consideration of the following items:

1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.

2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, then cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled.

3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end, using low-viscosity repair material.

f. Cleanup

1) Remove the surface seal by grinding or other appropriate means.

2) Coat fittings and holes at injection ports with an epoxy patching compound.

3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3. Open through thickness non-structural cracks are to be repaired to deliver a water tight hydraulic structure passing the specified leakage test. Open through thickness cracks with lengths of at least 3 feet on each side of the wall and roof, at least 2 feet of length on the foundation or floor slab are to be injected unless they do not accept grout. All 3 foot long minimum or greater through thickness cracks greater than a minimum 15 mil thickness in the walls are to be injected unless they do not accept grout. All 2 foot long through thickness cracks greater than 10 mil thickness in the floors and roof are to be injected unless they do not accept grout. Perform non-structural crack repairs in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

a. Remove unsound and foreign materials from the crack in a manner that does not trap debris in the crack and prevent the flow of repair materials.

b. Remove contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air.

c. Install the injection ports in accordance with the manufacturer's directions.

d. Moisture

1) For non-structural cracks, moisture must be present for the chemical grout to react.

2) Prior to injecting the repair materials, inject the crack with a small amount of water in order to completely moisten the crack.

e. Inject the repair materials, with consideration of the following items:

1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.

2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled, and then, starting again at the lowest port, re-inject into all ports in order to ensure that all voids are properly sealed off.

3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end.

f. Cleanup

1) Remove excess surface material by grinding or other appropriate means.

2) Coat fittings and holes at injection ports with an epoxy patching compound.

3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3.5 SPALLED AND DELAMINATED CONCRETE REPAIR

A. Repair spalls and delaminated concrete using repair mortar.

B. Surface Preparation

1. Remove all delaminated concrete and all unsound concrete beyond the spalled or delaminated area.

2. Boundaries

a. Determine the boundaries of the patch by sawcuts to a depth of at least ¼ inch up to one inch deep.

b. Where the sawcut locations are not shown on the Drawings, the boundaries shall be layouts designed to reduce boundary edge length.

c. Avoid excessive or complex edge conditions.

3. Sawcuts

a. Perform sawcuts perpendicular to the surface or slightly undercut.

b. Construct sawcuts in maximum ¼-inch increments.

c. After each incremental cut, inspect the cut surface in order to ensure that the existing reinforcement has not been cut.

d. If at any depth the reinforcement becomes exposed, terminate the sawcut and notify the Engineer.

4. Chip away concrete within the repair area to a depth sufficient to expose sound concrete over the entire repair area, or to a minimum depth required by repair mortar, whichever is greater.

5. Base the selection of partial depth concrete removal equipment on the size of repair area, depth of concrete to be removed, and the location of the deteriorated concrete such as wall, slab-on-grade, underside or top of elevated slab.

6. Removal

    a. The maximum allowable pneumatic chipping hammer shall be a 30-lb class hammer.

    b. Hydroblast removal shall use a maximum pressure of 40,000 psig.

    c. Sand blasting is not permitted.

    d. Hydroblast concrete removal is recommended for large area of surface defects.

    e. Remove water blasting debris daily in order to prevent it from setting up.

    f. If a chipping hammer is used, ensure that the existing reinforcement is not damaged during the concrete removal operations.

    g. Remove protrusions, such as mortar spatter or fins, by grinding or by striking with a hammer or other tool.

7. Reinforcement

    a. Remove concrete from around reinforcement when the rebar is rusted, more than half the rebar perimeter is already exposed, the concrete bond around the rebar is broken, or if the concrete is unsound or honey-combed.

    b. Remove concrete in order to provide a clear space of minimum one inch on all sides of the reinforcement, such that the rebar can be cleaned and the repair material will completely surround the rebar.

    c. Clean exposed reinforcement by water blasting or wire brushing.

    d. After fully exposing and cleaning the reinforcement, check for steel deterioration, and if the cross-sectional area of the steel has been reduced by more than 10 percent, whether by deterioration, surface preparation, or a combination of both, provide additional reinforcement.

    e. Consult with the Engineer before adding or replacing rebar.

C. Repairing Surface Defects

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning the reinforcement.

2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.

3. Remove dust, including new dust generated by surface preparation or scarifying.

4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

6. Repair Mortar

    a. Apply repair mortar in accordance with the manufacturer's recommendations.

    b. The thickness of each lift of repair mortar shall be in accordance with the manufacturer's recommendations, with the minimum thickness being not less than ¼ inch.

7. Fully consolidate the repair mortar, working the material into the substrate to completely fill all pores and voids in the area to be filled.

8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

9. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

10. Float-finish the repaired surface using wood or sponge floats.

11. For repaired surfaces to receive a protective coating, brush-finish the surface in order to produce a roughened substrate for the coating.

12. Minimum and maximum ambient and surface temperatures shall be as recommended by repair material manufacturer.

D. Curing

1. Curing of repair mortar to receive waterproofing shall be as follows:

    a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;

    b. Weight the curing blankets or otherwise held them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;

    c. Ensure that edges are continuously held in place; and,

    d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.

2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

3. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.6 SCALED CONCRETE REPAIR

A. Repair scaling and pop-outs using repair mortar.

B. Surface Preparation

1. Prior to repair, prepare the surface in accordance with the repair mortar manufacturer's recommendations with the following minimum requirement.

2. Remove unsound concrete from surfaces by high-pressure water blasting, using a minimum pressure of 10,000 psigg and maximum pressure of 40,000 psigg.

3. Clean exposed reinforcement by water blasting or wire brushing.

C. Repairing Surface Defects

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning reinforcement.

2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.

3. Remove dust, including new dust generated by surface preparation or scarifying.

4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

6. Apply repair mortar in accordance with the manufacturer's recommendations, using a minimum repair material thickness of ¼ inch.

7. Fully consolidate the repair material, working the material into the substrate to completely fill all pores and voids in the area to be filled.

8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

9. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

10. Float-finish the repaired surface using wood or sponge floats.

D. Provide strip joint in newly placed mortar at the location of repaired cracks.

E. Curing

1. Curing of repair mortar to receive waterproofing shall be as follows:

a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;

b. Weight the curing blankets or otherwise held them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;

c. Ensure that edges are continuously held in place; and,

d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.

2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

3. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.7 POP-OUT REPAIR, AND REPAIR OF OTHER SURFACE DAMAGE, DETERIORATION, OR DEFECTS

A. Repair pop-outs and other surface damage, deterioration, and defects which are ¼ inch deep or shallower, using the procedures described under "SCALED CONCRETE REPAIR," above.

B. Repair other pop-outs and surface damage, deterioration, and defects using the procedures described under "SPALLED AND DELAMINATED CONCRETE REPAIR," above.

3.8 PATCHING OF HOLES IN CONCRETE

A. General

1. For the purposes of this Section, holes are defined as penetrations completely through the concrete member and with interior surfaces approximately perpendicular to the surface of the existing member.

2. Interior surface areas which are inclined and do not meet this criteria shall be chipped as needed to meet this requirement.

3. The perimeter of holes at the surface shall form a regular shape composed of curved or straight line segments.

4. Provide the minimum depth of placement for the material used; score the existing concrete by sawcutting, and chip as needed to meet this requirement.

5. Roughen the interior surface of holes less than 12 inches in diameter to a minimum of 0.125-inch amplitude, and roughen larger holes to a minimum of 0.25-inch amplitude.

6. At holes, coat the existing surface to be repaired with a bonding agent.

B. Patching Small Holes: For holes which are less than 12 inches in their least dimension and extend completely through concrete members, fill with non-shrink grout.

C. Patching Large Holes

1. Fill holes which are larger than 12 inches in their least dimension with structural repair grout.

2. Provide large holes which are normally in contact with water or soil with hydrophilic waterstop placed in a groove.

3. Alternatively, bond the hydrophilic waterstop to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material.

4. Install the waterstop in accordance with the requirements of Section 03 32 00 – Joints in Concrete.

5. Provide reinforcing steel in layers matching existing reinforcement location, size, spacing and cover requirements unless directed otherwise by the Engineer.

6. In locations where NSF/ANSI Standard 61 approval is required by the authority having jurisdiction, use one of the following procedures:

a. Provide Product Data showing the proposed structural repair grout is NSF/ANSI Standard 61 approved.

b. Complete the repair with structural repair grout. Coat all surfaces required to have NSF/ANSI Standard 61 approval completely with Sikadur 31, Tyfo S, or equal.

c. Place the structural repair grout to within 1 ½" of the finished surface of the repair. Complete the remainder of the repair with SikaTop123 Plus, or equal.

3.9 PATCHING OF LINED HOLES

A. General

1. This Work applies to those openings which have embedded material over all or a portion of their inside edge.

2. The requirements for repairing holes in concrete, as indicated above, apply as modified herein.

3. The Engineer will determine whether the embedded material is allowed to remain.

B. Where embedded material is allowed to remain, trim it back a minimum of 2 inches from the concrete surface.

C. Roughen or abrade the embedded material in order to promote good bonding to the repair material.

D. Remove substances that interfere with good bonding.

E. Completely remove embedded items that are not securely and permanently anchored into the concrete.

F. Completely remove embedded items which are larger than 12 inches in their least dimension, unless they are composed of a metal to which reinforcing steel can be welded; where reinforcement is required, weld it to the embedded metal.

G. The following requirements shall apply to concrete members which are in contact with water or soil:

1. Using epoxy grout, fill lined openings which are less than 4 inches in their least dimension;

2. Using an epoxy bonding agent, coat lined openings which are greater than 4 inches but less than 12 inches in their least dimension, prior to being filled with non-shrink grout.

3. Using an epoxy bonding agent, coat lined openings which are greater than 12 inches in their least dimension, and provide a hydrophilic waterstop bonded to the interior of the opening with epoxy adhesive, prior to being filled with approved repair material.

3.10 APPLICATION OF PROTECTIVE COATINGS

A. Waterproofing

1. Apply waterproofing in accordance with the manufacturer's printed instructions.

2. Do not begin waterproofing Work until repairs and new construction in the affected area have been completed and adequately cured.

3.11 EXPANSION JOINT REPAIR

A. Repair deteriorated expansion joints as follows:

1. Completely remove existing sealant;

2. Remove defective backer materials in the joint;

3. Sand-blast the joint and prepare the surface in accordance with the sealant manufacturer's instructions;

4. Prepare the wall surface on each side of the joint in accordance with the expansion joint manufacturer's instructions;

5. Ensure that the prepared surface is clean, sound, and bare concrete;

6. Place backer material in the joint;

7. Apply a primer recommended by the sealant manufacturer;

8. Fill the joint with polyurethane sealant;

9. Allow a minimum of 3 days curing prior to installing the expansion joint; and,

10. Install the expansion joint in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 03 11 00 - CONCRETE FORMING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall furnish concrete formwork, bracing, shoring, and supports for cast-in-place concrete and shall design and construct falsework, all in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Manufacturer’s information demonstrating compliance with requirements for the following:

1. Form ties and related accessories, including taper tie plugs, if taper ties are used.

2. Form gaskets.

3. Form release agent, including NSF certification if not using mineral oil.

C. Manufacturer's design information on formwork, form materials, and locations for use. Shop Drawings: Detailed plans for the fabrication and erection of falsework to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Include a list of form materials and locations for use.

1.3 QUALITY ASSURANCE

A. Tolerances: The variation from required lines or grade shall not exceed 1/4-inch in 10-feet, non-cumulative, and there shall be no offsets or visible waviness in the finished surface. Other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials

PART 2 -- PRODUCTS

2.1 GENERAL

A. Except as otherwise expressly accepted by the Engineer, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:

Walls	Steel, fiberglass, or plywood panel
Columns	Steel, plywood or fiberglass
Roof and floor	Plywood
All other Work	Steel panels, fiberglass, plywood or tongue and groove lumber

B. Form materials that may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water System Components.

C. Water-based form release agent shall be **Clean Strip J1EF** by **Dayton Superior**, or equal.

D. For water containing structures, oil-based form release agent shall be **Atlas Bio-Guard** by **Atlas Tech**, or another NSF Standard 61 compliant equal. For other applications, a general use low VOC (<250 g/L) mineral oil-based release agents, **Clean Strip J1A** by **Dayton Superior** or equal, shall be submitted for approval.

2.2 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of PS 1 – Construction and Industrial Plywood, for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

4. Steel leave in place forms shall not be used.

B. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to 1/2-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf minimum. The minimum design load for combined dead and live loads shall be 100 psf.

PART 3 -- EXECUTION

3.1 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in

sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. Concrete forms shall conform to the shape, lines, and dimensions of members required, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

C. Forms shall be removed unless approved otherwise by the Engineer.

3.2 FORM DESIGN

A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the Engineer. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 31 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the Engineer.

3.3 CONSTRUCTION

A. Vertical Surfaces: Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties that cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

3.4 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.5 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this Work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28 Day strength in Section 03 31 00. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28 Day strength and has been in place for a minimum of 7 Days. The time required to establish said strength shall be as determined by the Engineer who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7 Day minimum, then that time shall be used as the minimum length of time. Forms for vertical walls of waterholding structures shall remain in place at least 36 hours after the concrete has been placed. Forms for parts of the Work not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

3.6 MAINTENANCE OF FORMS

A. Forms shall be maintained in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a nonstaining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the Contractor shall perform the oiling at least 2 weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.7 FALSEWORK

A. The Contractor shall be responsible for the design, engineering, construction, maintenance, and safety of falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements herein.

B. Falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework shall be placed upon a solid footing, safe against undermining, and be protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

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SECTION 03 21 00 - REINFORCEMENT STEEL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide reinforcement steel and appurtenant Work, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Furnish shop bending diagrams, placing lists, and drawings of reinforcement steel prior to fabrication.

2. Diagrams

a. The shop bending diagrams shall show the actual lengths of bars to the nearest inch, measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface.

b. Include bar placement diagrams that clearly indicate the dimensions of each bar splice.

3. Reinforcement

a. Details of the concrete reinforcement steel and concrete inserts shall be submitted at the earliest possible date after receipt by the Contractor of the Notice to Proceed.

b. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 - Details and Detailing of Concrete Reinforcement, and the indicated requirements.

4. Mechanical Couplers

a. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, submit the following items:

1) manufacturer's literature containing instructions and recommendations for installation for each type of coupler used;

2) certified test reports that verify the load capacity of each type and size of coupler used; and

3) Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.

5. Welding

   a. If reinforcement steel is to be spliced by welding at any location, submit mill test reports containing the information necessary for determination of the carbon equivalent per AWS D1.4 - Structural Steel Welding Code - Reinforcing Steel.

   b. Submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable.

   c. If reinforcement steel is spliced by welding at any location, submit certifications of procedure qualifications for each welding procedure and certification of welder qualifications, for each welding procedure and for each welder performing on the Work.

1.3 QUALITY ASSURANCE

A. Materials Testing

1. If requested by the Engineer, furnish samples from each heat of reinforcement steel in a quantity adequate for testing.

2. Costs of initial tests will be paid by the Owner.

3. Costs of additional tests if material fails initial tests shall be the Contractor's responsibility.

B. Welding

1. Welder qualifications and procedure qualifications shall be as indicated in AWS D1.4.

2. If requested by the Engineer, furnish samples of each type of welded splice in a quantity and of dimensions adequate for testing.

3. At the discretion of the Engineer, radiographic testing of direct butt-welded splices will be performed.

4. Provide assistance necessary to facilitate testing.

5. Repair welds that fail to meet AWS D1.4.

6. The costs of testing will be paid by the Owner, but the costs of tests that show failure to meet requirements shall be the Contractor's responsibility.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. Materials that may remain or leave residues on or within the concrete shall be certified as compliant with NSF Standard 61- Drinking Water System Components.

2.2 REINFORCEMENT STEEL

A. Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar and spiral reinforcement shall conform to ASTM A 615 - Deformed and Plain Billet - Steel Bars, for Grade 60 reinforcement, unless otherwise indicated.

2. Welded Reinforcement

   a. Bar and spiral reinforcement that is welded shall conform to ASTM A 706 - Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement, for Grade 60 reinforcement, unless otherwise indicated.

   b. The carbon equivalent in reinforcing that is welded shall not exceed 0.55 percent.

3. Welded Wire Reinforcement

   a. Welded wire reinforcement shall conform to ASTM A 185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement, and the indicated Details.

   b. Welded wire reinforcement with longitudinal wire of W4 size wire and smaller shall be in flat sheets or in rolls with a core diameter of not less than 10-inches.

   c. Welded wire reinforcement with longitudinal wires larger than W4 size shall be in flat sheets only.

B. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement.

2. Bar Supports

   a. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice, including special requirements for supporting epoxy-coated reinforcing bars.

   b. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating that extends at least 1/2 inch from the concrete surface.

   c. Plastic shall be gray in color.

3. Concrete Blocks

   a. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength as required for the concrete in which they are located.

   b. Wire ties shall be embedded in concrete block bar supports.

4. Tie wire: Minimum 16-gauge, black annealed.

2.3 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where indicated and where approved by the Engineer.

B. The couplers shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

C. Multi-Component Couplers

1. Where the type of coupler used is composed of more than one component, components required for a complete splice shall be provided.

2. This shall apply to mechanical splices, including those splices intended for future connections.

D. Connection

1. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection.

2. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

E. Couplers shall be **Lenton Form Saver** by **Erico Products, Dowel Bar Splicer System** by **Dayton/Richmond**, or equal.

2.4 WELDED SPLICES

A. Welded splices shall be provided where indicated and where approved by the Engineer.

B. Welded splices of reinforcement steel shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcement bars that are connected.

C. Materials as required to conform the welded splices to AWS D1.4 shall be provided.

2.5 EPOXY GROUT

A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled.

B. Epoxy grout shall be in conformance with the requirements of Section 03 60 00 – Grouting.

PART 3 -- EXECUTION

3.1 GENERAL

A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the Building Code and the indicated supplementary requirements.

3.2 FABRICATION

A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318 - Building Code Requirements for Reinforced Concrete, except as modified by the Drawings.

2. Bars shall be bent cold.

3. Bars shall be bent in accordance with the requirements of ACI 318.

4. Fabricate reinforcement bars for structures in accordance with accepted bending diagrams, placing lists, and placing drawings.

B. Fabricating Tolerances

1. Bars used for concrete reinforcement shall conform to the following fabricating tolerances:

a. Sheared Length: plus and minus one inch

b. Depth of Truss Bars: plus zero, minus 1/2 inch

c. Stirrups, Ties and Spirals: plus and minus 1/2 inch

d. Other Bends: plus and minus one inch

3.3 PLACEMENT

A. Reinforcement steel shall be accurately positioned as indicated, and shall be supported and wired together to prevent displacement using annealed iron wire ties or suitable clips at intersections.

B. Reinforcement steel shall be supported by concrete, plastic or metal support spacers, or metal hangers that are sufficiently strong and rigid to prevent any displacement of the reinforcement steel.

C. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous.

D. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties that are embedded in the blocks.

E. For concrete over formwork, provide concrete, metal, plastic, or other acceptable bar chairs and spacers.

F. Limitations on the use of bar support materials shall be as follows.

1. Concrete Dobies

a. permitted at any location except where architectural finish is required

b. required for slabs on grade and surfaces in contact with or above ozonated process water

2. Wire bar supports will be permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. Plastic bar supports will be permitted at every location except on-grade.

G. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.

H. Bars additional to those indicated that may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at no additional expense to the Owner.

I. Except where in conflict with the Building Code, unless otherwise indicated reinforcement placing tolerances shall be within the limits in Section 7.5 of ACI 318.

J. Moving Bars

1. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items.

2. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be as reviewed and accepted by the Engineer.

K. Welded Wire Reinforcement

1. Welded wire reinforcement placed over horizontal forms shall be supported on slab bolsters.

2. Slab bolsters shall be spaced not more than 30-inch on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane indicated.

3. Welded wire reinforcement placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction.

4. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

L. Storage and Handling

1. Epoxy-coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid chipping of the epoxy coating.

2. Non-abrasive slings made of nylon and similar materials shall be used.

3. Specially coated bar supports shall be used.

4. Chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

M. Accessory Spacing

1. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars.

2. When used to space the reinforcing bars from wall forms, the forms and bars shall be located such that there is no deflection of the accessory when the forms are tightened into position.

3.4 SPACING OF BARS

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.

C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.5 SPLICING

A. General

1. Reinforcement bar splices shall only be used at indicated locations.

2. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be as reviewed and accepted by the Engineer.

3. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318 for a Class B splice.

2. Welded Wire Reinforcement

a. Laps of welded wire reinforcement shall be in accordance with ACI 318.

b. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet.

c. Wires shall be staggered and tied in such a manner that they cannot slip.

3. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

C. Bending or Straightening

1. Reinforcement shall not be straightened or re-bent in a manner which will injure the material.

2. Bars shall be bent or straight as indicated.

3. Do not use bends different from the bends indicated.

4. Bars shall be bent cold, unless otherwise permitted by the Engineer.

5. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the Engineer.

D. Couplers

1. Couplers that are located at a joint face shall be of a type that can be set either flush or recessed from the face as indicated.

2. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering.

3. Couplers intended for future connections shall be recessed a minimum of 1/2 inch from the concrete surface.

4. After the concrete is placed, the coupler shall be plugged with plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials.

5. Threaded couplers shall be plugged .

E. Unless indicated otherwise, mechanical coupler spacing and capacity shall match the spacing and capacity of the reinforcing indicated for the adjacent section.

3.6 CLEANING AND PROTECTION

A. Reinforcement steel shall always be protected from conditions conducive to corrosion until concrete has been placed around it.

B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

C. Where there is delay in depositing concrete, the reinforcement shall be re-inspected and, if necessary, re-cleaned.

3.7 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

A. Hole Preparation

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 1/4 inch greater than the diameter of the outer surface of the reinforcing bar deformations.

2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless indicated otherwise.

3. The hole shall be drilled by methods that do not interfere with the proper bonding of epoxy.

4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling, and the location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.

5. The hole shall be blown clean with clean, dry compressed air to remove dust and loose particles.

B. Embedment

1. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole.

2. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets.

3. The hole shall be filled to a depth that insures excess material will be expelled from the hole during dowel placement.

4. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy.

5. The bar shall be inserted slowly enough to avoid developing air pockets.

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SECTION 03 31 00 - CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide cast-in-place concrete, as indicated in accordance with the Contract Documents.

B. The following types of concrete are covered in this Section:

1. Structural Concrete

a. Regular Mix: Roof, floor slabs, columns, walls, pavements, and other concrete items not indicated otherwise in the Contract Documents.

b. Thick Section Mix: For 12-inch and thicker walls, slabs on grade, pavements, and footings. This type of concrete may be used at the indicated locations at the Contractor's option if the Engineer agrees.

c. Pea Gravel Mix: At the bottom 6 inches of walls.

2. Structural Chloride-Resistant Concrete

a. Regular C-R Concrete

1) Ffor roof, floor slabs, columns, walls, pavements, and other concrete items indicated to be chloride-resistant

b. Thick Section C-R Concrete

1) Ffor 12-inch and thicker walls, slabs on grade, pavements, and footings indicated to be chloride-resistant.

2) This type of concrete may be used at the indicated locations if the Contractor chooses and the Engineer agrees.

c. Pea Gravel C-R Concrete

1) Aat the bottom 6 inches of walls indicated to be chloride-resistant

d. The following shall be constructed of chloride-resistant concrete:

1) Items as indicated on the Drawings.

3. Other Concretes

a. Structural Silica-Fume Concrete

1) S-F concrete shall contain a silica fume admixture per the Contract Documents and the silica fume manufacturer’s recommendations.

2) The following shall be constructed of structural S-F concrete:

a) Items as indicated on the Drawings.

b. Sitework Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, fence and guard post embedment, underground duct bank encasement, and other concrete appurtenant to electrical facilities, unless otherwise indicated.

c. Lean Concrete

1) Concrete to be used for thrust blocks, pipe trench cut-off blocks, and cradles that are indicated as unreinforced

2) Lean concrete shall be used as protective cover for dowels intended for future connections.

C. The term "hydraulic structure" shall mean environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, other fluids, or gases.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Placement drawings showing the location, type of concrete, and type of joints for each structure.

C. Mix Designs

1. Prior to beginning the Work and within 14 Days of the Notice to Proceed, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete.

2. Mix designs shall be checked through trial batch and laboratory testing by an independent testing laboratory acceptable to the Engineer.

3. Costs related to trial batch and related laboratory testing shall be Contractor’s responsibility as part of the Work.

4. Since laboratory trial batches require 35 calendar days to complete, the Contractor shall test a minimum of 2 mix designs for each class of concrete.

D. Delivery Tickets

1. Where ready-mix concrete is used, the Contractor shall furnish delivery tickets at the time of delivery of each load of concrete.

2. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amount of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix.

3. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

E. Test Data: Test data relating to the cement, aggregate, and admixtures shall be less than 6 months old.

F. Furnish the following submittals in accordance with ACI 301 – Structural Concrete:

1. Mill tests for cement

2. Admixture certification, including chloride ion content

3. Aggregate gradation test results and certification

4. Materials and methods for curing

1.3 CONCRETE CONFERENCE

A. The Engineer will chair a meeting to review the detailed requirements of the Contractor's proposed concrete design mixes and to determine the procedures for producing proper concrete construction no later than 14 Days after the Notice to Proceed.

B. Parties involved in the concrete Work shall attend the conference, including the following at a minimum:

1. Contractor's representative

2. Testing laboratory representative

3. Concrete subcontractor

4. Reinforcing steel subcontractor and detailer

5. Concrete supplier

6. Admixture manufacturer's representative

C. The conference shall be held at a time and place proposed by the Contractor and accepted by the Engineer.

D. The conference shall be held at least 5 Days after acceptance.

1.4 QUALITY ASSURANCE

A. General

1. Tests on component materials and for compressive strength and shrinkage of concrete shall be performed as indicated.

2. Tests for determining slump shall be in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

3. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness, according to ASTM C 33 – Concrete Aggregates.

4. The cost of trial batch laboratory tests on cement, aggregates, and concrete shall be the Contractor's responsibility.

5. The cost of laboratory tests on field-placed cement, aggregates, and concrete and the cost of Special Inspections required by Code will be the Owner's responsibility.

6. The Contractor shall be responsible for the cost of any tests and investigations of Work that is determined to be Defective Work.

7. The testing laboratory shall meet or exceed ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation.

8. Concrete for testing shall be furnished by the Contractor, and the Contractor shall assist the Engineer in obtaining samples and disposal and cleanup of excess material.

B. Inspections

1. Continuous inspection by a special inspector approved by the local building department having jurisdiction and by the Engineer will be required where necessary to conform with Code requirements.

2. Costs of the special inspector shall be paid by the Owner.

3. Inspection reports shall be submitted to the Engineer.

4. The special inspector shall observe the following for conformance to the Contract Documents:

   a. The preparation and taking of required test specimens; and,

   b. Placement of concrete, except sitework concrete fully supported on earth.

C. Field Compression Tests

1. Compression test specimens shall be taken during construction from the first placement of each type of concrete and at intervals thereafter as selected by the Engineer to insure continued compliance with the Specifications.

2. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31 – Practices for Making and Curing Concrete Test Specimens in the Field.

3. Specimens shall be 6-inches diameter by 12-inches tall cylinders.

4. Compression tests shall be performed in accordance with ASTM C 39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens.

5. Each set of specimens shall include 5 cylinders.

   a. One test cylinder shall be tested at 7 Days, and 2 test cylinders tested at 28 Days.

   b. The remaining two cylinders shall be held to verify test results, if needed.

6. At the Contractor's option, additional cylinders my be taken for testing at different ages. All costs associated with the additional cylinders and testing shall be paid by the Contractor.

D. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be in accordance with ACI 318 – Building Code Requirements for Reinforced Concrete, Chapter 5 "Concrete Quality," and as indicated.

2. A statistical analysis of compression test results shall be performed according to ACI 214 – Recommended Practice for Evaluation of Strength Test Methods.

3. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.

4. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.

5. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the required compressive strength is 1 in 100.

6. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.

7. Concrete that fails to meet the ACI requirements and the indicated requirements is subject to removal and replacement.

E. Shrinkage Tests

1. Drying shrinkage tests shall be performed for the trial batches indicated in the Article below entitled "Trial Batch and Laboratory Tests," for the first placement of each class of structural concrete except pea gravel mix, and during placement to determine continued compliance.

2. Neither structural pea gravel nor structural C-R pea gravel mix need to be tested for shrinkage.

3. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gauge length of 10-inches, and fabricated, cured, dried, and measured in accordance with ASTM C 157 – Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete, modified as follows:

    a. Specimens shall be removed from molds at an age of 23 hours, plus or minus one hour, after trial batching, and shall be placed immediately in water at 70 degrees F, plus or minus 3 degrees F, for at least 30 minutes.

    b. Specimens shall be measured within 30 minutes thereafter to determine original length and then shall be submerged in saturated lime water at 73 degrees F, plus or minus 3 degrees F.

    c. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 Days.

d. This length at age 7 Days shall be the base length for drying shrinkage calculations ("0" days drying age).

e. Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F, plus or minus 3 degrees F, and 50 percent relative humidity, plus or minus 4 percent, for the remainder of the test.

f. Measurements to determine shrinkage, expressed as percentage of base length, shall be performed and reported separately for 7, 14, 21, and 28 Days of drying after 7 Days of moist curing.

4. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age.

5. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001 inch at each test age.

6. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004 inch, the results obtained from that specimen shall be disregarded.

7. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage.

8. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens.

9. These tests shall be considered a part of the normal compression tests for the project.

10. Allowable shrinkage limitations are indicated in PART 2 - PRODUCTS, below.

F. Aggregate Testing: Aggregate testing shall be performed for the trial batch in the Article below entitled “Trial Batch and Laboratory Tests” prior to construction and every 12 months during construction to determine continued compliance.

G. Construction Tolerances

1. The Contractor shall set and maintain concrete forms and perform finishing operations to ensure that the completed Work is within tolerances.

2. Surface defects and irregularities are defined as finishes and are different from tolerances.

3. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings.

4. Where tolerances are not indicated, permissible deviations shall be in accordance with ACI 117 – Standard Tolerance for Concrete Construction and Materials.

5. The following non-cumulative construction tolerances apply to finished walls, columns and slabs unless otherwise indicated:

ITEM	TOLERANCE
Variation of the constructed linear outline from the established position in plan.	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation from the level or from the grades indicated.	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation from plumb	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation in the thickness of slabs and walls.	minus 1/4 inch plus 1/2 inch
Variation in the locations and sizes of slabs and wall openings	plus or minus 1/4 inch

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

A. General

1. Concrete materials in contact with potable water shall be classified as acceptable for potable water use in accordance with NSF/ANSI Standard 61 as required by the authority having jurisdiction. Not all products listed herein are for use in contact with potable water.

2. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.

3. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage.

4. Cement reclaimed from cleaning bags or leaking containers shall not be used.

5. Cement shall be used in the sequence of receipt of shipments.

B. Materials and storage of materials shall comply with ACI 301, as applicable.

C. Materials for concrete shall conform to the following requirements:

1. Cement

a. Cement shall be standard brand Portland cement conforming to ASTM C 150 –Portland Cement, for Type II or Type V.

b. A minimum of 85 percent of cement by weight shall pass a 325 screen.

c. A single brand of cement shall be used throughout the Work, and prior to its use, the brand shall be accepted by the Engineer.

d. The cement shall be suitably protected from exposure to moisture until used.

e. Cement that has become lumpy shall not be used.

f. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling.

g. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the Engineer, if requested, regarding compliance with the Specifications.

2. Water

a. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities.

b. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies.

c. Agricultural water with high total dissolved solids (greater than 1000 mg/L TDS) shall not be used.

3. Aggregates

a. Aggregates shall be obtained from pits acceptable to the Engineer, shall be non-reactive, and shall conform to ASTM C 33 – Concrete Aggregates.

b. The maximum size of coarse aggregate shall be as indicated, and the substitution of lightweight sand for fine aggregate will not be permitted.

c. Coarse Aggregates

1) Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof.

2) The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates, with a maximum size greater than 3/4 inch.

3) When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined (also refer to the Article below entitled "Trial Batch and Laboratory Tests").

d. Fine Aggregates

1) Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable.

2) When tested in accordance with ASTM D 2419 – Test Methods for Sand Equivalent Value of Soils and Fine Aggregate, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test.

3) The gradation of fine aggregate shall conform to ASTM C 33 when tested in accordance with ASTM C 136 for the fineness modulus of the sand used, including the optional grading in Section 6.2.

4) The fineness modulus of sand used shall not be greater than 3.1.

5) When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

e. Combined Aggregates

1) Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce concrete that has optimum workability and consolidation characteristics.

2) Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

3) When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions or 10.5 percent after 100 revolutions.

f. When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

g. When tested in accordance with ASTM C 33, the loss resulting after 5 cycles of the soundness test shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.

4. Ready-mixed concrete shall conform to the requirements of ASTM C 94 – Ready Mixed Concrete.

5. Admixtures

a. Admixtures shall be compatible and shall be furnished by a single manufacturer capable of providing qualified field service representation.

b. Admixtures shall be used in accordance with manufacturer's recommendations.

c. If the use of an admixture is producing an inferior end result, the Contractor shall discontinue use of the admixture.

d. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

e. Air Content

1) An air-entraining agent meeting the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used.

2) Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent.

3) The Owner reserves the right, at any time, to sample and test the air-entraining agent.

4) The air-entraining agent shall be added to the batch in a portion of the mixing water.

5) The solution shall be batched by means of a mechanical batcher capable of accurate measurement.

6) Air content shall be tested at the point of placement.

7) The air entraining agent shall be **Micro-Air** by **Master Builders; Daravair by W.R. Grace; Sika AEA-15 by Sika Corporation**; or equal

f. Set-Controlling and Water-Reducing Admixtures

1) Admixtures may be added at the Contractor's option, subject to the Engineer's approval, to control the set, effect water reduction, and increase workability.

2) The cost of adding an admixture shall be the Contractor's responsibility.

3) Concrete containing an admixture shall be first placed at a location determined by the Engineer.

4) Admixtures shall conform to ASTM C 494 – Chemical Admixtures for Concrete.

5) The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

6) Concrete shall not contain more than one water-reducing admixture, unless it can be demonstrated that the proposed mix will meet the indicated drying shrinkage requirements.

7) The set-controlling admixture may be either with or without water-reducing properties.

8) Where the air temperature at the time of placement is expected to be consistently greater than 80 degrees F, a set-retarding admixture such as **Plastocrete 161MR by Sika Corporation**, **Pozzolith or Delvo** by **BASF**, **Daratard** by **W.R. Grace**, or equal shall be used.

9) Where the air temperature at the time of placement is expected to be consistently less than 40 degrees F, a non-corrosive set accelerating admixture such as **Plastocrete 161FL** by **Sika Corporation**, **MasterSet FP 20** by **BASF**, **Daraset** by **W.R. Grace**, or equal shall be used.

10) Mid-Range Water Reducers

a) General use water-reducing admixtures shall be mid-range and shall conform to ASTM C 494, Type A and F.

b) Use **Daracem** by **W.R. Grace, Polyheed** by **BASF**, **Sikament** by **Sika Corporation**, or equal.

c) The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.

11) High-Range Water Reducers

a) High-range water reducers shall conform to ASTM C 494, Type F or G.

b) Use **ADVA** by **W.R. Grace**, **ViscoCrete** by **Sika Corporation**, **Glenium** by **BASF**, or equal.

c) The high-range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified.

d) No more than 14 ounces of water reducer per sack of cement shall be used.

e) The water reducer shall be considered as part of the mixing water when calculating the water/cement ratio.

f) If the high-range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch plant.

g) Concrete shall have a slump of 3 inches, plus or minus 1/2 inch, prior to adding the high-range water reducing admixture at the Site.

h) The high-range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician.

i) A standby system shall be provided and tested prior to each day's operation of the primary system.

j) Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high-range water reducer, unless recommended otherwise by the manufacturer.

g. Other Admixtures

1) Fly ash

a) Fly ash shall not be used for concrete sections containing process water in water or wastewater treatment plants or potable water.

b) For other concrete, fly ash may be substituted for not more than 15 percent, by weight, of cement in structural concrete and not more than 30 percent, by weight, for sitework concrete, and not more than 50 percent, by weight, of cement in other concrete.

c) Fly ash shall conform to ASTM C618 and shall not have loss-on-ignition greater than 3 percent.

d) The water/cement ratio shall be calculated based on cement plus fly ash.

2) Ground Blast Furnace Slag Cement

a) Slag cement shall not be used for concrete sections containing process water in water or wastewater treatment plants or potable water.

b) Slag cement shall conform to ASTM C989 – Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars, Grade 100 or 120.

c) Blended cements shall conform to ASTM C595 – Blended Hydraulic Cements, Type 1S, or ASTM C1157 – Performance Specification for Hydraulic Cement.

d) Slag cement substitution, if used, shall be not less than 25, nor more than 50 percent by weight of cement.

e) Slag cement substitution shall not be used with fly ash substitution.

f) The water/cement ratio shall be calculated based on cement plus slag cement.

3) Fiber reinforcing

a) Fiber-reinforced concrete shall be furnished where indicated.

b) Fiber reinforcement shall be synthetic fiber reinforcement.

c) Use **Fibermesh 300**, as manufactured by **Propex**, or equal.

d) Fiber reinforcing shall be batched at the plant at a rate of 1.5 pounds per cubic yard of concrete.

e) Material: 100-percent virgin homopolymer polypropylene-fibrillated fibers; containing no reprocessed olefin materials

f) Conformance: ASTM C 1116, Type III

g) Fire Classifications: UL Report File No. R8534-11; Southwest Certification Services (SWCS), Omega Point Laboratories No. 8662-1

h) Fiber Length: one inch

i) Alkali Resistance: alkali-proof

j) Absorption: nil

k) Specific Gravity: 0.91

l) Melting Point: 324 degrees F (162 degrees C)

h. Silica Fume

1) Silica fume shall conform to ASTM C 1240.

2) Use **Force 10,000S Silica Fume by W.R. Grace, Sikacrete 950 by Sika Corporation, Rheomac SF 110 by Master Builders**, or equal.

3) Blended cements with interground silica fume will not be accepted.

4) The water content of liquid slurry silica fume admixtures shall be considered as part of the mixing water when calculating the water/cement ratio, which shall be calculated based on cement plus silica fume.

5) Batching

a) Silica fume shall be added at the batch plant as recommended by the manufacturer.

b) Regardless of the type of mixing equipment, mix times shall be increased by 40 percent over the minimum mix time required to achieve mix uniformity as defined by ASTM C 94.

c) For truck-mixed and central-mixed concrete, the maximum allowable batch size shall be 80 percent of the maximum in accordance with ASTM C 94.

i. Corrosion Inhibitor

1) The corrosion inhibitor shall be **DCIS** by **W.R. Grace**, or equal.

2) Mixing water shall be adjusted for the admixture in accordance with the manufacturer's recommendations.

2.2 CURING MATERIALS

A. General: Curing compounds shall be resin-based and shall be compliant with local VOC requirements, unless otherwise indicated herein.

B. Regular Curing Compound

1. Regular curing compound shall be white-pigmented and shall conform to ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete, Type 2, Class B.

2. Sodium silicate compounds will not be accepted.

3. The concrete curing compound shall be:

a. **Kurez VOX White Pigmented by Euclid Chemical Company**;

b. **L&M Cure R-2 by L&M Construction Chemicals;**

c. 1**200-White by W.R. Meadows;**

d. **Kure-N-Seal WB White Pigmented by Sonneborn/Degussa Building Systems**;

e. or equal.

C. Dissipating Curing Compound

1. When the curing compound must be removed for finishes or grouting, compounds shall be of a dissipating type, conforming to ASTM C 309, Type 1 or 2, Class B.

2. The dissipating curing compound shall be:

a. **Korez DR VOX by Euclid Chemical Company;**

b. **L&M Cure R-2 by L&M Construction Chemicals;**

c. **1100-Clear by W.R. Meadows;**

d. or equal.

D. Curing Compound for Applications Requiring NSF/ANSI Standard 61 Compliance

1. When the curing compound is required to conform to NSF/ANSI Standard 61, the curing compound shall be water-based and shall be compliant with all local VOC requirements; shall conform to ASTM C 309; and shall be certified to conform to the requirements of NSF/ANSI Standard 61.

2. The NSF/ANSI Standard 61 Certified curing compound shall be:

a. **E-Cure by SpecChem, LLC;**

b. **Atlas Quantum-Cure NSF by Atlas Tech Products**;

c. or equal.

E. Concrete Curing Blanket

1. Polyethylene Sheets

a. Polyethylene sheets for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils.

b. The loss of moisture when determined in accordance with ASTM C 156 – Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.

2. Polyethylene-Coated Waterproof Paper

a. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, shall have a nominal thickness of 2-mils, and shall be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A – Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant).

b. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

3. Polyethylene-Coated Burlap

a. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, with white opaque polyethylene film impregnated or extruded into one side of the burlap.

b. The burlap shall weigh not less than 9 ounces per square yard.

c. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

F. Curing Mats

1. Curing mats for use in Curing Method 6, below, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center.

2. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

G. Evaporation Retardant

1. An evaporation retardant shall be used.

2. The evaporation retardant shall be:

a. **MasterKure ER 50 by BASF/Master Builders;**

b. **Eucobar by Euclid Chemical Company;**

c. **E-CON by L & M Construction Chemicals, Inc.;**

d. or equal.

2.3 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-waterstop joints in concrete shall conform to the following requirements:

1. The preformed joint filler shall be a non-extruding neoprene sponge or polyurethane type conforming to Section 03 32 00 – Joints in Concrete.

2. The elastomeric joint sealer shall conform to Section 07 92 13 – Elastomeric Joint Sealants.

3. Mastic Joint Sealer

a. The mastic joint sealer shall be a material:

1) that does not contain evaporating solvents;

2) that will tenaciously adhere to concrete surfaces;

3) that will remain permanently resilient and pliable;

4) that will not be affected by the continuous presence of water;

5) that will not in any way contaminate potable water;

6) and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement from expansion and contraction.

b. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants.

c. The sealer shall be capable of meeting the indicated test requirements, if testing is required by the Engineer.

2.4 MISCELLANEOUS MATERIALS

A. Damproofing Agent

1. The damproofing agent shall be an asbestos-free, fibered asphalt emulsion intended for cold application to green concrete, both above- and below-grade.

2. Damproofing shall meet the requirements of ASTM D 1227 – Emulsified Asphalt Used as a Protective Coating for Roofing, Type II, Class I.

3. Dampproofing shall be:

a. **Hydrocide 700 Series by Sonneborn/Degussa Building Systems;**

b. **Sealmastic by W. R. Meadows;**

c. **HE 789 by Henry Company;**

d. or equal.

B. Bonding Agents

1. Bonding agents shall be epoxy adhesives.

2. Bonding agents for bonding freshly-mixed, plastic concrete to hardened concrete shall be:

a. **Sikadur 32 Hi-Mod Epoxy Adhesive by Sika Corporation;**

b. **MasterEmaco ADH 326 by BASF/Master Builders;**

c. **BurkEpoxy MV by Edoco;**

d. or equal.

3. Bonding agents for bonding hardened concrete or masonry to steel shall be:

a. **Sikadur 31 Hi-Mod Gel by Sika Corporation;**

b. **BurkEpoxy NS by Edoco;**

c. **Concresive Paste (LPL) by MBT/Degussa Building Systems;**

d. or equal.

C. Vapor Retarder

1. The vapor retarder shall be a plastic sheet meeting the Class A permeance and strength requirementsof ASTM E 1745 – Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs. The minimum thickness shall be 10 mils.

2. The vapor retarder shall be **Griffolyn Type-65 G** by **Reef Industries, Inc.**, or equal.

D. Colorant for duct bank concrete shall be an integral red oxide coloring pigment used in the proportion of 8 pounds per cubic yard of concrete.

2.5 CONCRETE DESIGN REQUIREMENTS

A. General

1. Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated.

2. The exact proportions in which these materials are to be used for different parts of the Work shall be determined during the trial batches.

3. In general, the mix shall be designed to produce a concrete capable of being deposited to obtain maximum density and minimum shrinkage, and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface.

4. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items.

5. The proportions shall be changed whenever necessary or desirable to meet the required results, and such changes shall be subject to review by the Engineer.

B. Fine Aggregate Composition

1. In mix designs for structural concrete, except for 1/2-inch and 3/8-inch maximum size aggregate, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table:

FINE AGGREGATE	
Fineness Modulus	Percent (maximum)
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

2. For other concrete, the maximum percentage of fine aggregate of total aggregate by weight shall not exceed 50 percent.

C. Structural silica fume concrete shall contain 10 percent silica fume by weight of cement.

D. Structural Chloride-Resistant Concrete

1. Structural chloride-resistant concrete shall contain 4 gallons per cubic yard of a corrosion inhibiting admixture and a high range water reducer.

2. The workability or strength demands shall be obtained by additional admixtures, if necessary.

E. Duct Bank Concrete

1. Duct bank concrete shall contain an integral red-oxide coloring pigment.

2. The concrete shall be dyed red throughout.

3. Using a surface treatment to color duct banks will not be accepted.

F. Water/Cement Ratio

1. The indicated water/cement ratio is for a saturated-surface dry condition of aggregate.

2. Throughout every Day, the added batch water shall be adjusted for the total free water in the aggregates, which shall be determined as follows:

   a. The total moisture content of all aggregate shall be calculated by ASTM C 566 – Test Method for Total Moisture Content of Aggregate by Drying.

   b. Subtract the moisture absorbed by the coarse aggregate, calculated by ASTM C 127 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.

   c. Subtract the moisture absorbed by the fine aggregate, calculated by ASTM C 128 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate.

G. Concrete Property Tables

1. The maximum cement contents (determined from the maximum W/C Ratios and maximum Water Contents given in the Concrete Property Tables below) are intended to minimize drying shrinkage and heat of hydration of the concrete.

2. It is understood that the indicated maximum cement contents may require additional water reducing agent for the workability required by the Contractor's methods, and may not result in the least costly concrete mix for the required concrete strength.

3. If the Contractor wishes to increase the maximum cement content for any mix, the Contractor must notify the Engineer in writing and submit the request within 30 days of the Notice to Proceed.

4. Increases in cement content shall be at the Contractor's expense.

STRUCTURAL CONCRETE				
Type of Work	Regular Mix (roof, floor slabs, walls, pavements, and other concrete items not categorized elsewhere)	Thick Section Mix (12-inch and thicker walls, slabs on grade, pavements, and footings)	Congested Section Mix (Use where indicated or at the Contractor's option and approved by the Engineer)	Pea Gravel Mix (concrete at the bottom 6 inches of waterstopped walls) At the Contractor's option, superplastic Regular Mix may be substituted for the first lift

Min 28 Day Compressive Strength, psi	4500	4500	5000	5000
Max Aggregate Size, in	1	1-1/2	1/2	3/8
Cement Content per cubic yard, lb, minimum	564	564	600	752
Water content per cubic yard, lb, maximum	254	254	240	301
Max W/C Ratio by weight	0.42	0.42	0.40	0.40
Total Air Content, percent	4.5 to 7.5, severe 3 to 6, all others	4 to 7, severe 3 to 6, all others	5.5 to 8.5, severe 3 to 6, all others	6 to 9, severe 4.5 to 7.5, all others
Slump	4 inches +/- 1 in with high-range water reducer: 7 inches +/- 2 in	4 inches +/- 1 in with high-range water reducer: 7 inches +/- 2 in	with high-range water reducer: 7 inches +/- 2 in	with high-range water reducer: 7 inches +/- 2 in

STRUCTURAL CHLORIDE-RESISTANT CONCRETE			
Type of Work	Regular C-R Mix (roof, floor slabs, walls, pavements, and other concrete items not categorized elsewhere)	Thick Section Mix (12-inch and thicker walls, slabs on grade, pavements, and footings)	Pea Gravel Mix (concrete at the bottom 6 inches of waterstopped walls) At the Contractor's option, superplastic Regular Mix may be substituted for the first lift
Min 28 Day Compressive Strength, psi	5,000	5,000	5,000
Max Aggregate Size, in	1	1-1/2	3/8

Cement Content per cubic yard, minimum, lb	658	658	752
Water content per cubic yard, lb, maximum	250	250	286
Max W/C Ratio by weight	0.38	0.38	0.38
Total Air Content, percent	4.5 to 7.5, severe 3 to 6, all others	4 to 7, severe 3 to 6, all others	6 to 9, severe 4.5 to 7.5, all others
Slump, inches	4 inches +/- 1 in with high-range water reducer: 7 inches +/- 2 in	4 inches +/- 1 in with high-range water reducer: 7 inches +/- 2 in	7 inches +/- 2 in

Type of Work	Sitework Concrete (curbs, gutters, sidewalks, catch basins, fence embedments, encasements, and ductbanks)	Lean Concrete (thrust blocks, pipe trench cut-off blocks, and cradles)
Min 28 Day Compressive Strength, psi	3000	2000
Max Aggregate Size, in	1	1
Cement Content per cubic yard, lb, minimum	470	376
Water content per cubic yard, lb, maximum	254	270
Max W/C Ratio by weight	0.50 normal 0.45 frost or sulfates	0.60
Total Air Content, percent	4 to 7 severe 3 to 6 all others	4.5 to 7.5 severe 3 to 6 all others
Slump	4 inches +/- 1 in ductbanks and encasements: 5 inches +/- 1 in	4 inches +/- 1 in

NOTE: The Contractor is cautioned that the limiting parameters above are not a mix design. Admixtures may be required to achieve workability required by the Contractor's construction methods and aggregates. The Contractor shall be responsible for providing concrete with the required workability and strength.

H. Adjustments to Mix Design

1. The Contractor may elect to decrease the water/cement ratio to achieve the strength and shrinkage requirements and/or add water reducers, as required to achieve workability.

2. The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the Contractor shall be entitled to no additional compensation because of such changes.

3. Any changes to the accepted concrete mix design shall be submitted to the Engineer for review and shall be tested again in accordance with the indicated requirements.

2.6 CONSISTENCY

A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete that can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface.

B. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, in order to maintain uniform production of a desired consistency.

C. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

D. The slumps shall be as indicated with the concrete properties.

2.7 TRIAL BATCH AND LABORATORY TESTS

A. The Contractor shall only use a mix design for construction that has first met the trial batch testing requirements.

B. Before placing any concrete, a testing laboratory selected by the Engineer shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the Contractor.

C. Aggregate Proportions

1. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties.

2. If one size range produces an acceptable mix, a second size range need not be used.

3. Such adjustments will be considered refinements to the mix design and will not be the basis for extra compensation to the Contractor.

4. Concrete shall conform to the indicated requirements whether the aggregate proportions are from the Contractor’s preliminary mix design or whether the proportions have been adjusted during the trial batch process.

5. The trial batch shall be prepared using the aggregates, cement, and admixture proposed for the project.

D. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage and 6 compression test specimens from each batch.

E. The determination of compressive strength shall be made by testing 6-inch diameter by 12-inch high cylinders, which have been made, cured, and tested in accordance with ASTM C 192 – Practice for Making and Curing Concrete Test Specimens in the Laboratory, and ASTM C 39.

F. The testing schedule shall be 3 compression test cylinders tested at 7 Days and 3 at 28 Days.

G. The average compressive strength for the 3 cylinders tested at 28 Days for any given trial batch shall be not less than 125 percent of the indicated compressive strength.

H. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136 – Method for Sieve Analysis of Fine and Coarse Aggregates, and values shall be provided for percent passing each sieve.

2.8 SHRINKAGE LIMITATION

A. General

1. The Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements.

2. Shrinkage limitations shall apply only to structural concrete.

B. Maximum Shrinkage

1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-Day drying age or at 28-Day drying age, shall be 0.036 percent or 0.042 percent, respectively.

2. Standard deviation will not be considered.

3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

C. If the required shrinkage limitation is not met during construction, the Contractor shall take any or all of the following actions to reestablish compliance:

1. changing the source of aggregates, cement and/or admixtures;

2. reducing water/cement ratio;

3. washing of coarse and/or fine aggregate to reduce fines;

4. increasing the number of construction joints;

5. modifying the curing requirements; or

6. other actions to minimize shrinkage or the effects of shrinkage.

2.9 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the Contractor and acceptable to the Engineer.

B. Weighing Tolerances

Material	Percent of Total Weight
Cement	1

Aggregates	3
Admixtures	3

2.10 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the Engineer and capable of measuring the water in variable amounts within a tolerance of one percent.

B. The water feed control mechanism shall be capable of being locked in position in order to constantly deliver the required amount of water to each batch of concrete.

C. A positive, quick-acting valve shall be used for a cut-off in the water line to the mixer, and the operating mechanism shall prevent leakage when the valve is closed.

2.11 READY-MIXED CONCRETE

A. General

1. At the Contractor's option, ready-mixed concrete may be used if it meets the indicated requirements as to materials, batching, mixing, transporting and placement, and is in accordance with ASTM C 94 and the following supplementary requirements.

2. Ready-mixed concrete shall be delivered to the Work, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever occurs first.

3. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted.

4. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted.

5. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

B. Counters

1. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified.

2. The counter shall be of the resettable, recording type and shall be mounted in the driver's cab.

3. The counters shall be actuated at the time of starting the mixers at mixing speeds.

C. Mixing

1. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment.

2. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed.

3. Materials, including the mixing water, shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

D. Uniformity

1. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading.

2. If slump tests taken at approximately the 1/4- and 3/4-point of the load during discharge result in slumps differing by more than one inch when the required slump is 3 inches or less, or if they differ by more than 2 inches when the required slump is more than 3 inches, the mixer shall not be used on the Work unless the causative condition is corrected and satisfactory performance is verified by additional slump tests.

3. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

E. Each batch of ready-mixed concrete delivered to the Site shall be accompanied by a delivery ticket that is furnished to the Engineer in accordance with the Paragraph in Part 1 of this Section entitled “Delivery Tickets.”

PART 3 -- EXECUTION

3.1 PROPORTIONING AND MIXING

A. Proportioning of the mix shall conform to ACI 301.

B. Mixing shall conform to ACI 301.

C. Slumps shall be as indicated.

D. Re-tempering of concrete or mortar that has partially hardened will not be permitted.

3.2 PREPARATION OF SURFACES FOR CONCRETING

A. General

1. Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon.

2. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. Vapor Retarder

1. Aggregate base on which the vapor retarder is placed shall be at least 6-inches thick within the floor slab-on-grade line after compaction per Section 31 30 00 – Earthwork.

Aggregate base surface shall be flat and level with a tolerance of plus zero inches to minus ¾-inch.

2. Place, protect, and repair defects in sheet according to ASTM E 1643 – Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs, and the manufacturer's written instructions.

3. Seams shall be lapped a minimum of 6 inches and sealed in accordance with ASTM E 1643, and as recommended by the vapor retarder manufacturer.

4. Take precautions to avoid damaging the vapor retarder while placing the slab. Keep the vapor retarder dry and place concrete directly on the vapor retarder unless otherwise noted on the Construction Documents.

C. Joints in Concrete

1. Construction joints are defined as concrete surfaces upon which or against which concrete is to be placed, but placement of concrete has been stopped or interrupted and the Engineer has determined that the new concrete cannot be incorporated integrally with the concrete previously placed.

2. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding.

3. Except where coated joint surfaces have been indicated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude.

4. Cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing.

5. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.

6. Gravel

   a. After the surfaces have been prepared, each approximately horizontal construction joint shall be covered with a 6-inch lift of a pea gravel mix.

   b. The gravel mix shall be placed and spread uniformly.

   c. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

D. Placement Interruptions

1. When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means that will secure proper union with subsequent Work.

2. Such construction joints shall be made only where acceptable to the Engineer.

E. Embedded Items

1. No concrete shall be placed until the formwork, the installation of parts to be embedded, the reinforcement steel, and the preparation of surfaces involved in the placing have been completed and accepted by the Engineer at least 4 hours before the placement of concrete.

2. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

3. Inserts or other embedded items shall conform to the indicated requirements.

4. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations as indicated or shown by Shop Drawings, and shall be acceptable to the Engineer before any concrete is placed.

5. Accuracy of placement shall be the responsibility of the Contractor.

F. Casting New Concrete Against Old Concrete

1. Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate.

2. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the Engineer.

G. Water

1. No concrete shall be placed in any structure until water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes or other means, and carried out of the forms, clear of the Work.

2. No concrete shall be deposited underwater nor shall the Contractor allow still water to rise on any concrete until the concrete has attained its initial set.

3. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete.

4. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to review by the Engineer.

H. Corrosion Protection

1. Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be positioned and supported prior to placement of concrete such that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement.

2. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

I. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall be provided, where practicable, during the placement of concrete.

J. Anchor bolts shall be accurately set and shall be maintained in position by templates while embedded in the concrete.

K. Cleaning: The surfaces of metalwork to be in contact with the concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

3.3 HANDLING, TRANSPORTING, AND PLACING

A. General

1. The placement of concrete shall conform to the applicable portions of ACI 301 and the indicated requirements.

2. No aluminum materials shall be used in conveying any concrete.

B. Non-Conforming Work or Materials

1. Concrete which during or before placing is found not to conform to the indicated requirements will be rejected and shall be immediately removed from the Work.

2. Concrete that is not placed in accordance with these requirements or which is of inferior quality shall be removed and replaced.

C. Unauthorized Placement

1. No concrete shall be placed except in the presence of an authorized representative of the Engineer.

2. The Contractor shall notify the Engineer in writing at least 24 hours in advance of the placement of any concrete.

D. Placement in Wall and Column Forms

1. Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete.

2. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation.

3. In no case shall the free fall of concrete below the ends of ducts, chutes, or buggies exceed 4 feet in walls and 8 feet in columns.

4. Concrete shall be uniformly distributed during the process of deposition, and in no case after deposition shall any portion be displaced in the forms more than 6 feet in the horizontal direction.

5. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2 feet, and care shall be exercised to avoid inclined layers or inclined construction joints except where such are required for sloping members.

6. Each layer shall be placed while the previous layer is still soft.

7. The rate of placing concrete in wall forms shall not exceed 5 feet of vertical rise per hour.

8. Sufficient illumination shall be provided in the interior of forms such that the concrete at the places of deposit is visible from the deck or runway.

E. Casting New Concrete Against Old

1. An epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations.

2. This provision shall not apply to joints where waterstop has been provided.

3. Refer to Section 03 32 00 – Joints in Concrete, for other requirements.

F. Conveyor Belts and Chutes

1. Ends of chutes, hopper gates, and other points of concrete discharge throughout the Contractor's conveying, hoisting, and placement system shall be designed and arranged such that concrete passing from them will not fall separated into whatever receptacle immediately receives it.

2. Conveyor belts, if used, shall be of a type acceptable to the Engineer.

3. Chutes longer than 50 feet will not be permitted.

4. The minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them.

5. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted.

6. Conveyor belts and chutes shall be covered.

G. Placement in Slabs

1. Concrete placement in sloping slabs shall proceed uniformly from the bottom of the slab to the top for the full width of the placement.

2. As the Work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

H. Temperature of Concrete

1. The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 50 degrees F.

2. For sections less than 12 inches thick, the temperature of concrete when placed shall be not less than 55 degrees F.

I. Hot or Cold Weather Procedures

1. If required by the Engineer, the Contractor shall submit detailed procedures for the production, transportation, placement, protection, curing, and temperature monitoring of concrete during hot or cold weather.

2. The submittal shall include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

3. The Contractor shall not be entitled to additional compensation for satisfying the hot weather placement or the cold weather placement requirements below.

J. Hot Weather Placement

1. If the temperature of the concrete is 85 degrees F or greater, the time between introducing the cement into the aggregates and discharge shall not exceed 45 minutes.

2. If the concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the Contractor shall employ effective means such as pre-cooling of aggregates, using ice as mixing water, or placing at night as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed.

3. During the curing period, the maximum temperature decrease measured at the surface of the concrete shall not exceed 50 degrees F in 24 hours nor 5 degrees F in one hour.

K. Cold Weather Placement

1. The placement of concrete shall conform to ACI 306.1 – Cold Weather Concreting, and the following requirements:

a. Remove snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed.

b. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6 inches.

c. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

d. Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.

e. Concrete ingredients shall not be heated more than necessary to prevent the temperature of the mixed concrete, as placed, from falling below the minimum temperature criterion.

3.4 PUMPING OF CONCRETE

A. General: If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. Pumping Equipment

1. The pumping equipment shall have 2 cylinders and shall be designed to operate with one cylinder in case the other one is not functioning.

2. In lieu of this requirement, the Contractor may have a standby pump on the Site during pumping.

3. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R – Placing Concrete by Pumping Methods.

4. Pumping equipment and hose conduits that are not functioning properly shall be replaced.

5. Aluminum conduits for conveying the concrete will not be permitted.

C. Field Control: Concrete samples for slump, air content, and test cylinders shall be taken at the placement end of the hose.

3.5 ORDER OF PLACING CONCRETE

A. General

1. The order of placing concrete in the Work shall be acceptable to the Engineer.

2. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations.

B. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 Days for hydraulic structures and 2 Days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 Days for hydraulic structures and 4 Days for all other structures.

C. Concrete Surfaces

1. The surface of the concrete shall be level whenever a run of concrete is stopped.

2. For a level, straight, intermediate joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces.

3. The concrete shall be carried approximately 1/2 inch above the underside of the strip.

4. The strip shall be removed one hour after the concrete is placed, and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.

3.6 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated, into a dense and homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete.

B. Vibrators

1. Vibrators shall be Group 3 in accordance with ACI 309 – Consolidation of Concrete, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required.

2. Group 2 vibrators may be used only at specific locations when accepted by the Engineer.

C. Waterstops

1. Care shall be exercised when placing concrete around waterstops.

2. The concrete shall be carefully worked by rodding and vibrating to make sure that air and rock pockets have been eliminated.

3. Where flat-strip type waterstops have been placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated.

4. Concrete that is surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to ensure complete embedment of the waterstops in the concrete.

D. Concrete in Walls

1. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against each surface.

2. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly.

3. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency has been placed in the forms.

4. The vibrating head shall not contact the surfaces of the forms.

5. Care shall be exercised not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.7 FINISHING CONCRETE SURFACES

A. General

1. Concrete surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface.

2. Surface defects are defined as fins, bulges, ridges, offsets, honeycombing, roughness of any kind, and surface holes larger than 1/2 inch in diameter or deeper than 1/4 inch.

3. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions are defined as tolerances and shall be as indicated.

4. These tolerances are to be distinguished from irregularities in finish as indicated.

5. Aluminum finishing tools shall not be used.

B. Formed Surfaces

1. No treatment shall be required after form removal except for curing, repair of defective concrete, and treatment of surface defects.

2. Where architectural finish is required, treatment(s) shall be as indicated.

C. Unformed Surfaces

1. General

a. After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools.

b. Immediately after the concrete has been screeded it shall be treated with a liquid evaporation retardant, and the retardant shall be used again after each operation as necessary to prevent drying shrinkage cracks.

2. The classes of finish for unformed concrete surfaces are defined as follows:

a. Finish U1

1) Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8 inch.

2) No further special finish is required.

b. Finish U2

1) After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades.

2) Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted.

3) Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture.

4) Surface irregularities shall not exceed 1/4 inch.

5) Joints and edges shall be tooled where indicated or as determined by the Engineer.

c. Finish U3

1) After the Finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the

floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks.

2) The finish shall be smooth and free of irregularities.

d. Finish U4

1) Trowel the Finish U3 surface to remove local depressions or high points.

2) In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated.

3) The resulting surface shall be sufficiently rough to provide a nonskid finish.

e. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE	
Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Water bearing slabs with slopes 10 percent and less	U3
Water bearing slabs with slopes greater than 10 percent	U4
Slabs not water bearing	U4
Sslabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U3
Top surface of walls	U3

3.8 CURING AND DAMPPROOFING

A. General: Concrete shall be cured for not less than 7 Days after placement, in accordance with the methods indicated below for the different parts of the Work.

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Construction joints between footings and walls, and between floor slab and columns	2
Encasement and ductbank concrete and thrust blocks	3
Concrete surfaces not specifically indicated in this Paragraph	4
Floor slabs on grade in hydraulic structures	5

Slabs not on grade	6
Wall sections with forms removed	6

B. Method 1

1. Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal.

2. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed.

3. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 6, below.

C. Method 2

1. The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed.

2. No curing compound shall be applied to surfaces cured under Method 2.

D. Method 3

1. The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed.

2. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of the concrete.

E. Method 4

1. The surface shall be sprayed with a liquid curing compound.

2. The compound shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.

3. Seal Protection

   a. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7-Day curing period.

   b. If the seal is damaged or broken before expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

4. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, such compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

5. Application Schedule

a. The curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms.

b. Repairs to formed surfaces shall be made within the 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied.

c. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.

6. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6 feet of the joint and to any other location where the curing membrane has been disturbed.

7. Prior to final acceptance of the Work, visible traces of curing compound shall be removed in such a manner that does not damage the surface finish.

F. Method 5

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow such that the surface is not marred or washed.

2. The concrete shall be given a coat of curing compound in accordance with Method 4, above.

3. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs.

4. Curing Blankets

a. The curing blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches, and fastened together with a waterproof cement to form a continuous watertight joint.

b. The curing blankets shall be left in place during the 7-Day curing period and shall not be removed until after concrete for adjacent Work has been placed.

c. If the curing blankets become torn or otherwise ineffective, the Contractor shall replace damaged sections.

d. During the first 3 Days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials will be permitted on the curing blankets.

e. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket.

f. The Contractor shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces.

G. Method 6

1. Method 6 shall apply to both walls and slabs.

2. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days, beginning immediately after the concrete has reached final set or the forms have been removed.

3. Until the concrete surface is covered with the curing mats, the entire surface shall be kept damp by applying water using nozzles that atomize the flow such that the surface is not marred or washed.

4. Curing Mats

a. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period.

b. The curing mats shall be weighted or otherwise held substantially in contact with the concrete surface to prevent dislodging by wind or other causes.

c. Edges shall be continuously held in place.

5. The curing mats and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

6. Immediately after the application of water has terminated at the end of the curing period, the curing mats shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4, above.

7. The Contractor shall dispose of excess water from the curing operation in order to avoid damage to the Work.

H. Method 7

1. Method 7 shall apply to concrete containing silica fume for walls and slabs, shall be used in addition to the curing methods 1 through 6, and shall be concluded within one hour of concrete placement.

2. In addition to the requirements of: (a) Method 1 for unstripped forms; (b) Method 6 for walls after the forms are removed; and (c) Method 4 for slabs, the Contractor shall coat wall surfaces after the forms are removed and slab surfaces with 2 coats of a white pigmented curing compound as indicated in Method 4, above.

3. A second coat of white pigmented curing compound shall be applied to the concrete surface at 7 Days after the application of the initial coats.

4. A pre-wetted burlap shall be placed over the flatwork surface and kept continuously wet for a minimum of 7 Days or until the time necessary to attain 70 percent of the required compressive strength in accordance with ACI 308, Section 3.1.3.

I. Dampproofing

1. The exterior surfaces of roof slabs to be buried and walls to be backfilled shall be dampproofed as follows.

2. Asphalt Emulsion

    a. Immediately after the completion of curing, the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion.

    b. Application of the agent shall be in 2 coats.

    c. The first coat shall be diluted to 1/2 strength by the addition of water, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution.

    d. The second coat shall consist of an application of the undiluted material, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon.

3. Whitewash

    a. As soon as the material has taken an initial set, the entire area thus coated shall be coated with whitewash.

    b. Any formula for mixing the whitewash may be used if it produces a uniformly-coated white surface and remains until placing of the backfill.

    c. If the whitewash fails to remain on the surface until the backfill is placed, the Contractor shall apply additional whitewash.

3.9 PROTECTION

A. The Contractor shall protect the concrete against damage until final acceptance.

B. Weather Protection

1. Fresh concrete shall be protected from damage due to rain, hail, sleet or snow.

2. The Contractor shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.10 CURING DURING COLD WEATHER

A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F, provided that during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing has been temporarily discontinued.

B. Compound-Cured Concrete

1. Concrete that is to be cured by an application of curing compound shall require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces.

2. Otherwise, the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F.

C. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.

D. Discontinuance of Protection

1. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours.

2. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive Days, the required 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F, provided that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

E. Artificial Heat

1. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying.

2. The use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound, provided that the use of curing compound for such surfaces is otherwise permitted.

3.11 TREATMENT OF SURFACE DEFECTS

A. General

1. Surface defects are defined in Finishing Concrete Surfaces, above.

2. As soon as forms are removed, the exposed concrete surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in order to secure a smooth, uniform, and continuous surface satisfactory to the Engineer.

3. Plastering or coating of surfaces to be smoothed will not be permitted.

4. No repairs shall be made until after inspection by the Engineer.

5. In no case will extensive patching of honeycombed concrete be permitted.

6. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below.

7. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced..

8. Repairs of surface defects shall be performed promptly.

B. Preparation

1. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area.

2. Feathered edges will not be permitted.

3. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of laitance and soft material, plus not less than 1/32-inch depth of the surface film from hard portions by means of an efficient sandblast.

4. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar such that while the repair material is being applied the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends.

C. Materials

1. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand.

2. For exposed walls, the cement shall contain such a proportion of Atlas White Portland cement as is required to make the color of the patch match the color of the surrounding concrete.

D. Holes

1. Holes left by tie-rod cones shall be reamed with suitably toothed reamers in order to leave the surfaces of the holes clean and rough.

2. Holes then shall be repaired in an approved manner with dry-packed cement grout.

3. Holes left by form-tying devices having a rectangular cross section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

E. Repairs

1. Repairs shall be built up and shaped in such a manner that the completed Work will conform to the indicated requirements, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures.

2. The surfaces of repaired concrete shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

F. Cracks: Prior to filling any structure with water, cracks shall be repaired in accordance with the requirements of Section 03 01 30 – Concrete Repair and Rehabilitation.

3.12 CONCRETE REPAIR AND REHABILITATION

A. All defects and repairs not covered under Treatment of Surface Defects shall be repaired per Section 03 01 30 – Concrete Repair and Rehabilitation.

3.13 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until Final Acceptance.

B. Particular care shall be exercised in order to prevent the drying shrinkage damage of concrete and to avoid roughening or otherwise damaging the concrete surface.

C. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed Work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be repaired or removed and replaced with acceptable materials to the satisfaction of the Engineer.

END OF SECTION

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SECTION 03 32 00 - JOINTS IN CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.

B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the Engineer.

1.2 TYPES OF JOINTS

A. Construction Joints

1. When fresh concrete is placed against a hardened concrete surface, the joint between the pours shall be defined as a construction joint.

2. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop and/or sealant groove of the shape indicated.

B. Contraction Joints

1. Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the earlier pour.

2. The slab reinforcement shall be stopped 4-1/2 inches from the joint; which is provided with a sleeve-type dowel, in order to allow shrinkage of the concrete of the later pour.

3. Waterstop and/or sealant groove shall be provided where indicated.

C. Expansion Joints

1. In order to allow the concrete to expand freely, a space shall be provided between the 2 pours, and the joint shall be formed as indicated.

2. The space shall be obtained by placing a filler joint material against the earlier pour to act as a form for the later pour.

3. Unless otherwise indicated, expansion joints in water bearing members shall be provided with a center-bulb type waterstop.

4. Provide premolded expansion joint material with the edge at the indicated distance below or back from the finished concrete surface.

5. Provide a slightly tapered, dressed and oiled wooden strip secured to or placed at the edge of the expansion joint during concrete placement, and remove the strip later to form a space for the sealing material.

6. The space so formed shall be filled with a joint sealant material as indicated below. In order to keep the 2 wall or slab elements in line, the joint shall also be provided with a sleeve-type dowel as indicated.

D. Control Joints

1. The function of the control joint is to provide a weaker plane in the concrete where shrinkage cracks would likely occur.

2. Formed Groove

a. A groove, of the shape and dimensions indicated, shall be formed or saw-cut in the concrete and the groove shall then be filled with a joint sealant material.

b. The formed groove shall be placed in the first of the two sections cast at the control joint, in order to assure that the sealant bonds to the second section across the joint and not to the cement paste from the first pour.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Furnish placement drawings showing the location and types of joints for each structure.

2. Test Reports

a. Furnish certified test reports from the sealant manufacturer on the actual batch of material supplied, demonstrating compliance with the indicated requirements.

b. Furnish the test reports before using the sealant on the Project.

3. Waterstop Welding Certification

a. Furnish copies of the waterstop welding certification by manufacturer or authorized agent of the manufacturer.

b. Every person who is to be involved with waterstop installation shall be required to have individual certification on file with the Engineer, stating that the named individual is certified and trained to install waterstop in accordance with the manufacturer's recommendations and specifications.

4. Furnish manufacturer's information demonstrating compliance of the following with the indicated requirements:

a. Bearing pad

b. Neoprene sponge

c. Preformed joint filler

d. Backing rod

e. Waterstop

f. Slip dowels

g. PVC tubing

C. Samples

1. Prior to production of the material required under this Section, submit qualification samples of waterstops which accurately represent the material being provided.

2. Such samples shall be extruded or molded sections of each size or shape to be installed.

3. The balance of the material to be used shall not be produced until after the Engineer has reviewed the qualification samples.

D. Certificates

1. Furnish written certification from the manufacturer, as an integral part of the shipping form, that the material shipped to the Site meets or exceeds the indicated physical property requirements.

2. Supplier certificates will not be accepted.

1.4 QUALITY ASSURANCE

A. Waterstop Inspection

1. Waterstop field joints shall be subject to inspection, and no such Work shall be scheduled or started without having made prior arrangements with the Engineer for the required inspections.

2. Provide not less than 24 hours notice for the scheduling of such inspections.

3. Field joints in waterstops shall be subject to inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects that would reduce the potential resistance of the material to water pressure at any point.

4. Defective field joints shall be replaced with material that passes inspection, and faulty material shall be removed from the Site and destroyed.

B. The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

1. Offsets at joints greater than 1/16 inch or 15 percent of material thickness at any point, whichever is less.

2. Exterior cracking at the joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness at any point, whichever is less.

3. Any combination of offset or exterior cracking that will result in a net reduction in the cross-section of the waterstop in excess of 1/16 inch or 15 percent of material thickness at any point, whichever is less.

4. Misalignment of the joint which results in misalignment of the waterstop in excess of 1/2 inch in 10 feet

5. Porosity in the welded joint as evidenced by visual inspection

6. Bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a penknife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

7. Visible signs of separation when the cooled splice is bent by hand at any sharp angle

8. evidence of burned material

C. Waterstop Samples

1. Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) mitered cross and a tee constructed of each size or shape of material to be used shall be submitted.

2. Samples shall be prefabricated (shop made fitting) so that the material and workmanship represent the fittings to be provided.

3. In addition, field samples of prefabricated fittings (crosses, tees, and the like) will be selected at random by the Engineer for testing by a laboratory at the Owner's expense.

4. When tested, the tensile strength across the joints shall be at least 1120 psi for PVC waterstops and 1380 psi for Thermoplastic Elastomeric Rubber (TPER) waterstops.

D. Construction Joint Sealant

1. The Contractor shall prepare adhesion and cohesion test specimens at intervals of 5 Days while sealants are being installed.

2. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

a. Sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch).

b. Spacing between the blocks shall be one inch.

c. Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to set and hold sealant cross-sections of 1/2-inch by 2-inch with a width of one inch.

d. The sealant shall be cast and cured in accordance with the manufacturer's recommendations, except that the curing period shall be not less than 24 hours.

e. Following the curing period, the gap between the blocks shall be widened to 1-1/2 inches, and spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

1.5 SPECIAL CORRECTION OF DEFECTS REQUIREMENT

A. The Contractor shall furnish a 5-year written warranty of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement

that the Contractor agrees to repair or replace, to the satisfaction of the Owner, any defective areas which become evident within the 5-year period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Joint materials shall be listed as compliant with NSF Standard 61.

2.2 WATERSTOPS

A. PVC Waterstops

1. Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the indicated requirements of this Section.

2. No reclaimed or scrap material shall be used.

3. The Contractor shall obtain from the waterstop manufacturer and shall furnish to the Engineer for review, current test reports and a written certification of the manufacturer that the material to be shipped to the Site meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572-PVC Waterstops, and those indicated.

4. Flatstrip and Center-Bulb Waterstops

   a. Flatstrip and center-bulb waterstops shall be manufactured such that at no place shall the thickness of waterstops, including the center bulb type, be less than 3/8 inch.

   b. The waterstop shall be provided with hog rings installed at 12 inches on centers along the waterstop.

   c. Shapes shall be as indicated, or as acceptable to the Engineer.

5. Multi-Rib Waterstops

   a. Multi-rib waterstops shall be as indicated or as acceptable to the Engineer.

   b. Prefabricated joint fittings shall be used at intersections of the ribbed-type waterstops.

6. Retrofit Waterstops

   a. Retrofit waterstops and batten bars shall be as indicated or as acceptable to the Engineer.

   b. The waterstop shall be supplied as a complete system including waterstop, SS batten bar, SS anchor bolts, and epoxy gel.

7. When tested in accordance with the indicated test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Std
Tensile Strength-min, psi	2000	D 638, Type IV
Ultimate Elongation-min, percent	350	D 638, Type IV
Low Temp Brittleness, max degrees F	-35	D 746
Stiffness in Flexure, min, psi	600	D 747
Accelerated Extraction (CRD-C572		
Tensile Strength-min, psi	1500	D 638, Type IV
Ultimate Elongation, min, percent	300	D 638, Type IV
Effect of Alkalies (CRD-C572		
Change in Weight, percent	plus 0.25/minus 0.10	------
Change in Durometer, Shore A	plus and minus 5	D 2240
Finish Waterstop		
Tensile Strength-min, psi	1400	D 638, Type IV
Ultimate Elongation, min percent	280	D 638, Type IV

B. Preformed Hydrophilic Waterstop

1. Hydrophilic (bentonite-free) waterstops shall be **Hydro-Flex Waterstop** as manufactured by **Henry Co., or Earthshield Type 20**, as manufactured by **JP Specialties, or equal**.

2. The cross-sectional area of the waterstop shall not be less than 0.5 square inch.

3. Hydrophilic waterstop shall be the type that expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

4. The waterstop shall be manufactured from butyl rubber with hydrophilic properties.

5. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.

6. The minimum expansion ratio of modified chloroprene shall be not less than 2-to-1 volumetric change in distilled water at 70 degrees F (21 degrees C).

7. The bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

C. Ozonated Process Water

1. Waterstops for joints in concrete tanks in contact with or over ozonated process water shall be chemical resistant Thermoplastic Elastomeric Rubber (TPER) waterstops and shall meet all other dimensional, installation and fabrication requirements for the type of waterstop listed in this Section.

2. TPER waterstops shall be **Earth Shield Thermoplastic Vulcanizate Waterstops (TPER/TPV)** as manufactured by **JP Specialties, or equal.**

3. Crosses and intersections shall be shop-fabricated, mitered, and welded by the manufacturer.

4. Field splices shall be butt-welded in accordance with the manufacturer's recommendations.

D. When types of waterstops not listed above are indicated, they shall be subjected to the same requirements as those listed in this Section.

2.3 JOINT SEALANT FOR WATER-BEARING JOINTS

A. The joint sealant shall be a polyurethane polymer designed for bonding to concrete which is continuously submerged in water.

B. No material will be accepted which has an unsatisfactory history as to bond or durability when used in the joints of water-retaining structures.

C. Joint sealant material shall meet the following requirements (73 degrees F and 5 percent R.H.):

Work Life, minutes	45 - 180
Time to Reach 20 Shore A Hardness (at 77 degrees F, 200 gram quantity), max	24 hours
Ultimate Hardness (ASTM D 2240, Shore A)	20 - 45
Tensile Strength (ASTM D 412), min	175 psi
Ultimate Elongation (ASTM D 412), minimum	400 percent
Tear Resistance (Die C, ASTM D 624), pounds per inch of thickness, min	75
Color	Light Gray

D. Polyurethane sealants for waterstop joints in concrete shall conform to the following requirements:

1. Sealant shall be 2-part polyurethane with the physical properties of the cured sealant conforming to or exceeding the requirements of ASTM C 920 – Elastomeric Joint Sealant, or Federal Specification TT-S-0227 E(3) - Sealing Compound, Elastomeric Type, Multicomponent, for Caulking, Sealing, and Glazing Buildings and Other Structures, for 2-part material, as applicable.

2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used, conforming to the requirements of ASTM C 920, Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.

3. For plane horizontal joints, use the self-leveling compounds meeting the requirements of ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I.

4. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics and having a Shore A hardness range of 35 to 45 shall be used.

5. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the manufacturer.

E. Sealant Manufacturers

1. Sealants shall be **PSI-270** as manufactured by **Polymeric Systems Inc., Sikaflex 2C**, as manufactured by **Sika Corporation, Pelseal (with Viton) 2112/2012, or equal.**

2. **Pelseal (with Viton) 2112/2012** shall be the only sealant used at the ozone contact basin.

F. Sealants for non-waterstop joints in concrete shall be in conformance with the requirements of Section 07 92 13 – Elastomeric Joint Sealants.

2.4 JOINT MATERIALS

A. Bearing Pad

1. The bearing pad shall be neoprene conforming to ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications, BC 420, 40 durometer hardness, unless otherwise indicated.

B. Neoprene Sponge

1. The sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber, Type 2C5-E1.

C. Joint Filler

1. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D 1056, Type 2C5-E1.

2. Joint filler material in other locations shall be of the preformed non-extruding type, constructed of cellular neoprene sponge rubber or polyurethane of firm texture.

3. Bituminous fiber type will not be accepted.

4. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, for Type I, except as otherwise indicated.

2.5 BACKING ROD

A. The backing rod shall be an extruded closed-cell, polyethylene foam rod.

B. The rod material shall be compatible with the joint sealant material, and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi.

C. The rod shall be 1/8 inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.6 SLIP DOWELS

A. Slip dowels in joints shall be smooth epoxy-coated bars conforming to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

2.7 PVC TUBING

A. PVC tubing in joints shall be SDR 13.5, conforming to ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

PART 3 -- EXECUTION

3.1 GENERAL

A. Waterstops shall be embedded in the concrete across joints as indicated.

B. Waterstops shall be fully continuous for the extent of the joint.

C. Splices necessary to provide such continuity shall conform to the printed instructions of the waterstop manufacturer.

D. The Contractor shall take suitable precautions and provide means to support and protect the waterstops during the progress of the Work, and shall repair or replace any waterstops damaged during progress of the Work at no additional cost to the Owner.

E. Waterstops shall be stored so as to permit free circulation of air around the waterstop material.

F. When any waterstop is installed in the concrete on one side of a joint while the other portion of the waterstop remains exposed to the atmosphere for more than 2 Days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure time until the exposed portion of waterstop is embedded in concrete.

3.2 SPLICES IN PVC WATERSTOPS

A. Splices in PVC waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations.

B. It is essential that:

1. The material shall not be damaged by heat sealing.

2. The splices shall have a tensile strength of not less than 80 percent of the unspliced material.

3. The continuity of the waterstop ribs and of its tubular center axis shall be maintained.

4. No edge welding will be accepted.

C. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.

D. Other Joints

1. Joints with waterstops involving more than 2 ends to be jointed together, and joints that involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections, shall be prefabricated prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint.

2. Upon inspection and approval, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt-welded to the straight run portions of waterstop in place in the forms.

E. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

3.3 JOINT CONSTRUCTION

A. Setting Waterstops

1. In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken as to the correct positioning of the waterstops during installation.

2. Adequate provisions shall be made to support and anchor the waterstops during the progress of the Work and to ensure proper embedment in the concrete.

3. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints.

4. The center axis of the waterstops shall be coincident with the joint openings.

5. Thoroughly work the concrete in the vicinity of joints for maximum density and imperviousness.

B. Waterstop Placement

1. In placing waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed.

2. Waterstops shall be held in place with light wire ties on 12-inch centers, which shall be passed through hog rings at the edge of the waterstop and tied to the curtain of reinforcing steel.

3. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked.

4. In placing concrete around horizontal waterstops with their flat face in a horizontal plane, the concrete shall be worked under the waterstops by hand in order to avoid the formation of air and rock pockets.

C. In placing centerbulb waterstops in expansion joints, the centerbulb shall be centered on the joint filler material.

D. Waterstop in vertical wall joints shall terminate 6 inches from the top of the wall, where such waterstop does not connect with any other waterstop and is not to be connected to a future concrete placement.

E. Joint Location

1. Construction joints and other types of joints shall be provided where indicated.

2. If not indicated, construction joints shall be provided at a 25-foot maximum spacing.

3. Where joints are indicated to be spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing.

4. The location of joints, regardless of type, shall be submitted for acceptance by the Engineer.

F. Joint Preparation

1. Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required.

2. Unless otherwise indicated, such bonding shall be required at every horizontal joint in walls.

3. Surfaces shall be prepared in accordance with Section 03 31 00 – Cast-in-Place Concrete.

G. Retrofit Joint Preparation

1. Existing surfaces to receive a retrofit waterstop shall be clean and free from any loose or foreign material.

2. The surface shall be given a light sandblast or hydroblast finish to 1/8-inch amplitude prior to the application of epoxy and waterstop.

H. Construction Joint Sealant

1. Construction joints in water-bearing floor slabs and elsewhere as indicated shall be provided with tapered grooves which shall be filled with a construction joint sealant.

2. The material used to form the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant.

3. After removing the forms from the grooves, laitance and fins shall be removed, and the grooves shall be sand blasted.

4. The grooves shall be allowed to thoroughly dry, after which they shall be blown out and immediately thereafter they shall be primed and filled with the construction joint sealant.

5. The primer shall be furnished by the sealant manufacturer, and no sealant shall be used without a primer.

6. Care shall be used to completely fill the sealant grooves.

7. Areas designated to receive a sealant fillet shall be thoroughly cleaned as outlined for the tapered grooves prior to application of the sealant.

I. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application.

J. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant.

K. The sealant shall achieve final cure at least 7 Days before the structure is filled with water.

L. The sealant shall be installed by a competent waterproofing specialty contractor with a successful record of performance in similar installations.

M. Mixing

1. Catalyst-cured, 2-part materials shall be thoroughly and uniformly mixed, and special care shall be taken to properly mix the sealer before its application.

2. Before any sealer is placed, the Contractor shall arrange to have workers performing the Work carefully instructed on the proper method of mixing and application by a representative of the sealant manufacturer.

N. Failure to Cure

1. Any joint sealant that fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the Work shall be completely removed, and the groove shall be thoroughly sandblasted to remove traces of the uncured or partially cured sealant and primer.

2. The groove shall be re-sealed with the indicated joint sealant.

3. Costs of such removal, joint treatment, re-sealing, and appurtenant Work shall be the Contractor’s responsibility as part of the Work.

O. Hydrophilic Waterstop

1. Where a hydrophilic waterstop is indicated, it shall be installed in accordance with the manufacturer's instructions and recommendations except as may be modified in this Section.

2. When requested by the Engineer, the Contractor shall arrange for the manufacturer to furnish technical assistance in the field.

3. Hydrophilic waterstop shall only be used where complete confinement by concrete is provided.

4. Hydrophilic waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of a non-intersecting joint.

5. Location

    a. The hydrophilic waterstop shall be located as near as possible to the center of the joint, and it shall be continuous around the entire joint.

    b. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.

6. Placement

    a. Where the thickness of the concrete member to be placed on the hydrophilic waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete.

    b. The groove shall be at least 3/4 inch deep and 1-1/4 inches wide.

    c. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2-1/2 inches.

7. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be adhered to PVC waterstop by a single component water-swelling sealant as recommended by the manufacturer.

8. The hydrophilic waterstop shall not be installed where the air temperature falls below the manufacturer's recommended range.

9. Preparation

    a. The concrete surface under the hydrophilic waterstop shall be smooth and uniform, and the concrete shall be ground smooth if needed.

    b. Alternatively, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout that completely fills voids and irregularities beneath the waterstop material.

    c. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.

10. Securing

    a. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing.

    b. The above requirement shall be in addition to the adhesive recommended by the manufacturer.

P. Retrofit Waterstop

1. Retrofit waterstops shall be set in a bed of epoxy over a sandblasted surface with stainless steel batten bars and 1/4-inch diameter stainless steel anchors at 6 inches on-center, staggered, and in accordance with the manufacturer's written recommendations.

END OF SECTION

SECTION 03 60 00 - GROUTING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide grout, complete and in place, in accordance with the Contract Documents. For concrete repair material and procedures, reference Section 03 01 30 – Concrete Repair and Rehabilitation.

B. Grout provided as a base support for mechanical and electrical equipment shall conform to manufacturer's requirements and the requirements of this section.

C. The following types of grout are covered in this Section:

1. Non-Shrink Grout

2. High Strength Non-Shrink Grout

3. Non-Shrink Epoxy Grout

4. Topping Grout and Concrete/Grout Fill

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

B. ASTM C307 -- Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings

C. ASTM C531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

D. ASTM C579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

E. ASTM C580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

F. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

G. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear

H. ASTM C1090 – Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout

I. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

J. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete

K. ASTM C1339 – Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1. Certified testing lab reports for tests indicated herein.

2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.

3. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the Work, and location of use.

4. Documentation indicating that the grouts contain no chlorides or other chemicals that cause corrosion.

5. Manufacturer's Safety Data Sheet documenting composition of grouts.

6. Submit manufacturer's written warranty as indicated herein.

7. Name and telephone number of grout manufacturer's representative who will give on-site service. The representative shall have at least one year of experience with the indicated grouts.

1.4 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the Engineer. The specimens will be made by the Engineer or its representative.

2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C1107 at intervals during construction selected by the Engineer.

3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill will be performed in accordance with Section 03 31 00 - Cast-in-Place Concrete at intervals during construction selected by the Engineer.

4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C579, Method B, at intervals during construction selected by the Engineer. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.

5. The cost of laboratory tests on grout will be paid by the Owner except where test results show the grout to be defective. In such case, the Contractor shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the Work.

6. The Contractor shall assist the Engineer in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. Construction Tolerances: Construction tolerances shall be as indicated in Section 03 31 00 unless indicated otherwise.

C. Pre-Installation Demonstration and Training

1. Non-Shrink Grouts

a. The grout manufacturer shall give a demonstration and training session for the cement based and epoxy non-shrink grouts to be used on the project before any installation of grout is allowed.

b. Training session shall use a minimum of 5 bags of cement-based non-shrink grout mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 Days shall be made. The remaining grout shall be placed, and curing may be initiated on actual project placements such as baseplates to provide on-the-job training for the Contractor and Engineer. The Contractor employees who will be doing the grouting shall participate in this training and demonstration session. The training session shall include methods for curing the grout.

c. The Contractor shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the Engineer.

1.5 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. Manufacturer's Warranty

1. Furnish one year warranty for Work provided under this section.

2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

PART 2 -- PRODUCTS

2.1 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Beam and column base plates less than 16-inches in the least dimension.	Non-Shrink
Under precast concrete elements	High Strength Non-Shrink
Storage tanks and other non-motorized equipment or machinery under 30 horsepower	Non-Shrink
Motorized equipment over 30 horsepower and equipment under 30 horsepower but subject to severe shock loads and high vibrations	Non-Shrink Epoxy

Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink
Toppings and concrete/grout fill less than 3-inches thick	Topping Grout
Anchor bolts, anchor rods and reinforcing steel required to be set in epoxy or adhesive.	Post-Installed Anchors in Concrete per Section 05 05 19
Repair of holes and defects in concrete members.	Concrete Repair and Rehabilitation per Section 03 01 30

2.2 NON-SHRINK GROUTS

A. General

1. All non-shrink grout shall be cement based unless otherwise noted.

2. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

3. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each non-shrink grout shall be as recommended by the manufacturer for the particular application.

4. The manufacturer’s product information shall state the acceptability of the non-shrink grout for the intended purpose and location.

5. Grout shall not contain chlorides or additives that may contribute to corrosion.

6. Grout placed in continuously wet environments or in exterior conditions shall not contain gypsum or calcium salt.

7. All cement-based non-shrink grout shall have the following general properties:

   a. Meet the requirements of ASTM C1107.

   b. Have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C827. The grout when tested shall not bleed or segregate at maximum allowed water.

   c. No shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.

   d. A minimum bond strength (concrete to grout) of 1900 psi per modified ASTM C882.

8. Environmental and ambient conditions shall be a factor in the selection of non-shrink grout. If a non-shrink grout is to be used in a high sulfate environment, marine environment, high temperature environment, or freeze/thaw environment, the

manufacturer’s product information shall state the acceptability for each environmental condition.

B. Non-Shrink Grout

1. Non-Shrink Grout shall have a minimum 28 Day compressive strength of 5000 psi when mixed at a fluid consistency and tested per ASTM C109.

2. Non-Shrink Grout shall be **Five Star Grout** by **Five Star Products, Five Star Fluid Grout 100** by **Five Star Products, Sikagrout 212** by **Sika Corporation,** or approved equal.

C. High Strength Non-Shrink Grout

1. High Strength Non-Shrink Grout shall have a minimum 28-Day compressive strength of 10,000 psi when mixed at a fluid consistency and tested per ASTM C109.

2. High Strength Non-Shrink Grout shall be **Five Star High Strength Grout** by **Five Star Products, Sikagrout 428 FS,** or approved equal.

2.3 NON-SHRINK EPOXY GROUT

A. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents.

B. The manufacturer’s product information shall state the acceptability of the epoxy grout for the intended purpose and location.

C. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

D. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable.

E. Non-shrink epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested in accordance with ASTM C531.

F. Non-shrink epoxy grout shall develop a minimum compressive strength of 9000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C579, method B.

G. The effective bearing area shall be a minimum of 85 percent effective bearing area (EBA) in accordance with ASTM C1339, for bearing area and flow.

H. The chemical formulation of the non-shrink epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

I. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 Days:

1. Minimum bond strength to concrete of 3000 psi per ASTM C882 modified.

2. Minimum bond strength to steel of 1700 psi per ASTM C882 modified.

3. Minimum flexural strength of 2500 psi per ASTM C580.

4. Minimum tensile strength of 2000 psi per ASTM C307.

J. Non-shrink epoxy grout shall be **Five Star DP Epoxy Grout** by **Five Star Products, Inc.**, **Masterflow 648** by **BASF Corporation**, **Sikadur 42 Grout-Pak** by **Sika Corporation**, or approved equal.

2.4 TOPPING GROUT AND CONCRETE/GROUT FILL

A. Where fill thickness is 3-inches or greater, structural concrete as indicated in Section 03 31 00 - Cast-in-Place Concrete, may be used when accepted by the Engineer. Fiber reinforcing shall be as indicated below.

B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tanks, channels, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as indicated. Materials and procedures indicated for structural concrete in Section 03 31 00 - Cast-in-Place Concrete, shall apply unless indicated otherwise.

C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water/cement ratio of 0.45. Topping grout in clarifiers shall contain between 750 and 800 pounds of cement per cubic yard with a maximum water/cement ratio of 0.42.

D. Coarse aggregate shall be graded as follows:

U.S. Standard Sieve Size	Percent By Weight Passing
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

E. Final mix design shall be as determined by trial mix design as indicated in Section 03 31 00 except that drying shrinkage tests are not required.

F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 31 00.

G. Strength: Minimum compressive strength of topping grout and concrete/grout fill at 28 days shall be 4000 psi.

H. Topping grout used in clarifiers, or where the fill thickness is 3 inches or greater shall contain fiber reinforcing, unless otherwise shown on the Contract Documents. Fiber reinforcing shall be 100 percent virgin polypropylene fibrillated fibers specifically manufactured in a blended gradation for use as concrete secondary reinforcement. Fibers shall be added at a rate of 1.5 pounds per cubic yard of concrete. Fibers shall conform to ASTM C1116.

2.5 STRUCTURAL REPAIR GROUT

A. Structural repair grout shall be an extended set, pre-packaged cement based mortar requiring only the addition of potable water. The material shall not contain any chlorides or lime other than the amounts contained within the hydraulic cement composition.

B. Structural repair grout shall have a minimum compressive strength per ASTM C 109 of 6,000 psi at 7 days.

C. Structural repair grout shall have a minimum bond strength per ASTM C 882 of 2,000 psi at 1 day.

D. For repairs larger than 2 cubic feet in volume, the structural repair grout may be extended by the addition of clean, damp, coarse aggregate per the manufacturer’s written recommendations.

E. Structural repair grout shall be **Structural Concrete ES** by **Five Star Products,** or equal.

2.6 CURING MATERIALS

A. Curing materials shall be in accordance with Section 03 31 00 and as recommended by the manufacturer of prepackaged grouts.

2.7 CONSISTENCY

A. The consistency of grout shall be as necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

2.8 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Grout shall be stored in accordance with manufacturer's recommendations.

3.2 GENERAL

A. Contractor shall arrange for the manufacturer of prepackaged grouts to provide on-site technical assistance within 72 hours of request, as part of the Work.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the Engineer.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 31 00. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the Work from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.3 GROUTING PROCEDURES

A. General: Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.

2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the Engineer, alternate grouting methods shall be submitted by the Contractor for acceptance by the Engineer.

3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

C. Topping Grout and Concrete/Grout Fill

1. Mechanical, electrical, and finish Work shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively, where accepted by the Engineer, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.

2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.

3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping grout and grout fill. No topping grout shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.

6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the Engineer, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.4 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

END OF SECTION

SECTION 04 05 19.29 – POST-INSTALLED ANCHORS IN MASONRY

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide post-installed anchors and appurtenances, complete and in place, as indicated in accordance with the Contract documents.

B. Unless otherwise indicated, drilled masonry anchors shall be adhesive anchors.

C. Section Includes:

1. Adhesive anchors

2. Expansion anchors

3. Screw anchors

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Definitions

1. Epoxy anchors are considered adhesive anchors.

2. Expansion anchors, screw anchors, and undercut anchors are considered mechanical anchors.

B. References

1. IBC 2021 – International Building Code

2. TMS 402-2016 – Building Code Requirements for Masonry Structures

3. TMS 602-2016 – Specification for Masonry Structures

4. ASCE 7 – ASCE Standard ASCE/SEI 7-22 Minimum Design Loads for Buildings and Other Structures

5. ASCE 41 - ASCE Standard ASCE/SEI 41-13 Seismic Evaluation and Retrofit of Existing Buildings

6. ICC ES AC01 – Acceptance Criteria for Expansion Anchors in Masonry Elements

7. ICC ES AC58 –Acceptance Criteria for Adhesive Anchors in Masonry Elements

8. ICC ES AC106 –Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements

9. NSF 61 – NSF/ANSI 61-2016 Drinking Water System Components – Health Effects

1.3 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit the following:

1. Product data and technical information

2. Safety Data Sheets (SDS) for adhesives

3. Manufacturer's literature containing installation instructions and appropriate uses for each type of post-installed anchor and location of use

4. Current ICC-ES or IAPMO-UES Evaluation Reports

5. Certification for each installer demonstrating that they have been qualified in accordance with the Quality Assurance requirements below.

C. No substitution for the indicated anchors will be considered unless accompanied with an ICC-ES or IAPMO-UES report verifying strength and material equivalency.

D. Complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be completed and submitted in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1. Where adhesive anchors are used for structural applications (such as dowels between new and existing masonry) and an embedment depth is not shown on the contract documents, the anchor shall be installed in accordance with the following :

   The minimum depth of embedment shall be greater than or equal to the development length (l_d) determined in accordance with TMS 402/602 for a cast in place reinforcing bar of the same diameter and grade, unless it can be shown by calculation that the anchor spacing and edge distance is sufficient to develop the tensile strength of the anchor in a lesser depth of embedment. Calculations shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

1.4 QUALITY ASSURANCE

A. Special inspection for all post-installed anchor installations shall be provided:

1. As recommended or required by the ICC-ES or IAPMO-UES report.

2. As required by the enforceable building code.

3. As otherwise indicated in the Contract Documents.

B. The most stringent of the above requirements shall be used. The cost of Special Inspection of post-installed anchors shall be paid for by the Owner.

C. Before installing adhesive anchors in the Work, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading if required.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

D. Before installing mechanical anchors in the Work, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, and torqueing.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

E. Defective anchors noted by the Special Inspector shall be replaced and re-installed by the Contractor without any additional compensation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer’s or distributor’s packaging undamaged, complete with installation instructions.

B. Protect and handle materials in accordance with manufacturer’s recommendations to prevent damage or deterioration.

C. Anchoring adhesives shall be stored at temperatures prescribed by the manufacturer and must not be used beyond the expiration date.

1.6 FIELD AND SITE CONDITIONS

A. Post-installed anchors shall be installed in grout filled, concrete masonry having the minimum age required by the ICC-ES or IAPMO-UES report, or manufacturer’s instructions, at the time of anchor installation.

B. The anchor or fastener coating, plating, or steel type must provide suitable corrosion resistance for the environment in which the anchor or fastener is installed. Anchors, nuts, and washers in the locations listed below shall be fabricated from type 316 or 304 stainless steel:

1. Buried locations

2. Submerged locations

3. Locations subject to seasonal or occasional flooding

4. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

5. Chemical handling areas

6. Inside trenches, containment walls, and curbed areas

7. Locations indicated or designated by the ENGINEER to be provided with stainless steel anchors.

PART 2 -- PRODUCTS

2.1 ADHESIVE ANCHORS

A. General

1. The adhesive anchor system shall consist of: 1) adhesive product; and 2) threaded rod or reinforcing bar insert. The complete system shall be compatible as required by the adhesive manufacturer.

2. Adhesives shall be injectable, two-component, cartridge-type systems dispensed and mixed through a static mixing nozzle supplied by the manufacturer.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the adhesive anchor for the intended purpose and location.

4. Adhesive anchors shall be permitted when regular ambient temperatures are consistent with manufacturer's recommendation for long and short term temperatures.

5. Adhesive anchors shall not be used where anchors are subject to vibration or fire.

6. Adhesive anchors shall not be used in overhead applications.

7. Adhesive shall meet the requirements of NSF/ANSI Standard 61.

8. Adhesive shall be capable of being used in submerged applications once cured.

B. Adhesive Anchors in Grout Filled Concrete Masonry Units

1. Threaded rod inserts shall meet the requirements of Section 01 33 17 – Structural Design, Support, and Anchorage

2. Reinforcing dowel inserts shall meet the material requirements of Section 03 21 00 – Reinforcement Steel and 03 31 00 – Cast-in-Place Concrete.

3. Adhesive anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and shall have been tested and qualified for performance in grout filled concrete masonry adhesive anchors in accordance with ICC-ES AC 58 to resist static, wind, and earthquake (Seismic Design Categories A through F).

4. Adhesive anchors for masonry shall be **HIT-HY 270** by **Hilt,** or equal.

2.2 EXPANSION ANCHORS

A. General

1. Expansion anchors are post-installed torque-controlled mechanical expansion anchors used to resist structural loads.

2. Expansion anchors shall be an imperial sized, threaded stud with an integral cone expander, expansion clip, nut and washer.

3. Lead caulking anchors will not be permitted.

4. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

5. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the expansion anchor for the intended purpose and location.

6. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Expansion Anchors for Grout Filled Concrete Masonry Units

1. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in grout filled, uncracked concrete masonry units in accordance with ICC-ES AC01.

2. Expansion anchors for grout filled concrete masonry shall be **Kwik-Bolt TZ** by **Hilti**, or equal.

2.3 SCREW ANCHORS

A. General

1. Screw anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

2. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the screw anchor for the intended purpose and location.

3. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Screw Anchors for Grout Filled Concrete Masonry

1. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in grout filled concrete masonry in accordance with ICC-ES AC106.

2. Screw anchors for grout filled concrete masonry shall be **Kwik HUS-EZ (KH-EZ)** by **Hilti**, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Post-installed anchors shall be installed in strict accordance with the manufacturer's instructions, the ICC-ES or IAPMO-UES report, and project specific design requirements indicated on the Contract Documents or in the design calculations provided by the Contractor per Section 1.3.D.

B. Where holes are drilled in masonry, holes shall be accurately and squarely drilled, and the holes shall be cleaned in accordance with the manufacturer's recommendations.

C. Acceptable installation and performance temperature ranges shall be verified with manufacturer's literature prior to installation. Minimum substrate temperatures shall be maintained during the full curing period as required by the manufacturer.

D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

E. The Contractor shall identify the position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in drilling to avoid damaging existing reinforcing or embedded items. The location of drilled holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

F. Core drilling of holes is not allowed.

G. Identification of reinforcing steel and/or embedded items, relocation of drilled holes and adjustments or modifications to anchored or fastened items shall be considered part of the Work and shall be provided at no additional cost to the Owner.

H. All abandoned drilled holes shall be repaired in accordance with Section 03 01 30 - Concrete Repair and Rehabilitation at no additional cost to the Owner.

END OF SECTION

SECTION 04 21 15 – MASONRY VENEER

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide masonry veneer and appurtenant Work, complete and in place, in accordance with the Contract Documents.

B. The Contractor shall coordinate color samples with other Sections through the submittal process, as required by the Engineer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
04 22 00	Reinforced Concrete Block Masonry
07 11 00	Dampproofing
07 19 00	Water Repellents
09 96 00	High-Performance Coatings

B. Reference Standards

1. The edition of the standards applicable to the Work shall be those editions referenced by the 2018 International Building Code (IBC). Referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

ASTM International (ASTM)	
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A951	Standard Specification for Steel Wire for Masonry Joint Reinforcement
ASTM C90	Standard Specification for Loadbearing Concrete Masonry Units
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C140	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C207	Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C270	Standard Specification for Mortar for Unit Masonry

ASTM C272	Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
ASTM C426	Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units
ASTM C518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C979	Standard Specification for Pigments for Integrally Colored Concrete
ASTM D1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials
ASTM E514	Standard Test Method for Water Penetration and Leakage Through Masonry
International Code Council (ICC)	
IBC	2018 International Building Code
The Masonry Society (TMS)	
TMS 402	Building Code Requirements for Masonry Structures
TMS 602	Specification for Masonry Structures

C. Building Code: Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referenced herein as “the Code.”

1.03 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Literature: Manufacturer’s specifications, technical data, installation methods, maintenance instructions, and the following:

1. Literature for masonry veneer units:

a. Literature for integral color pigment admixtures.

1) Manufacturer’s standard and extended color range for color selection by the Owner.

b. Literature for integral water repellent admixture.

2. Literature for Mortar:

    a. Literature for integral color pigment admixtures:

        1) Manufacturer's standard and extended color range for color selection by the Owner.

    b. Literature for integral water repellent admixtures.

3. Literature for masonry cleaners.

4. Literature for joint reinforcement, anchors, straps, and ties.

5. Literature for accessories.

C. Warranty: Submit a copy of the warranty.

D. Certifications:

1. Certification by the integral water repellent admixture Manufacturer that the integral water repellent admixture is suitable for, and compatible with, the masonry veneer, masonry veneer mortar, and admixtures provided under this Section.

2. Certification by the masonry cleaner Manufacturer that the masonry cleaners are suitable for, and compatible with, the masonry veneer, masonry veneer mortar, and admixtures provided under this Section.

3. Certification by the masonry cleaner Manufacturer that the masonry cleaner is suitable for, and compatible with, the surface applied water repellent provided under Section 07 19 00 – Water Repellents.

4. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and owner.

5. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

6. Certification that the Contractor is not associated with the independent testing laboratory and that the Contractor has no beneficial interest in the laboratory.

7. Certification from the masonry veneer unit Manufacturer certifying that the units conform to ASTM C90.

8. For each type of masonry veneer unit, certified preconstruction test reports, including compressive strength, absorption, dimensional analysis, unit weight, and moisture content in accordance with ASTM C140.

9. Certification from the mortar Manufacturer certifying that the mortar conforms to the property specifications of ASTM C270. Certification shall indicate the proposed mortar proportions and admixtures to be used.

    a. Submit laboratory test data demonstrating that the mortar, including admixtures, has the minimum compressive strength when sampled and tested in accordance with ASTM C270.

10. Certification of conformance to ASTM standards for the following materials: cement, hydrated lime, coarse and fine aggregate, and admixtures.

11. When requested by the Engineer, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

E. Shop Drawings: Complete Shop Drawings showing location and details of installation.

    1. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of masonry veneer, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

        a. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories for masonry veneer.

F. Samples: The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show thicknesses, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

    1. Four-inch by 6-inch samples of masonry veneer units.

    2. Representative samples of masonry veneer mortar.

    3. Representative samples of joint reinforcement, anchors, ties, and straps.

    4. Representative samples of accessories.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility:

    1. Masonry veneer units shall be provided by a single Manufacturer.

    2. Integral color pigment admixture shall be provided by single Manufacturer.

    3. Integral water repellent admixture, for both block and mortar, shall be provided by a single Manufacturer.

4. Masonry cleaner shall be provided by a single Manufacturer.

5. Joint reinforcement, anchors, ties, and straps shall be provided by a single Manufacturer, each.

6. Each masonry accessory shall each be provided by a single Manufacturer.

B. Manufacturer's Qualifications:

1. Integral Water Repellent Admixture Manufacturer Qualifications:

a. Integral water repellent admixture Manufacturer, for both block and mortar admixtures, shall have a minimum of 10 years of integral water repellent admixture manufacturing experience.

b. Integral water repellent admixture Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Masonry Cleaner Manufacturer Qualifications:

a. Masonry cleaner Manufacturer shall have minimum of 15 years of masonry cleaner manufacturing experience.

b. Masonry cleaner Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

3. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications:

1. A minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installers without these qualifications will not be accepted.

D. Field Sample:

1. Coordinate field sample with other field samples required in other Sections.

2. Prior to installation, erect field sample wall panel mock-up at the Site using materials and details required for final Work. The panel shall be approximately 6-feet long by 4-feet high and of the same construction as the exterior cavity walls for the building, and shall include the masonry Work in Section 04 22 00 – Reinforced Concrete Block Masonry. Field sample panel shall show the workmanship, coursing, bond, thickness, and tooling of joints, range of color and texture of the masonry veneer, the color of the mortar, and installation of joint reinforcement, anchors, ties, straps, and accessories.

a. Field sample shall also demonstrate cleaning materials, means, and methods as indicated in Part 3 below.

3. The field sample shall be erected in a location as designated by the Engineer.

4. Obtain the Engineer's acceptance of qualities of field sample before installation. Modify and/or reconstruct field sample at the direction of the Engineer until acceptance. Retain mock-up during construction as a standard for judging completed Work. Do not alter, move, or destroy field sample until approved by the Engineer.

5. Acceptance of field sample shall not relieve the Contractor from compliance with the Contract Documents.

E. Inspections will be performed in accordance with Special Inspections per the Code.

F. Testing services required to fulfill the certification requirements of Part 1.03, and to otherwise demonstrate that the materials proposed for incorporation into the Work comply with the requirement of the Contract Documents shall be provided by the Contractor. The cost of such testing, unless specifically stated otherwise, shall be performed by an independent testing laboratory approved by the Engineer, and paid by the Contractor.

1. Field testing and inspection services necessary to confirm that the properties of the materials actually incorporated into the Work conform to the Contract Documents, and to satisfy the Code requirements, will be provided by the Owner, at the Owner's expense.

G. The Contractor shall facilitate testing and inspection as follows:

1. Advise the Engineer of installation far enough in advance to allow for assignment and scheduling of inspection and testing personnel.

2. Furnish labor necessary to assist the Owner's testing agency in obtaining and handling samples.

H. Independent Testing Laboratory:

1. Provide masonry veneer unit, mortar, and grout testing prior to installation by an independent testing laboratory engaged by the Contractor and acceptable to the Engineer.

2. Laboratories affiliated with the Contractor or in which the Contractor or its officers have a beneficial interest will not be accepted.

I. When requested by the Engineer, additional tests may be required. Upon such request, the Contractor shall confirm properties of materials used for construction and test results for compressive strength as follows:

1. During construction, the Owner's testing lab may test the following specimens for compressive strength. Provide and test one set of specimens for each 5,000 sq. ft. of masonry wall area, but not less than one set per building, for testing.

a. One set of 3 masonry veneer units to be tested in compliance with ASTM C140 (concrete masonry).

b. One set of 3 cube mortar specimens mixed and tested in compliance with ASTM C270.

1.05 SPECIAL WARRANTY PROVISIONS

A. Cavity Wall Insulation: Furnish Manufacturer's 15-year written thermal warranty.

B. Warranties shall be non-prorated for the entire warranty period.

C. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Masonry veneer shall be suitable for, and compatible with, the required installation.

B. Admixtures shall be suitable for, and compatible with, the masonry veneer, masonry veneer mortar, and other admixtures provided under this Section.

C. Admixtures shall be suitable for, and compatible with, surface applied water repellent in Section 07 19 00 – Water Repellents.

D. Masonry cleaners shall be suitable for, and compatible with, the masonry veneer, masonry veneer mortar, and admixtures provided under this Section.

E. Masonry cleaners shall be suitable for, and compatible with, surface applied water repellent in Section 07 19 00 – Water Repellants.

F. Description:

1. Masonry veneer units shall be solid and hollow concrete masonry architectural facing units conforming to ASTM C90, normal weight, loadbearing units of the nominal size and bed dimension as indicated.

2. Masonry veneer includes split-face and smooth-face concrete masonry units, as indicated on the Drawings.

a. Provide internal corner units, external corner units, solid units, sills, caps, keystone, arches, and special shapes as indicated or as required.

b. Precast sills and caps shall be 3,000 psi concrete using ASTM C150 Type II Portland Cement. Finish shall be smooth face.

3. Masonry veneer units shall be nominal 8-inch high by 16-inch long by 4-inch (thickness) as indicated.

4. The bed dimension of masonry veneer shall be as follows: For single face units, the actual thickness (and length for corner units) shall be 7/16-inch less than the nominal thickness on the Drawings with a tolerance of plus or minus 1/16-inch. For units with 2 faces, the actual thickness shall be 1/2- inch less than the nominal thickness on the Drawings with a tolerance of plus or minus 1/16-inch.

5. Cementitious and pozzolanic (or siliceous) materials, admixtures, and normal weight aggregates shall conform to their respective ASTM Standards and shall be suitable for use in autoclaved concrete.

6. Masonry veneer units shall be sound and free of cracks or other defects that would interfere with the proper placing of the units or impair the strength or permanence of the construction.

7. Masonry veneer units shall be free from substances that will cause staining or pop-outs and units shall have straight and true edges, with surface texture to be approved by the Engineer.

    a. Minor cracks or defects incidental to the usual method of manufacture, or minor chipping resulting from customary methods of handling in shipment and delivery, will not be deemed grounds for rejection except that not more than 3 percent of a shipment will be permitted to contain chips larger than 1/4-inch (6.4 mm) from any edge or corner on the faces.

    b. Compressive strength of masonry veneer and mortar assembly, f'_m, shall be 2,000psi. The Engineer has selected this compressive strength based on the Unit Strength Method in accordance with the Code. Refer to Section 04 22 00 – Reinforced Concrete Block Masonry.

8. Masonry Veneer Unit Admixtures:

    a. Masonry veneer units shall have integral colored pigment, as indicated herein, added during manufacture in accordance with Manufacturer's written instructions.

    b. Masonry veneer units shall have integral water repellent, as indicated herein, added during manufacture in accordance with Manufacturer's written instructions.

    c. Masonry veneer admixtures shall be non-staining and shall not contain fillers, adulterants, or additives that will negatively affect the characteristics or performance of the masonry veneer, or mortar mix design.

    d. Amount of admixtures used shall be as recommended in writing by the Manufacturer.

9. Masonry Veneer Unit Appearance:

    a. Surface texture and aggregate exposure shall be uniform within the industry's normal manufacturing accepted range as represented by accepted field sample erected at the Site.

        1) Units shall be "architectural-grade," of high visual quality, with uniform color and texture characteristics, and shall have very dense surfaces, with tight, closed pores, suitable for exterior use, and readily capable of shedding rainwater. Heavily pitted units, with large, open surface pores, and/or large exposed aggregate will be rejected. All visual qualities are subject to the approval of the Engineer.

b. Provide in2 color groups as indicated on the Drawings:

1) Colors shall be selected and approved by the Owner from Manufacturer's full color range including custom colors, and may be required to exactly match other building components, as determined by the Owner.

a) Tentative color selection: Color A: Smooth face CMU veneer to match existing campus, Color B: Split face CMU veneer to match existing campus.

b) The Owner reserves the option of changing this tentative color selection during the submittal process.

10. Cure masonry veneer units in an autoclave in a saturated steam atmosphere at an average temperature exceeding 350 deg F for a period of time sufficient to assure that the units will meet the requirements for drying shrinkage.

11. At the time of delivery to the Site, masonry veneer units shall conform to the physical requirements given in ASTM C90, and the linear shrinkage of units shall not exceed 0.030 percent when tested in accordance with ASTM C426.

2.02 INTEGRAL COLOR PIGMENT ADMIXTURE (BLOCK, CAPS, SILLS)

A. Description:

1. Colored pigment shall be made of iron oxides that provide natural tinting strength, durability, and pure chemical resistance. Pigments shall be non-fading.

2. Color pigment shall conform to ASTM C979.

3. Integral colored pigment shall be integrally-mixed, alkali-stable, lightfast, weather and UV resistant pigment.

4. Color shall be maintained uniformly throughout the Work as represented by accepted field sample mock-up wall panel erected at the Site.

2.03 INTEGRAL WATER REPELLENT ADMIXTURE (BLOCK, CAPS, SILLS)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Master Builders MasterPel 240 Admixture.

B. Description: Integral water repellent shall be a liquid polymeric admixture resistant to water penetration.

2.04 MASONRY VENEER MORTAR

A. Description:

1. Mortar for masonry veneer units shall be Type S Portland cement – lime mortar conforming to the property specification requirements of ASTM C270.

    a. Portland cement shall conform to ASTM C150 Type I or Type II. Masonry cements, mortar cements, and plastic cement shall NOT be used.

        1) White Portland cement shall contain a maximum of 0.03 percent water-soluble alkali when tested in accordance with ASTM C114.

    b. Lime for masonry mortar shall be hydrated lime conforming to ASTM C207, Type S.

2. Aggregates:

    a. Sand shall be clean, durable particles, free from injurious amounts of organic matter, dust, lumps, shale, alkali, or surface coatings.

        1) Sand for mortar shall conform to ASTM C144.

3. Water shall be from a potable water supply. Water shall be free from deleterious amounts of oils, acids, alkalis, or organic matter, and shall be clean and fresh.

4. Mortar Admixtures:

    a. Mortar admixtures shall not be used unless indicated herein.

        1) Antifreeze liquids, chloride salts, or other such substances shall NOT be used in mortar.

        2) Air entraining substances shall NOT be used in mortar.

    b. Mortar shall have integral colored pigment, as indicated herein, added during mixing in accordance with Manufacturer’s written instructions.

    c. Mortar shall have integral water repellent, as indicated herein, added during mixing in accordance with Manufacturer’s written instructions.

    d. Mortar admixtures shall be non-staining and shall not contain fillers, adulterants, or additives that will negatively affect the characteristics or performance of the masonry veneer, or mortar mix design.

    e. Amount of admixtures used shall be as recommended in writing by the Manufacturer.

2.05 INTEGRAL COLOR PIGMENT ADMIXTURE (MORTAR)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Davis Colors, TrueTone Colors.

B. Description:

1. Integral color pigments for mortar shall be pure iron oxide concentrated color pigments.

a. Colors shall be selected and approved by the Owner from Manufacturer's full color range including custom colors and may be required to exactly match other building components, as determined by the Owner.

1) Tentative color selection: To Be Selected.

2) The Owner reserves the option of changing this tentative color selection during the submittal process.

2.06 INTEGRAL WATER REPELLENT ADMIXTURE (MORTAR)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Master Builders MasterPel 240MA Mortar Admixture.

B. Description: Integral water repellent shall be a liquid polymeric admixture resistant to water penetration with a Class E rating in accordance with ASTM E514.

2.07 MASONRY CLEANER

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Prosoco, Inc., Enviro Klean Saftey Klean, Masonry Cleaner.

B. Description: A detergent masonry cleaner as recommended in writing by the masonry veneer Manufacturer.

2.08 JOINT REINFORCEMENT, ANCHORS, TIES, AND STRAPS

A. Joint Reinforcement: Joint reinforcement shall conform to the requirements of TMS 402, TMS 602 and the Code, and shall be prefabricated in straight lengths of not less than 10-feet (3.05 m) with matching corner and tee units. Units shall conform to ASTM A951 and shall be ASTMA A153 Hot Dipped Galvanized.

1. Joint reinforcement shall be welded wire units fabricated from cold-drawn steel wire with deformed continuous side rods and plain cross rods, crimped for cavity wall construction, and having a width of approximately 2-inches less than the nominal thickness of wall or partition.

a. Adjustable Masonry Veneer Ties, Hot Dipped Galvanized:

1) Manufacturer and Product or equal: Hohman & Barnard, Inc., No. 280 S.I.S; Dub'l Loop-Lok Seismiclip Interlock System, or equal.

2) Description: 9-gauge ladder type with adjustable ties having seismic clips and continuous 9-gauge wire to secure and reinforce the masonry veneer.

B. Anchors:

1. Dovetail slots shall be Heckmann Building Products, Dovetail Slot No. 100, or equal.

a. Dovetail slots shall be provided for masonry veneer anchorage to concrete framework, walls, and ceilings.

b. Dovetail slots shall be fabricated from 20-gauge, ASTM A153 , class B, hot dipped galvanized steel and shall be furnished with polystyrene fillers. Sizes shall be coordinated with the anchors used.

2. Dovetail anchors shall be Heckmann Building Products; Dovetail Triangular Anchors No. 103 C, or equal.

a. Provide 12-gauge dovetail clip attached to 3/16-inch diameter triangular tie, length as required, hot dipped galvanized steel ties manufactured for use with the anchor slots provided.

3. Dovetail seismic anchors shall be Heckmann Building Products; Dovetail Seismic Anchor No. 361, or equal.

4. Weld-On Adjustable Anchors and Ties shall be Heckmann Building Products, Anchors No. 315, Triangular ties No. 316, or equal.

a. Weld on adjustable anchors and ties shall be 1/4-inch (6.4 mm) diameter hot dipped galvanized steel.

C. Straps shall be Heckmann Building Products; No. 315-C, or equal.

1. Masonry straps shall be minimum 1/4-inch thick by 1-inch wide, and of the required length, fabricated from hot dipped galvanized steel.

2.09 MISCELLANEOUS ATTACHMENT DEVICES

A. Provide miscellaneous reinforcement, ties, anchors, fasteners, straps, and other attachment devices required both for the anchorage of Work of this Section and for that of other trades requiring attachment to masonry veneer which are not specifically provided under separate Sections.

B. Miscellaneous attachment devices shall be hot dipped galvanized steel and shall comply with ACI/ASCE 530 and the Code.

2.10 MASONRY ACCESSORIES

A. Through wall flashing shall be Hohmann and Barnard, Inc., Flashing, or equal.

1. Through wall flashing shall be type 304 stainless steel, 26 gauge.

B. Cavity wall Insulation shall be Dow; Styrofoam Square Edge, or equal.

1. Extruded closed cell polystyrene foam board with integral high density skins of the same material, ASTM C578 Type IV. Thickness shall be as indicated. Insulation shall have an R-factor of 5 per inch at 75 deg F mean temperature, ASTM C518. Cavity wall insulation shall have a minimum compressive strength of 25 psi, ASTM D1621. Water absorption shall be 0.1 percent, ASTM C272, with a water vapor permeance of 1.1, ASTM E96.

a. Adhere cavity wall Insulation to backup masonry and backup concrete with asphalt emulsion per Section 07 11 00 – Dampproofing.

C. Cavity wall mesh shall be Mortar Net USA, Ltd, The Mortar Net, or equal.

1. Mortar dropping collection device (mesh) shall be high-density polyethylene, 2-inches thick by 10-inches high, 90 percent open fibrous recycled polyester or high-density polyethylene mesh construction. Cavity wall mesh shall be constructed in a dovetail shape to prevent mortar from forming a continuous dam.

D. Weepholes shall be Wire-Bond, Clear Rectangular Vent, or equal.

1. Weepholes shall be made of clear butyrate and shall be 3/8-inch wide by 1 1/2-inches deep by 3 1/2-inches high.

E. Compressible Filler shall be Sandell Manufacturing Company; Polytite Filler, or equal.

1. Foamed polyurethane strip saturated with polybutylene waterproofing material. When compressed to 50 percent of its original volume, filler shall hold a head of 6-feet of water, and maintain its resiliency to allow for installation in temperatures as low as 40 deg F. Filler shall remain waterproof at 50 percent compression between temperatures of minus 40 deg F and 200 deg F. Elongation shall be at least 325 percent with a tensile strength of not less than 53 psi. The polybutylene compound shall not migrate in the polyurethane strip.

F. Control Joint Material shall be Dur-O-Wal, or equal.

1. Control joint material shall be factory-extruded preformed rubber shear keys conforming to ASTM D2000, 2AA-805.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

1. Materials shall be protected and stacked off the ground on the Site. Materials shall be protected from the weather and staining with the use of tarpaulins or other covering.

C. Handle materials in strict accordance with Manufacturer's written instructions.

D. Masonry units shall be particularly well-covered and protected during manufacture, storage, shipping, and while on the Site to prevent contamination that may lead to efflorescence in the finished Work.

1. If efflorescence or staining occurs, the Engineer may request the removal and replacement of areas so affected.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

C. Masonry construction in cold and hot weather shall conform to the applicable requirements of the Code unless more stringent requirements are indicated herein.

1. Cold Weather Construction: When the ambient temperature or the temperature of masonry units falls below 40 deg F, conform to procedures set by the Code for cold weather construction. Provide cold weather heating and protection for both mortar and grout.

a. Heat and enclosures will be the only protection method allowed for cold weather construction. Mortar additives shall NOT be used for this purpose.

2. Hot Weather Construction: Where the ambient temperature exceeds 100 deg F or 90 deg F with a wind velocity greater than 8 mph, conform to procedures set by the Code for hot weather construction.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where masonry veneer will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed masonry veneer.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of masonry veneer. Coordinate delivery with other Work to avoid delay.

b. Before beginning masonry Work, verify that tolerances of supporting members are within allowable limits, and that any required reinforcing and supports have been placed in accordance with the requirements of the Contract Documents.

c. Bearing surface for masonry shall be such that the thickness of the initial bed joint shall be not less than 1/4-inch nor more than 3/4-inch in thickness.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

D. Refer to Section 04 22 00 – Reinforced Concrete Block Masonry, for Special Inspection requirements which also apply to this Section.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

B. Before laying masonry, remove laitance, loose aggregate, or anything else that would interfere with bond between the mortar and substrate.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide necessary fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, and true to line, allowing for required movement, including expansion and contraction.

D. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

E. Horizontal lines shall be level, and vertical lines shall be plumb. Anchors for guides, brackets, and other fasteners shall be provided as shown on the Shop Drawings.

F. Do not wet concrete masonry veneer units before laying.

G. Mixing and Handling:

1. Mortar Mixing:

a. Accurately measure ingredients according to the proportions indicated for the batch and mix in a mechanically-operated batch mixer.

b. Mix mortar in accordance with the requirements of the Code, using a mechanically-operated mixer in which the quantity of water added can be accurately and uniformly controlled. Accurately measure mortar constituents by volume.

c. The consistency of the mortar shall be adjusted to the satisfaction of the mason with water added as necessary to produce a workable mix. Mortar may be re-tempered by adding water as frequently as needed to restore the required consistency. When water is added, it shall be mixed into the mortar, not splashed over the surface.

d. Mortar that has begun to "set" or that has not been used within 2-1/2 hours after initial mixing water was added to the dry ingredients shall be discarded.

e. Where the dry-mix method is employed, the materials for each patch shall be well turned over together until the even color of the mixed, dry materials indicates that the cementitious material has been thoroughly distributed throughout the mass, after which the water shall be gradually added until a thoroughly mixed mortar of the required plasticity is obtained.

H. Masonry units shall be laid in bonding pattern as indicated unless otherwise indicated. Tool joints dense and neat. Placing of mortar and units shall conform to the Code.

1. Where soldier courses or arches are indicated, maintain precise alignment and equal spacing of joints.

2. Unless otherwise indicated, corners and intersections of masonry veneer walls shall be bonded in each course with a true masonry bond, except that when necessarily erected separately, they shall be anchored with rigid steel anchors spaced not more than 2-feet (.61 m) apart vertically.

I. Sizes shall be as required by the Contract Documents. Where “soaps” and “splits” are used, the space between these members and the backup material shall be slushed full of mortar.

J. Joints of masonry shall be tooled in accordance with the following:

1. Wait until unit mortar is thumbprint hard before tooling joint.

2. The required labor personnel shall be kept on the job after hours, if necessary, to properly tool joints.

3. Vertical, horizontal, and arched joints shall maintain uniform in spacing.

4. Joints for masonry veneer units shall be 3/8-inch and concave, unless otherwise indicated.

K. Control joints shall be installed at the intersection of masonry walls with structural concrete and elsewhere as indicated. The maximum length, horizontally, between vertical control joints shall be 24-feet, however joints shall be located only as shown or approved in writing by the Engineer.

1. Do not start masonry wall construction until locations of control joints are approved by the Engineer.

2. Control joints shall be 3/8 inch, equal in width to the standard mortar joint.

3. Discontinue joint reinforcement at control joints and at expansion joints, unless otherwise indicated.

L. Joint reinforcement shall be installed continuously, interrupted only at control joints and at expansion joints, and shall be placed in every other course or 16-inches on center vertically, whichever is less, unless otherwise indicated.

M. Masonry slots, chases, or openings required for the proper installation of the Work of other Sections shall be constructed as indicated on the drawings or in accordance with information furnished before the Work is started at the points affected. No chase shall be cut into any wall constructed of hollow units after it is built.

N. Build-in miscellaneous items to be set in masonry for which placement is not specifically provided under separate Sections, including reglets, lintels, ties, electrical panel boxes, equipment, sleeves, vents, grilles, anchors, grounds, and exterior electric conduits and fixtures.

1. Do not place dissimilar metals in contact with each other.

2. Embedded aluminum conduits, pipes, or accessories in masonry, grout, or mortar, shall be coated or covered with materials that will effectively prevent galvanic action; provide specific products per Section 09 96 00 – High-Performance Coatings.

O. Anchorage, attachment, and bonding devices shall be set so as to prevent slippage and shall be completely covered with mortar or grout.

P. Ties and reinforcing for masonry shall be provided under this Section.

Q. Steel lintels shall be furnished under Division 5 and installed under this Section in accordance with the details shown on the Contract Drawings.

R. Pointing: During the tooling of joints, except for weep holes, enlarge any voids or holes, and completely fill with mortar matching the color of the surrounding Work as approved by Engineer and tool to match. Point-up joints at corners, openings, and adjacent Work to provide a neat, uniform appearance and properly prepare joints for application of sealants where required.

S. Before final cleaning, repoint unsatisfactory joints as indicated and as determined by the Engineer.

3.06 INSTALLATION – THROUGH-WALL FLASHING

A. On horizontal masonry surfaces to be flashed, the flashing shall be laid in a fresh bed of mortar or trowel coat of asphalt mastic, while other surfaces receiving the flashing shall be thoroughly dry, free from loose materials, reasonably smooth, and sufficiently spotted with asphalt mastic to hold it in place until the masonry is set. Splices shall be accomplished in accordance with the Manufacturer's written instructions.

B. Through-wall flashing shall start 1/2-inch in from the outside face of the wall and go through the wall.

C. Head flashing shall start 1/2-inch in from the outside face of the wall and go through the wall. It shall be carried to the vertical masonry joint on each side of the opening and be turned up at the sides to form a pan. Corners shall be folded and not cut.

3.07 INSTALLATION – CAVITY WALL INSULATION

A. Cavity wall insulation shall be installed in walls where indicated, in accordance with the Manufacturer's recommendations. Adhere insulation to concrete and concrete masonry units where required with additional daubs of dampproofing.

1. Coordinate placing of insulation with installation of masonry wall reinforcing, anchors, ties, and straps.

2. Refer to Air and Vapor Barrier specification 07 27 00.

3. At concrete masonry units backup, embed insulation in emulsion.

4. Cavity walls shall not receive insulation until the air temperature is above 50 deg F.

3.08 INSTALLATION – CAVITY WALL MESH

A. Cavity wall mesh shall be placed in the cavity wall continuously above through-wall flashing locations for the full cavity wall thickness, in accordance with the Manufacturer's written instructions.

3.09 INSTALLATION – WEEPHOLES

A. Weepholes shall be placed vertically in mortar joint without impairing bending or impairing bond.

B. Weepholes shall be installed 24-inches on center in joints containing through wall flashing; except at masonry openings less than 48-inches wide, where weepholes shall be spaced to allow for at least 2 weepholes equally spaced above each opening.

3.10 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, masonry veneer and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

3. Acid solutions shall not be used for cleaning any masonry veneer Work.

4. Sandblasting shall not be used for cleaning any masonry veneer Work.

5. High pressure washing shall not be used for cleaning any masonry veneer Work.

6. Cleaning materials, means, and methods shall be tested on the field sample panel prior to continuing with cleaning the remaining Work. A minimum of one week of dry weather is required to evaluate effectiveness of cleaning and effect on masonry and mortar by the Engineer.

7. Cleaning materials, means, and methods shall be compatible with masonry veneer Work herein, with the surface applied water repellents in Section 07 19 00 – Water Repellents.

8. Masonry veneer Work that is not satisfactorily cleanable shall be replaced as determined by the Engineer.

9. Any streaking, discoloration, or staining that occurs will be considered a defect that will be required to be repaired by the Contractor

10. After mortar has thoroughly set and cured (3 weeks minimum during the summer; 5 weeks minimum during the winter), a sample wall area (approximately 20 sq. ft.) shall be cleaned, with an approved commercial masonry cleaner, diluted, and mixed with potable water as recommended in writing by the Manufacturer. The sample area may be the field sample above or an area in the finish Work as approved by the Engineer.

11. Any dilution of the cleaning materials shall be performed with clean water according to the instructions on the Manufacturer's printed label (container label).

12. The Engineer's acceptance of sample cleaning shall be obtained before proceeding to clean remainder of masonry veneer Work. A minimum of one week of dry weather is required to evaluate effectiveness of cleaning and effect on masonry and mortar. Upon acceptance by the Engineer, the rest of the masonry shall be cleaned by the same method.

    a. Acceptance of sample cleaning shall not relieve the Contractor from compliance with the Contract Documents.

C. Surfaces shall be brushed as Work progresses and shall be maintained as clean as is practicable. Protect sills, ledges, offsets, etc. from mortar droppings. Unfinished Work shall be raked back where possible, and toothed only where acceptable to the Engineer. The top of partially completed Work shall be covered while Work is not in progress. Before leaving fresh or unfinished Work, walls shall be fully covered and protected against rain, wind, frost, or the elements. Covers of waterproof paper, tarpaulins, or other means, shall be draped over the wall, shall extend a minimum of 2-feet down both sides, and shall be firmly held in place.

D. Exposed masonry shall be protected against staining by wall coverings, and excess mortar shall be wiped off the surface as the Work progresses to reduce the amount of cleaning required at completion of the Work.

E. The Contractor shall make adjustments required until accepted.

F. Products shall be protected from damage from subsequent construction operations.

G. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

H. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

    1. Where ordered, remove masonry veneer units that are loose, chipped, broken, stained, or otherwise damaged, and units that do not match adjoining units and install new units in fresh mortar or grout, pointed to eliminate evidence of replacement, as approved by the Engineer.

    2. Remove and replace defective Work, including the product that are otherwise unacceptable.

I. When Work is completed, remove unused materials, containers, and equipment, and clean the Site of debris.

END OF SECTION

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SECTION 04 22 00 - REINFORCED CONCRETE BLOCK MASONRY

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide concrete masonry and appurtenant Work, complete and in place, in accordance with the Contract Documents. The summary of Work will include the construction of approximately 600 linear feet of 10-foot high reinforced concrete masonry unit (CMU) wall.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Samples

1. If the required product is a colored and textured unit, the samples shall be colored and textured units. Submit samples of concrete masonry units illustrating colors and textures available for the Owner to choose. Full size samples of the blocks selected shall be submitted for final approval after color selection, if requested.

2. Samples of mortar colors for color selection.

3. A minimum 4-ft square free-standing sample panel shall be prepared for approval before starting masonry Work. The panel shall remain at the Site for reference until masonry Work is completed.

C. Documentation

1. Reports from testing masonry units

2. Reports from mortar and grout testing.

D. Grout and mortar mix design

1. Proportions for components

2. Mill tests for cement

3. Admixture certification. Include chloride ion content.

4. Aggregate graduation and certification

5. Lime certification

1.3 QUALITY ASSURANCE

A. Applicable Standards: Concrete masonry shall conform to International Building Code (IBC), The Masonry Society TMS 402/602 Building Code Requirements and Specification for Masonry Structures and other applicable codes and standards of the governing authorities.

B. Work shall conform to the standard of quality established by the approved free-standing sample panel.

C. Concrete block masonry units shall be sampled and tested in accordance with ASTM C 140 - Test Methods of Sampling and Testing Concrete Masonry and Related Units.

D. Testing of Mortar and Grout: The Contractor shall have the mortar and grout tested to assure compliance with the Specifications and the governing codes by a recognized testing laboratory approved by the Engineer. Test reports shall be submitted to the Engineer.

1. Tests shall be taken at the following times:

a. At commencement of masonry Work, at least 2 test samples each of mortar and grout shall be taken on 3 successive Days.

b. At any change in materials or job conditions, at least 2 samples of each modified material, grout, and mortar shall be tested.

c. Make 4 random tests each of mortar and grout. The random test samples shall be taken when requested by the Engineer.

d. Additional samples and tests may be required whenever, in the judgment of the Engineer, additional tests beyond the 4 random tests are necessary to determine the quality of the materials.

e. The costs of tests and test reports, except for any additional tests requested by the Engineer, shall be paid by the Contractor as part of the Work. The costs of the additional tests and reports, when reports verify compliance with the Contract Documents, will be paid by the Owner. When tests or reports do not verify compliance, the cost of every additional test and report shall be paid by the Contractor.

2. Samples shall be stored in a moist environment until tested, unless directed otherwise by the Engineer or the testing laboratory. Testing for mortar shall be in accordance with ASTM C 270 - Mortar for Unit Masonry. Grout shall be tested per ASTM C 1019 - Standard Test Method for Sampling and Testing Grout.

E. Unit Strength Testing: The Owner will test the masonry units to assure compliance with the Specifications and the governing Codes. Testing will be by a recognized testing laboratory.

1. Tests will be made of the following items:

a. At the time of the construction of the sample panel above, at least 6 masonry units shall be tested for each type of block herein, except separate tests are not required for block which only varies by texture.

b. At any change in materials during construction, at least 6 masonry units shall be tested.

c. One set of at least 6 masonry units will be tested for each masonry structure, besides the structure that the sample is part of, or for each week in which block is laid, for each type of block involved; whichever occurs first.

d. Additional sets of at least 6 masonry units shall be tested whenever, in the judgment of the Engineer, additional tests are necessary to determine the quality of the materials.

e. The Contractor shall submit a letter of certification from the CMU Supplier at the time of, or prior to, delivery of the materials to the Site that the materials used in construction are representative of the materials used to construct the prisms.

2. The masonry units shall be sampled and tested in accordance with ASTM C 140.

F. Inspection: Whenever required under the provisions of the Building Code, Work hereunder will be subject to inspection by a Special Inspector selected by the Engineer and approved by the local Building Code representative having jurisdiction. Costs of such inspection will be paid by the Owner. The Special Inspector will work under the supervision of the Engineer. Special inspections will be per the Contract Drawings.

G. Extreme Weather Construction Cold weather construction shall be per the more stringent of TMS 402/602 and local Code requirements. Hot weather construction shall be per the more stringent of TMS 402/602 and local Code requirements.

H. Product Storage: Cement, lime, and other cementitious materials shall be delivered and stored in dry, weather-tight sheds or enclosures, in unbroken bags, barrels, or other approved containers, plainly marked and labeled with the manufacturers' names and brands. Mortar and grout shall be stored and handled in a manner that prevents the inclusion of foreign materials and damage by water or dampness. Masonry units shall be handled with care to avoid chipping and breakage, and shall be stored as directed in TMS 602. Materials stored on newly constructed floors shall be stacked in such manner that the uniformly distributed loading does not exceed 30 psf. Masonry materials shall be protected from contact with the earth and exposure to the weather and shall be kept dry and clean until used.

PART 2 -- PRODUCTS

2.1 CONCRETE MASONRY UNITS

A. Concrete masonry units shall conform to ASTM C 90 - Load-Bearing Concrete Masonry Units. Units shall be normal weight units unless indicated otherwise.

B. Concrete masonry units at exterior walls shall be normal weight block 8-inch by 8-inch by 16-inch modular size. The color and texture of wall shall match that of the existing wall or as required by Owner.

C. Bond beam, corner, lintel, sill, and other specially shaped blocks shall be provided where required or necessary. Specially shaped non-structural blocks may be constructed by saw cutting. Color and texture shall match that of adjacent units.

D. Concrete masonry units hidden from view entirely may be natural color units the same size as other adjacent masonry units.

2.2 MATERIALS

A. Portland cement shall be Type I or II, low alkali, conforming to ASTM C 150 - Portland Cement.

B. Fly Ash shall conform to ASTM C618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete, except that loss on ignition shall not be greater than 3 percent. Fly ash substitution, if used, shall be a minimum of 30 percent by weight of cement, but shall not exceed 40 percent.

C. Ground blast furnace slag cement shall conform to ASTM C989 - Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars, grade 100 or 120. Blended cements

shall conform to ASTM C595 – Blended Hydraulic Cements, Type 1S, or ASTM C1157 – Performance Specification for Hydraulic Cement. Slag cement substitution, if used, shall be not less than 25 nor more than 50 percent by weight of cement. Slag cement substitution shall not be used with fly ash substitution.

D. Water-repellant and efflorescence control admixture

1. Provide integral water repellant admixture in block and in mortar in all exterior exposed concrete masonry walls, including exterior single-wythe walls, exposed faces of screen walls, retaining walls, and other locations as indicated on the drawings.

2. For block, provide admixture as recommended by the manufacturer to obtain ASTM E 514-90–Standard Test Method for Water Penetration and Leakage Through Masonry – test extended to 72 hours, Class E rating. Admixtures shall be **BASF "MasterPel 240", Euclid Chemical Company "Eucon Blocktite"**, or equal.

E. Hydrated lime shall be Type S conforming to ASTM C 207 - Hydrated Lime for Masonry Purposes.

F. Aggregate for mortar shall conform to ASTM C 144 - Aggregate for Masonry Mortar. Aggregate for grout shall conform to ASTM C 404 - Aggregates for Masonry Grout.

G. Water for mixing shall be clear potable water.

H. Reinforcing steel shall be deformed bars conforming to ASTM A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Grade 60.

I. Joint reinforcing

1. Joint reinforcing shall conform to ASTM A 951 – Masonry Joint Reinforcement.

2. The minimum size of longitudinal and cross wires shall be W1.7 (9-gauge). Longitudinal wires shall be deformed. Maximum spacing of cross wires in ladder-type and points of connection of cross wires to longitudinal wire of truss-type shall be 16-inches.

3. Joint reinforcement shall be stainless steel, or hot-dip galvanized after fabrication per ASTM A 153 – Zinc Coating (Hot-Dip) on Iron and Steel Hardware, Class B.

4. Corners and wall intersections shall use prefabricated corners and tees.

5. Joint reinforcement shall be continuous or

a. lapped by 54 wire diameters in a grouted cell, or

b. lapped by 75 wire diameters in a mortared bed joint, or

c. in alternate bed joints of running bond masonry, lapped a distance not less than 54 diameters plus twice the spacing of the bed joints.

J. Integral water repellant admixture is required for mortar for exterior masonry units, and shall be **BASF MasterPel 240 MA, Euclid Blocktite Mortar Admixture,** or equal. The admixture shall not be detrimental to the bonding or help the process of efflorescence.

K. Admixture for grout shall be **Sika Co., Sika Grout Aid, Type II, BASF Pozzolith**, normal, or equal.

L. Veneer ties shall be per ACI 530 - Building Code Requirements for Masonry Structures and ACI 530.1. - Specifications for Masonry Structures. Additional ties shall be provided around openings larger than 16-inches in either direction.

M. Masonry cleaner shall be a non-acidic cleaner, **SafEtch by Prosoco, Inc.,** or equal.

2.3 MORTAR

A. Mortar for concrete block masonry shall conform to ASTM C 270 and IBC section 2103.2 for cement-lime Type M or S, with a minimum 28 Day compressive strength of 2000 psi.

2.4 GROUT

A. Grout shall conform to ASTM C 476 - Grout for Masonry and have a minimum 28 Day compressive strength of 2000 psi. Where the grout space is less than 4-inches, coarse aggregate shall be omitted.

B. Admixtures may only be used when approved by the Engineer. If approved for use, admixtures shall be used in accordance with the manufacturer's published recommendations for the grout.

PART 3 -- EXECUTION

3.1 GENERAL

A. Measurements for mortar and grout shall be accurately made. Shovel measurements are not acceptable. Mortar proportions shall be accurately controlled and maintained.

B. Work shall be performed in accordance with the provisions of TMS 402/602, the IBC, and the local codes for reinforced concrete hollow-unit masonry.

C. The Contractor shall set or embed anchors, bolts, reglets, sleeves, conduits, and other items as required.

D. Block cutting shall be by machine.

E. Masonry units shall be supported off the ground and shall be covered to protect them from rain. Only clean, dry, uncracked units shall be incorporated.

F. Reinforcing steel shall be cleaned of loose rust and scale, oil, dirt, paint, laitance, or other substances that may be detrimental to or reduce bonding of the steel and concrete.

G. Immediately before starting Work, concrete upon which the masonry will be laid shall be cleaned with water under pressure.

H. Full mortar joint for first course shall be provided.

I. Units shall be shoved tightly against adjacent units to assure good mortar bond.

J. Equipment for mixing and transporting the mortar and grout shall be clean and free from set mortar, dirt, or other foreign matter.

3.2 MIXING

A. Mortar shall be mixed by placing 1/2 of the water and sand in the operating mixer, after which the cement, lime, and remainder of the sand and water shall be added. After ingredients are in the mixer, they shall be mechanically mixed for not less than 5 minutes. Retempering shall be done on the mortar board by adding water within a basin formed

within the mortar, and the mortar reworked into the water. Mortar that is not used within one hour shall be discarded.

3.3 ERECTION OF CONCRETE BLOCK MASONRY

A. Masonry Work shall be erected in plane, plumb, level, straight and true to dimensions, and be executed in accordance with acceptable practices of the trade and the tolerances of TMS 402/602.

B. Unless indicated otherwise, masonry shall be laid up in straight uniform courses with running bond.

C. Masonry shall be erected to preserve the unobstructed vertical continuity of the cells measuring not less than 3 inches by 3 inches in cross-section. Walls and cross webs shall be full bedded in mortar. Head (or end) joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells.

3.4 JOINTS

A. Vertical and horizontal joints shall be uniform and approximately 3/8 inch wide. Exterior joints and interior exposed block joints shall be concave-tooled to a dense surface. Special care shall be used in tooling joints so as to match existing construction. Interior or exterior non-exposed masonry and masonry behind plaster shall have flush joints.

3.5 CLEANOUTS

A. Cleanout openings shall be provided at the bottoms of cells to be filled at each lift or pour of grout where such lift or pour is over 4 feet in height. Any overhanging mortar or other obstructions or debris shall be removed from the insides of such cell walls. The cleanouts shall be sealed before grouting and after inspection. Cleanout openings shall match the finished wall in exposed masonry.

3.6 REINFORCEMENT

A. Deep cut bond beam blocks shall be used where horizontal reinforcing steel is embedded. H-block bond beams may be used at locations other than openings.

B. Knock-out openings shall have no steel or joint reinforcing running through the opening. Head, jambs, and sill blocks shall be used to provide an even finish surface to install windows when blocks are removed. Joints at heads, jambs, and sills shall be stacked and continuous.

C. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 112 diameters of the reinforcement.

3.7 GROUTING

A. Cells containing reinforcing and bond beam spaces shall be filled solidly with grout unless indicated otherwise. Grouting shall not be started until the wall has cured for 24 hours. Grout shall not be poured in more than 5-ft lifts.

B. Grout shall be consolidated at time of pouring by puddling or vibrating. If the grouting operation has been stopped for one hour or longer, horizontal construction joints shall be formed by stopping the grout pour 1-1/2 inches below the top of the uppermost unit.

3.8 PROTECTION

A. Wall surfaces shall be protected from droppings of mortar or grout during construction.

3.9 FINISHING AND CLEANING

A. Masonry shall not be wet-finished unless exposed to extreme hot weather or hot wind and then only by using a nozzle-regulated fog spray sufficient only to dampen the face but not of such quantity to cause water to flow down over the masonry.

B. Finish masonry shall be cleaned and painted in a manner satisfactory to the Owner and Engineer, based upon the standards established by the approved sample panel.

C. Interior and exterior colored masonry Work exposed to view shall be cleaned by whip light sandblasting to remove stains and other imperfections.

D. Exposed masonry surfaces of openings and window and door openings such as sills, heads, and jambs shall be finish block surfaces, not formed surfaces, unless indicated otherwise. Closed bottom bond beam blocks shall be used at heads and sills. Pour holes may be used at the sill under window frame and where approved by the Engineer.

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SECTION 05 05 19 – POST-INSTALLED ANCHORS IN CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide post-installed anchors and appurtenances, complete and in place, as indicated in accordance with the Contract documents.

B. Unless otherwise indicated, drilled concrete anchors shall be adhesive anchors.

C. Section Includes:

1. Adhesive anchors

2. Expansion anchors

3. Screw anchors

4. Undercut anchors (dynamic loading)

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Definitions

1. Epoxy anchors are considered to be adhesive anchors.

2. Expansion anchors, screw anchors, and undercut anchors are considered to be mechanical anchors.

B. References

1. IBC 2021 – International Building Code

2. ACI 318 – Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary

3. ACI 355.2 – Qualification of Post Installed Mechanical Anchors in Concrete and Commentary (ACI 355.2-07)

4. ASCE 7 – ASCE Standard ASCE/SEI 7-22 Minimum Design Loads for Buildings and Other Structures

5. ASCE 41-17 - ASCE Standard ASCE/SEI 41-17 Seismic Evaluation and Retrofit of Existing Buildings

6. ICC ES AC 193 – Mechanical Anchors in Concrete Elements

7. ICC ES AC 308 – Post Installed Adhesive Anchors in Concrete Elements

8. NSF 61 – NSF/ANSI 61-2016 Drinking Water System Components – Health Effects

1.3 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures.

B. Submit the following:

1. Product data and technical information

2. Safety Data Sheets (SDS) for adhesives

3. Manufacturer's literature containing installation instructions and appropriate uses for each type of post-installed anchor and location of use

4. Current ICC-ES or IAPMO-UES Evaluation Reports

5. Certification for each installer demonstrating that they have been qualified in accordance with the Quality Assurance requirements below

C. No substitution for the indicated anchors will be considered unless accompanied with an ICC-ES or IAPMO-UES report verifying strength and material equivalency.

D. Complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be completed and submitted in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1. Where adhesive anchors are used for structural applications (such as dowels between new and existing concrete) and an embedment depth is not shown on the contract documents, the anchor shall be installed in accordance with Method 1 or Method 2 below:

a. Method 1: The minimum depth of embedment shall be greater than or equal to the development length (l_d) determined in accordance with ACI 318 for a cast in place reinforcing bar of the same diameter and grade, unless it can be shown by calculation that the anchor spacing and edge distance is sufficient to develop the tensile strength of the anchor in a lesser depth of embedment. Calculations shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

b. Method 2: Adhesive anchors in concrete that cannot develop the tensile capacity of the steel element may be used to transfer forces, provided that the loads on the anchor are amplified by the system overstrength factor (Ω_o) in Table 12.2-1 of ASCE 7-22, or where unreduced forces are used in accordance with ASCE 41-17 for existing structures. Calculations shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

1.4 QUALITY ASSURANCE

A. Special inspection for all post-installed anchor installations shall be provided:

1. As recommended or required by the ICC-ES or IAPMO-UES report.

2. As required by the enforceable building code.

3. As otherwise indicated in the Contract Documents.

B. The most stringent of the above requirements shall be used. The cost of Special Inspection of post-installed anchors shall be paid for by the Owner.

C. Before installing adhesive anchors in the Work, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading if required.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

D. Before installing mechanical anchors in the Work, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, and torquing.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

E. Defective anchors noted by the Special Inspector shall be replaced and re-installed by the Contractor without any additional compensation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer’s or distributor’s packaging undamaged, complete with installation instructions.

B. Protect and handle materials in accordance with manufacturer’s recommendations to prevent damage or deterioration.

C. Anchoring adhesives shall be stored at temperatures prescribed by the manufacturer and must not be used beyond the expiration date.

1.6 SITE CONDITIONS

A. Post-installed anchors shall be installed in concrete having a minimum age of 21 days at time of anchor installation.

B. The anchor or fastener coating, plating, or steel type must provide suitable corrosion resistance for the environment in which the anchor or fastener is installed. Anchors, nuts, and washers in the locations listed below shall be fabricated from type 316 or 304 stainless steel:

1. buried locations

2. submerged locations

3. locations subject to seasonal or occasional flooding

4. inside hydraulic structures below the top of the structure

5. inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

6. chemical handling areas

7. inside trenches, containment walls, and curbed areas

8. locations indicated or designated by the Engineer to be provided with stainless steel anchors.

PART 2 -- PRODUCTS

2.1 ADHESIVE ANCHORS

A. General

1. The adhesive anchor system shall consist of: 1) adhesive product; and 2) threaded rod or reinforcing bar insert. The complete system shall be compatible as required by the adhesive manufacturer.

2. Adhesives shall be injectable, two-component, cartridge-type systems dispensed and mixed through a static mixing nozzle supplied by the manufacturer.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the adhesive anchor for the intended purpose and location.

4. Adhesive anchors shall be permitted when regular ambient temperatures are consistent with manufacturer's recommendation for long and short term temperatures.

5. Adhesive anchors shall not be used where anchors are subject to vibration or fire.

6. Adhesive anchors shall not be used in overhead applications.

7. Where required, adhesive shall be capable of being used in submerged applications once cured.

8. Adhesive shall meet the requirements of NSF/ANSI Standard 61.

B. Adhesive Anchors in Concrete

1. Threaded rod inserts shall meet the requirements of Section 05 50 00 - Miscellaneous Metalwork.

2. Reinforcing dowel inserts shall meet the material requirements of Section 03 21 00 – Reinforcement Steel and Section 03 31 00 – Cast-in-Place Concrete.

3. Adhesive for use in concrete adhesive anchors shall be certified for use in resisting seismic loads in cracked concrete applications in accordance with ICC-ES AC 308.

4. Where not detailed on the drawings, adhesive anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC 308.

5. Adhesive anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and shall have been tested and qualified for performance in cracked and uncracked concrete in accordance ICC-ES AC308 to resist static, wind, and earthquake (Seismic Design Categories A through F).

6. Adhesive anchors for concrete shall be, **HIT-RE 500 V3 by Hilti**, or equal.

2.2 EXPANSION ANCHORS

A. General

1. Expansion anchors are post-installed torque-controlled mechanical expansion anchors used to resist structural loads.

2. Expansion anchors shall be an imperial sized, threaded stud with an integral cone expander, expansion clip, nut and washer.

3. Lead caulking anchors will not be permitted.

4. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

5. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the expansion anchor for the intended purpose and location.

6. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Expansion Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318, which requires post-installed mechanical anchors to be qualified according to ACI 355.2.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2 and ICC-ES AC193.

3. Expansion anchors shall be **Kwik-Bolt TZ by Hilti,** or equal.

2.3 SCREW ANCHORS

A. General

1. Screw anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

2. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the screw anchor for the intended purpose and location.

3. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Screw Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC193.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ICC-ES AC193.

3. Screw anchors for concrete shall be **Kwik HUS-EZ (KH-EZ) by Hilti,** or equal.

2.4 UNDERCUT ANCHORS

A. General

1. Undercut anchors are post-installed mechanical anchors that require pre-drilling and a special undercut notch configuration cut into the concrete before installation.

2. Self-undercutting anchors are post-installed torque-controlled mechanical anchors that cut their own undercut notch by application of a setting torque that forces a sleeve over a cone.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the undercut anchor for the intended purpose and location.

4. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

5. Undercut anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

B. Undercut Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC193.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2 and ICC-ES AC193.

3. Undercut anchors for concrete shall be **HDA by Hilti**, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Post-installed anchors shall be installed in strict accordance with the manufacturer's instructions, the ICC-ES or IAPMO-UES report, and project specific design requirements indicated on the Contract Documents or in the design calculations provided by the Contractor per Section 1.3.D.

B. Where holes are drilled in concrete, holes shall be accurately and squarely drilled, and the holes shall be cleaned in accordance with the manufacturer's recommendations.

C. Post-installed anchors shall not be installed until the concrete has reached the required 21 days or per manufacturer's requirements, whichever is longer.

D. Acceptable installation and performance temperature ranges shall be verified with manufacturer's literature prior to installation. Minimum substrate temperatures shall be maintained during the full curing period as required by the manufacturer.

E. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

F. The Contractor shall identify the position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in drilling to avoid damaging existing reinforcing or embedded items. The location of drilled holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

G. Core drilling of holes is not allowed.

H. Identification of reinforcing steel and/or embedded items, relocation of drilled holes and adjustments or modifications to anchored or fastened items shall be considered part of the Work and shall be provided at no additional cost to the Owner.

I. All abandoned drilled holes shall be repaired in accordance with Section 03 01 30 - Concrete Repair and Rehabilitation at no additional cost to the Owner.

END OF SECTION

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SECTION 05 50 00 – MISCELLANEOUS METALWORK

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications

MIL-G-18015 A (3) (Ships) Aluminum Planks. (6063-T6)

MIL-PRF-907F Antiseize Thread Compound, High Temperature

B. Federal Specifications

1. MIL-G-18015 A (3) (Ships) Aluminum Planks. (6063-T6)
2. MIL-PRF-907F Antiseize Thread Compound, High Temperature

C. Occupational Safety and Health Administration (OSHA)

1. OSHA 1927.10 Fixed Ladders
2. OSHA 1926.501 Fall Protection

D. American Institute of Steel Construction (AISC)

1. AISC 300 Code of Standard Practice for Steel Buildings and Bridges
2. AISC 360 Specification for Structural Steel Buildings

E. American Society for Testing and Materials (ASTM)

1. ASTM A27/A27M Standard Specification for Steel Castings, Carbon, for General Application
2. ASTM A 36 Standard Specification for Carbon Structural Steel
3. ASTM A47/A47M Standard Specification for Ferritic Malleable Iron Castings
4. ASTM A 48 Standard Specification for Gray Iron Castings
5. ASTM A 53 Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
6. ASTM A108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
7. ASTM A 123/123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
8. ASTM A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
9. ASTM A 193 Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
10. ASTM A 194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
11. ASTM A283/A283M Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

12.	ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
13.	ASTM A 500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
14.	ASTM A512	Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
15.	ASTM A568/A568M	(2013) Standard Specifications for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements
16.	ASTM A575	Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
17.	ASTM A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
18.	ASTM A924/A924M	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
19.	ASTM A 992	Standard Specification for Steel for Structural Shapes
20.	ASTM A1008	Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
21.	ASTM A1011	Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and Ultra-High Strength
22.	ASTM F 1554	Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength
23.	ASTM F 3125	Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength

F. American Welding Society (AWS)

1.	AWS D1.1/D1.1M	Structural Welding Code - Steel
2.	AWS D1.2	Structural Welding Code - Aluminum
3.	AWS QC1	Qualification and Certification of Welding Inspectors

G. Aluminum Association

1. Aluminum Design Manual
2. Specifications for Aluminum Structures
3. Engineering Data for Aluminum Structures
4. AA M31C22A41

    a. M31: Mechanical Finish, Fine Satin
    b. C22: Finish, Medium Matte
    c. A41: Clear Anodic Coating, Class 1

H. Specification Sections

1. Section 01 33 00 – Submittal Procedures

2. Section 09 96 00 – High-Performance Coatings

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the Work.

2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

C. Grating

1. Submit layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners.

2. Submit load and deflection tables for each style and depth of grating used.

D. Anchor Submittals

1. For post installed anchors in concrete other than powder-drive pins or impact anchors, refer to Section 05 05 19 – Post Installed Anchors in Concrete.

2. For post installed anchors in concrete masonry units other than powder-drive pins or impact anchors, refer to Section 04 05 19.29 – Post Installed Anchors in Masonry.

3. For powder-drive pins or impact anchors, complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be signed and stamped by a Professional Engineer registered in the state in which the project is located.

1.4 QUALITY ASSURANCE

A. Weld procedures and welder qualifications shall be available in the Contractor's field office for review.

B. Welding Special Inspection shall be performed by the Owner in accordance with the enforceable Building Code.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Pre-assemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes. Remove blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and application of surface finishes, including zinc coatings.

C. Steel

Wide Flange Shapes	ASTM A 992
Shapes, Plates, Bars	ASTM A 36
Pipe, Pipe Columns, Bollards	ASTM A 53, Type E or S, Grade B standard weight unless indicated otherwise
HSS	ASTM A 500 Grade B

D. Corrosion Protection

1. Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water or wastewater shall be coated in accordance with the requirements of Section 09 96 00 – High-Performance Coatings, and shall not be galvanized prior to coating.

2. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

E. Stainless Steel

1. Unless otherwise indicated, stainless steel metalwork and bolts shall be fabricated from Type 316 stainless steel.

F. Aluminum

1. Unless otherwise indicated, aluminum metalwork shall be fabricated from Alloy 6061-T6.

2. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the requirements of Section 09 96 00 – High-Performance Coatings.

G. Cast Iron

1. Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B, or better.

2.2 ALUMINUM RAILINGS

A. General

1. Aluminum handrails and railings shall be component systems, complete with anchors, attachments, balusters, brackets, caps, fasteners, gates (swing with self-latching hardware or be removable), posts, sleeves, trim, and any other related items as required or necessary for a complete installation.

2. Gates and removable rail sections shall be complete with hardware such as self-closing hinges, self-latching latches, hasps, and the like.

3. Railings shall conform to Building Code and OSHA requirements, General Industry Occupational Safety and Health Standards (29CFR1910).

B. Materials shall conform to the following requirements:

1. Aluminum

a. Aluminum shall be U.S. Alloy 6063 T-5 or T-6.

b. Aluminum pipe rail shall not be less than 1-1/2-inch diameter Schedule 40 pipe.

2. Electrolysis protective material shall be in accordance with the requirements of Section 09 96 00 – High-Performance Coatings.

3. Sleeves shall be of galvanized steel or PVC.

4. Grout for handrail posts shall consist of an inorganic, non-shrink, non-metallic premixed grout in accordance with the requirements of Section 03 60 00 - Grouting, with a minimum 28-Day compressive strength of 4,000 psi.

5. Fasteners, screws, and bolts shall be concealed and shall be fabricated from stainless steel or aluminum.

6. Aluminum welding rods shall be of a type recommended by the aluminum manufacturer for anodized finished products.

7. Kickplates shall be provided on railings and not set in curbs.

C. Pipe railing systems, including handrails, railings, tube caps, and other miscellaneous parts of the rails, shall be provided with a clear anodized finish, AA-M32C22A41.

D. Manufacturers or Equal

1. **C-V Pipe Rail** by **Crane Veyor Corp.**

2. **Connectorail** by **Julius Blum and Co.**

2.3 STEEL PIPE HANDRAILS

A. Steel pipe handrails, including brackets and related hardware which may be partially or wholly submerged or which are located inside a hydraulic structure, shall be fabricated entirely of Type 316 stainless steel.

B. Other steel pipe handrails shall be standard 1-1/2-inch black steel pipe made up by welding, and shall be hot-dip galvanized after fabrication.

2.4 METAL STAIRS

A. Metal Stairs

1. Metal stairs shall be composed of steel or aluminum stringers and supports, shall be fabricated in accordance with the standard practice of the National Association of Ornamental Metal Manufacturers, and shall be as indicated.

2. Steel stair members shall be hot-dip galvanized after fabrication.

2.5 GRATING STAIR TREADS

A. Grating stair treads shall be designed to support a live load of 100 psf or a concentrated load at mid-span of 300 pounds, whichever creates the higher stress.

B. The maximum deflection due to the uniform live load shall be as required for metal grating, below.

C. Grating stair treads shall be provided with an integral non-slip nosing.

2.6 SAFETY STAIR NOSINGS

A. Safety stair nosing shall be provided on concrete stairs and other locations as indicated.

B. The nosing shall be 3 inches wide and fabricated from extruded aluminum with cast-in abrasive strips and integral extruded anchors.

C. The color of the cast abrasive shall be as selected by the Engineer from among the manufacturer's standard colors.

D. The nosing shall be **Amstep Products Style 231-A, Grating Pacific XRS-3, Robertson Grating Products Type 9511,** or equal.

2.7 LADDERS

A. Materials

1. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure shall be fabricated entirely of Type 316 stainless steel.

2. Other ladders shall be fabricated from materials as indicated.

B. Fixed Step-Through Ladders shall be equipped with grab bar extensions meeting OSHA requirements.

1. Approved products include **Model 504 Access Ladder** by **O'Keefe's**, or equal. Grab bars by **CAI Safety Systems** may be added to other existing or new ladders.

C. Fall Prevention System (Ladder Safety System)

1. The fall prevention system at ladders shall include top and bottom brackets, ladder rung clamps, a steel cable that runs the height of the ladder, sleeves and full body harness (one per ladder), dismount section, and other components as necessary for a complete system.

2. All requirements of OSHA 1910.29 must be met.

3. The system shall be stainless steel unless noted otherwise. When steel ladders are specified, the ladder safety system is permitted to be galvanized steel.

4. Approved products include **Lad-Saf** by **DBI Sala**, or equal.

D. Pop-Up Extension

1. Every ladder that does not extend above the access level shall be equipped with a pop-up ladder extension.

2. The pop-up ladder extension device shall be manufactured of the same material and finish as the ladder, and shall be provided with a telescoping tubular section that locks automatically when fully extended.

3. Upward and downward movement shall be controlled by stainless steel spring balancing mechanisms.

4. The units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

2.8 METAL GRATING

A. General

1. Metal grating shall be of the indicated design, size, and type.

2. Grating shall be supported around an opening by support members.

3. Where grating is supported on concrete, unless otherwise indicated provide embedded support angles that match the grating material and are mitered and welded at their corners.

4. Banding

a. The grating shall be completely banded at edges and cutouts.

b. The banding material and cross-section shall be equivalent to the bearing bars.

c. The banding shall be welded to each cut bearing bar.

5. The grating pieces shall be fastened to each support in 2 locations.

6. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral non-slip nosing with a width equal to that of the stairway.

7. Where the grating depth is not indicated, provide grating within allowable stress levels and which shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less.

8. Design Loading

a. For standard duty plank and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 1000 pounds.

b. For heavy duty grating, the loading used for determining stresses and deflections shall be in accordance with AASHTO HS-20.

B. Material

1. Grating shall be fabricated of material as indicated on the Contract Drawings.

2. Grating that may be partially or wholly submerged shall be fabricated entirely of Type 316 stainless steel

C. Standard-Duty Grating

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise.

2. Standard duty grating shall be composed of serrated bar grating.

3. Cross bars shall be welded or mechanically locked tightly into position such that there is no movement between the bearing and cross bars.

D. Safety Grating

1. Safety grating shall be fabricated from sheet metal punched into an open serrated diamond pattern and be formed into plank sections.

2. The open diamond shapes shall be approximately 1-7/8 inches by 11/16-inch in size.

3. Safety grating shall be **Grip Strut** by **Metal Products Division, United States Gypsum Company, Deck Span** by **IKG Industries**, or equal.

E. Heavy-Duty Grating

1. Heavy-duty grating shall be fabricated from welded steel, galvanized after fabrication.

2. Crossbars shall be welded in position.

F. Plank Grating

1. Plank grating shall be extruded in 6-inch widths with a minimum of 6 integral one-bar type bearing bars per plank.

2. The top surface shall be solid with raised ribs, unless indicated otherwise.

3. Where punched grating is required, the top surface shall be provided with a pattern of 3-inch by 19/32-inch rectangular openings spaced at 4 inches on-center.

4. The planks shall have a continuous tongue-and-groove type interlock at each side, except that interlocking planks shall be arranged such that any 4-foot wide section may be removed independently from the other grating sections.

2.9 CHECKERED PLATE

A. Checkered plate shall be provided with a pattern of raised lugs on one face, and shall be smooth on the opposite face.

B. Lugs

1. Lugs shall be a minimum of one inch in length and raised a minimum of 1/2 inch above the surface.

2. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in 2 orthogonal directions.

3. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

C. Where no material is indicated, the plates shall be fabricated from aluminum.

D. Unless indicated otherwise, the minimum plate thickness shall be as required to limit deflection resulting from a live load of 100 psf to 1/4 inch, or the span divided by 240, whichever is less.

2.10 HATCHES

A. Where access hatches are mounted on a floor slab (including top slabs that are not covered with a roofing membrane) or on a concrete curb, the hatch shall be flush-type as indicated.

B. Hatches shall be fabricated from aluminum 5086 H34, 6063-T5 or 6061-T6, unless otherwise indicated.

C. Hatch hardware shall be fabricated from Type 316 stainless steel, and shall be of the gutter-type.

D. The design live load shall be 300 psf, unless indicated otherwise.

E. Configuration

1. Hatch opening sizes, number and swing direction of door leaves, and locations shall be as indicated.

2. Indicated sizes are for the clear opening.

3. Where the number of leaves is not indicated, openings larger than 42 inches in either direction shall be provided with double-leaf doors.

4. Unless indicated otherwise, hinges shall be located on the longer dimension side.

5. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches long, with the ladder centered on the shorter dimension and the door hinge opposite the ladder.

F. Door leaves shall be fabricated from a minimum of 1/4-inch thick checkered-pattern plate.

G. Channel frames shall be fabricated from a minimum 1/4-inch material with an anchor flange around the perimeter.

H. Hatches shall be provided with an automatic hold-open arm with release handle.

I. Hatches shall be designed for easy opening from both inside and outside.

J. Hatches shall be designed to be water-tight and shall be equipped with a joint gutter, a moat-type edge drain, and drain piping of the length and size necessary to remove the drain water from all dry spaces accessed by the hatch.

K. A minimum 1-1/2 inch diameter drain connection shall be provided, located by the manufacturer.

L. Submersible Pump Station Hatches

1. Hatches for submersible pump stations shall include a **Unistrut**, or equal, channel around the frame perimeter.

2. The face of the channel shall be flush with the face of the frame, and shall be compatible with the upper guide rail bracket of the submersible wastewater pump.

M. Hatches shall be provided with a recessed hasp for a padlock covered by a hinged lid that is flush with the surface.

N. Hatches shall be **Bilco Type J** or **JD, Babcock-Davis Type B-FGA**, or equal.

O. Nets

1. Unless indicated otherwise, hatch nets shall be provided on floor hatches.

2. Hatch nets shall conform to OSHA requirements.

3. Hatch nets shall be **Hatch Net 121**, as manufactured by **Safe Approach, Inc, Auburn, ME**, or equal.

2.11 METAL DECKING

A. Metal decking shall be of the indicated size and gauge, and shall meet the requirements of the AISI specification for the "Design of Light Gauge, Cold-formed Steel Structural Members."

B. The steel shall be hot-dip galvanized after fabrication.

2.12 IRON CASTINGS

A. General

1. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects.

2. The castings shall be smooth and well cleaned by shotblasting.

3. Covers and grates shall fit together evenly, such that the cover fits flush with the surrounding finished surface and such that the cover does not rock or rattle when a loading is applied.

4. Round covers and frames shall be provided with machined bearing surfaces.

B. Covers and grates with matching frames shall be designed to support the following loadings:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no floor loading is indicated, a minimum of 300 pounds per square foot.

2. Exterior covers and grates shall be designed for AASHTO HS-20 loading unless indicated otherwise.

2.13 MANHOLE RUNGS

A. Rungs shall meet ASTM C 478 - Precast Reinforced Concrete Manhole Sections and the following requirements:

1. Rungs shall be spaced not less than 10 inches apart nor more than 14 inches apart, as measured between centerlines of the rungs.

2. Rungs shall be parallel, level, and uniformly spaced.

3. The rungs shall be shaped such that a person's foot cannot slide off the end of the rung.

4. Rungs shall be surfaced to prevent injury from punctures or lacerations, and to prevent snagging of clothing.

5. The minimum perpendicular clearance between rungs and any obstruction behind the ladder shall be 6 inches.

6. The minimum width of rungs shall be 14 inches.

B. Submit certified test results in accordance with ASTM C 497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile, Section 10, for the following loads:

1. The horizontal pull-out load shall be 400 pounds.

2. The vertical load shall be 800 pounds.

C. Material

1. Rungs shall be fabricated from co-polymer polypropylene that encapsulates a minimum 1/2-inch grade 60 steel reinforcing rod.

2. The co-polymer polypropylene shall meet ASTM D 4101, Type PP200B33430.

2.14 FALL PREVENTION SYSTEM

A. The fall protection system at each ladder shall include a carrier rung, ladder ring clamps, sleeves and full body harnesses, dismount section, and other components as necessary for a complete system.

B. The carrier rail shall be fabricated from the same material as the ladder, except for fiberglass ladders, which shall be provided with stainless steel carrier, rails, and shall be the length recommended by the manufacturer for the ladder dimensions, including extensions.

C. Provide an extension for each ladder.

2.15 BOLTS AND ANCHORS

A. Standard Service (Non-Corrosive Application)

1. Bolts, anchor rods, anchor bolts, washers, and nuts shall be fabricated from steel as indicated.

2. Threads on galvanized bolts, rods and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing.

3. Except as otherwise indicated, steel for bolt material, anchor rods, anchor bolts, and cap screws shall be in accordance with the following requirements:

a. Structural Connections: ASTM A 307, Grade A or B, hot-dip galvanized

b. Headed Anchor Rods and Anchor Bolts: ASTM F1554, Grade 36, hot-dip or mechanically galvanized with Grade A matching nuts

c. High-Strength Bolts, where indicated: ASTM A 325

d. Pipe and Equipment Flange Bolts: ASTM A 193, Grade B-7

B. Corrosive Service

1. Bolts, anchor rods, anchor bolts, nuts, and washers in the locations listed below shall be fabricated from stainless steel as indicated.

a. Buried locations

b. Submerged locations

c. Locations subject to seasonal or occasional flooding

d. Inside hydraulic structures below the top of the structure

e. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

f. Chemical handling areas

g. Inside trenches, containment walls, and curbed areas

h. Locations indicated or designated by the Engineer to be provided with stainless steel bolts

C. Unless otherwise indicated, stainless steel bolts, nuts, anchor rods, and washers shall be fabricated from Type 316 stainless steel, Class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts.

D. Buried pipe flange bolts and nuts on pipe of Class 275 and greater shall be in accordance with ASTM A193/A194, Grade B7.

E. Coating

1. Threads on stainless steel bolts and rods shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, meeting government specification MIL-A-907E.

2. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

3. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

4. Antiseize lubricant shall be "PURE WHITE" by **Anti-Seize Technology,** Franklin Park, IL, 60131, **AS-470** by **Dixon Ticonderoga Company,** Lakehurst, NJ, 08733, or equal.

F. Bolt Requirements

1. The bolt and nut material shall be free-cutting steel.

2. The nuts shall be capable of developing the full strength of the bolts.

3. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.

4. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

5. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.

6. Lock washers fabricated from material matching the bolts shall be installed where indicated.

7. The length of each bolt shall be such that the bolt extends at least 1/8 inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

2.16 POWDER-DRIVEN PINS

A. Powder-driven pins for installation in concrete or steel shall be fabricated from heat-treated steel alloy.

B. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they will be exposed, they shall be protected in an acceptable manner.

C. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support.

D. Pins that are connected to steel shall be provided with longitudinal serrations around the circumference of the shank.

2.17 IMPACT ANCHOR

A. Impact anchors shall be an expansion-type anchor in which a nail-type pin is driven to produce the expansive force.

B. The pin shall be provided with a zinc sleeve with a mushroom-style head and stainless steel nail pin.

C. Anchors shall be **Zinc Nailon Anchors**, manufactured by **Simpson Strong-Tie, Inc.**, **Metal Hit Anchors,** manufactured by **Hilti, Inc., Rawl Zamac Nailin,** manufactured by the **Rawlplug Company,** or equal.

PART 3 -- EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

A. **Fabrication and Erection:** Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

B. Aluminum Railings

1. Aluminum railing fabrication and installation shall be performed by craftsmen experienced in the fabrication of architectural metalwork.

2. Exposed surfaces shall be free from defects or other surface blemishes.

3. Dimensions and conditions shall be verified in the field.

4. Joints, junctions, miters, and butting sections shall be precision fitted with no gaps occurring between sections, and with surfaces flush and aligned.

5. Electrolysis protection of materials shall be provided.

C. Steel Railings: Field welding of steel pipe handrail joints will be permitted only if approved by the Engineer, and then only in accordance with the Engineer's instructions.

D. Unless otherwise indicated, provide a 1/2-inch drain line to the nearest floor drain for floor hatches.

E. Powder-Driven Pins

1. Powder-driven pins shall be installed by a craftsperson certified by the manufacturer as being qualified to install the manufacturer's pins.

2. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration.

3. Driven pins shall conform to the following requirements where "D" is equal to the pin shank diameter:

Material Penetrated by Pin	Material Minimum Thickness	Pin Shank Penetration in Supporting Material	Minimum Space From Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D minimum	14D	20D

Steel	1/4-inch	Steel thickness	4D	7D

3.2 WELDING

A. Method

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.

2. The qualification of the welders shall be in accordance with the AWS Standards.

B. Quality

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.

2. Weld reinforcement shall be as indicated by the AWS Code.

3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.

4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions.

5. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32 inch on the flat.

3.3 GALVANIZING

A. Structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123.

B. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.

C. Bolts, anchor rods, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153.

D. Field Repairs

1. Field repairs to damaged galvanizing shall be performed by preparing the surface and applying a coating.

2. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.

3. The coating shall be applied to at least 3 mils dry film thickness, and shall be **Zinc-Clad XI** by **Sherwin-Williams**, **Galvax** by **Alvin Products**, **Galvite** by **ZRC Worldwide**, or equal.

3.4 FALL PREVENTION SYSTEM

A. A fall prevention system shall be provided on ladders used to ascend heights exceeding 20 feet.

END OF SECTION

SECTION 06 10 00 – ROUGH CARPENTRY

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall construct rough carpentry and appurtenant Work, complete and in place, in accordance with the Contract Documents.

B. The Work shall include, at least the following items:

1. Rooftop equipment bases and support curbs.

2. Wood blocking, cants, and nailers.

3. Plywood backing panels.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

B. Reference Standards

American Wood Protection Association (AWPA)	
AWPA U1	Use Category System: User Specification for Treated Wood
AWPA M4	Standard for the Care of Preservative-Treated Wood Products
ASTM International (ASTM)	
ASTM D2898	Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM D3201	Standard Test Method for Hygroscopic Properties of Fire-Retardant Wood and Wood-Based Products
ASTM D5664	Standard Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire- Retardant Treated Lumber
ASTM D6841	Standard Practice for Calculating Design Value Treatment Adjustment Factors for Fire-Retardant-Treated Lumber
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
Forest Stewardship Council (FSC)	
FSC STD-01-001	FSC Principles and Criteria for Forest Stewardship

1.03 CONTRACTOR SUBMITTALS

A. Furnish the following in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 -- PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

A. Certified Wood: Lumber and plywood shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.

2. In DOC PS 20, dressed sizes of green lumber are larger than dry lumber.

3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

4. Provide dressed lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 15 percent unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.03 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 ft beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.

2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.

3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.

4. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841. For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.04 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

2. Nailers.

3. Rooftop equipment bases and support curbs.

4. Cants.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber and any of the following species:

1. Hem-fir (north); NLGA.

2. Western woods; WCLIB or WWPA.

C. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:

1. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.

2. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.05 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exterior, AC, fire-retardant treated, in thickness indicated or, if not indicated, not less than ¾-in nominal thickness.

PART 3 -- EXECUTION

3.01 INSTALLATION, GENERAL

A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

B. Install plywood backing panels by fastening to substrate with corrosion resistant fasteners; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

C. Do not splice structural members between supports unless otherwise indicated.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16-in o.c.

E. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96-in o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96-in o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-in nominal actual thickness.

3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.

4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 ft o.c.

F. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

H. Use inorganic boron for items that are continuously protected from liquid water.

I. Use copper naphthenate for items not continuously protected from liquid water.

J. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

3.02 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 07 11 00 – DAMPPROOFING

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Dampproofing

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. Reference Specifications

01 33 00	Submittal Procedures
04 21 15	Masonry Veneer

C. Reference Standards

American Society for Testing and Materials (ASTM)	
ASTM D 1187	Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM D 1227	Emulsified Asphalt Used as a Protective Coating for Roofing

1.03 SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions.

B. Certificates

1. Certification by the dampproofing Manufacturer that the dampproofing provided is suitable for, and compatible with, the required installation.

2. Certification by the dampproofing Manufacturer that the dampproofing is suitable for, and compatible with, the insulation provided under Section 04 21 15 – Masonry Veneer.

3. Certification by the dampproofing Manufacturer that the products supplied comply with local regulations controlling the use of volatile organic compounds (VOCs).

4. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and Owner.

5. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and Owner.

C. Application Schedule

1. Furnish a detailed and complete application schedule indicating location and detail of installation.

D. Samples

1. When requested by Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve Contractor from compliance with the Contract Documents.

1.05 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers

a. Minimum of 10 years of dampproofing manufacturing experience.

b. Minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers

a. Minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

B. Manufacturer's Technical Field Representative

1. The Contractor shall arrange for a Manufacturer's technical field representative to be on Site for at least 3 days, beginning at the start of surface preparation and continuing through application, to train the installers and to supervise the Work. The Manufacturer's technical field representative shall observe as necessary to certify in writing that the completed Work has been performed according to the Manufacturer's instructions.

1.06 WARRANTY

A. Manufacturer Warranty

1. Furnish Manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. Special Warranty

1. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

C. Warranty Provisions

1. Warranties shall be non-prorated for the entire warranty period.

2. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 DAMPROOFING

A. Dampproofing shall be suitable for, and compatible with, the insulation provided under Sections 04 21 15 – Masonry Veneer.

B. Manufacturer and Product, or Equal:

1. MasterSeal 615 by Master Builders Solutions, including primer as recommended by Manufacturer.

C. Performance Requirements

1. Cold-applied water-based emulsified-asphalt dampproofing and vapor-retarding coating for concrete and concrete block foundation and cavity wall applications, suitable for installation on "green" or slightly damp surfaces.

2. Shall be reinforced with short fibers for application by brush or spray.

3. Dampproofing shall comply with ASTM D 1227, Type 2, Class I, and ASTM D 1187, Type 1.

2.02 PROTECTION BOARD

A. Provide dampproofing manufacturer's recommended protection board, which shall be compatible with dampproofing.

B. Description: Protection board shall be suitable for the protection of dampproofing from damage during backfill operations, as recommended in writing by the dampproofing manufacturer.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Dampproofing shall be installed on the cavity side of reinforced concrete block masonry in cavity wall construction and shall be used to set the insulation in the cavity, per Section 04 21 15 – Masonry Veneer.

B. Dampproofing shall be installed on exterior face of foundation walls from top of footing, up to 2-in below finish grade line, to continuously dampproof below grade rooms or other internal spaces.

C. Dampproofing shall also be installed elsewhere, where noted on the Contract Drawings.

D. Protection board shall be applied at locations where foundation insulation is not otherwise provided in order to protect the dampproofing during backfill operations.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where dampproofing will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed dampproofing.

a. Surfaces to receive dampproofing shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the dampproofing materials.

b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

2. Notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the applicable references and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, form release agents, and other substances shall be removed as recommended by the dampproofing Manufacturer.

C. Protrusions, bumps, ridges, and loose substrate surface materials shall be removed by sanding or grinding.

D. Trowelable leveling and patching compounds shall be used per dampproofing Manufacturer's written instructions to fill cracks, holes, and depressions.

E. Immediately before application of dampproofing materials, scrape surfaces to be covered free from foreign materials and brush clean.

F. Substrate shall be swept to remove all loose materials prior to beginning dampproofing installation.

3.06 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

1. Do not begin dampproofing until penetrations have been installed so that dampproofing will not be penetrated or damaged by subsequent Work.

2. Do not begin dampproofing before plumbing, electrical, mechanical, and structural items under or passing through dampproofing have been secured in proper positions and appropriately sealed and protected.

3.07 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Particular care shall be given to the application of dampproofing at construction joints.

C. Primer, if recommended by the Manufacturer for the application, shall be applied per the Manufacturer's recommended procedures.

D. Surfaces to be dampproofed shall receive 2 heavy coats, the first coat being carefully applied so that "holidays" or untreated air-bubble depressions in the surface shall be completely filled and the second coat shall provide a 100 percent coating of the surface.

E. Install cavity wall insulation in Section 04 21 15 – Masonry Veneer, against dampproofing.

F. Dampproofing shall be cured prior to backfilling.

G. Install protection board against dampproofing as recommended in writing by the dampproofing manufacturer.

3.08 CLEANING, FINISHING, AND PROTECTION

A. Dampproofing shall be protected from damage from subsequent construction operations.

B. The Contractor shall make adjustments required until accepted.

C. Damaged or defective items shall be removed and replaced as determined by the Engineer.

D. When dampproofing Work is completed, remove unused materials, containers, and equipment, and clean the Site of dampproofing debris.

END OF SECTION

SECTION 07 14 00 – FLUID APPLIED WATERPROOFING

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fluid-applied waterproofing

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 77 00	Project Closeout

1.03 SUBMITTALS

A. Submit Shop Drawings, product data and samples in accordance with Section 01 33 00 - Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data

1. Submit manufacturer's product data including installation instructions. Submit manufacturer's statement of product compatibility with substrate and adjacent materials.

B. Samples

1. Submit samples of cured membrane, scrim, prefabricated drainage mat, and geotextiles.

C. Closeout Submittal

1. Submit warranty in accordance with Section 01 77 00 - Project Closeout.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications

1. Company must specialize in waterproofing.

2. Must be waterproof membrane manufacturer trained and approved.

3. Experience: Continuously applied fluid applied waterproofing for 3 years.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials in sealed, undamaged original containers, with manufacturer's labels and seals intact.

1.07 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

American Society for Testing and Materials (ASTM)	
ASTM C836	Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
ASTM C661	Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
ASTM D816	Standard Test Methods for Rubber Cements
ASTM D1644	Standard Test Methods for Nonvolatile Content of Varnishes
ASTM D2370	Standard Test Method for Tensile Properties of Organic Coatings
ASTM D2697	Standard Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

1.08 QUALITY ASSURANCE

A. Qualifications

1. Installers

a. Use an experienced installer and adequate number of skilled personnel who are thoroughly trained and experienced in the application of fluid applied waterproofing membranes.

2. Manufacturer

a. Obtain waterproofing materials from a single manufacturer regularly engaged in manufacturing the product.

B. Provide products which comply with all state and local regulations controlling use of volatile organic compounds (VOCs).

1.09 CONDITIONS

A. Ambient Conditions:

1. Do not apply waterproofing when substrate and ambient temperatures are below 50 deg F or above 100 deg F.

2. Perform Work only when existing and forecast weather conditions are within manufacturer's recommendations.

3. Do not apply membrane if rainfall is forecast or imminent within 12 hours.

B. Protection

1. Protect adjacent areas not indicated to be waterproofed. Where necessary, apply pressure sensitive masking tape to prevent staining of surfaces to remain exposed wherever materials abutt other finish surfaces. Provide additional covering necessary to supplement tape.

C. Clearance

1. Maintain minimum 24-in clearance for product application. For areas with less clearance, apply trowel grade membrane by hand.

1.10 ADMINISTRATIVE REQUIREMENTS

A. Sequencing

1. Do not begin Work until substrate has been completed and penetrations have been installed so membrane will not be penetrated or damaged by subsequent work.

2. Install waterproof membrane before placement of concrete slab.

B. Scheduling

1. Do not begin application of membrane before plumbing, electrical, mechanical, and structural items under or passing through membrane have been positively secured in proper positions and appropriately protected.

1.11 WARRANTY

A. Warranty

1. Provide 5 year written warranty covering materials and installation for watertight condition.

2. Warranty shall be by material manufacturer, fabricator, installer, and Contractor, jointly and severally, and be signed by officers of each company.

PART 2 -- PRODUCTS

2.01 MEMBRANE SYSTEM

A. Fluid Applied Waterproofing System**:** W.R. Meadows Inc., Hydralastic 836 or approved equal.

B. Physical Properties

Property	**Typical Value**	**Test Method**
Solids Content By Weight	98 percent	ASTM D-1644
Solids Content By Volume	98 percent	ASTM D-2697
Tensile Strength	70 psi	ASTM D-2370

Property	Typical Value	Test Method
Elongation	440 percent	ASTM D-2370
Water Vapor Transmission	0.07 perm inches	ASTM E-96
Shore 00 Hardness	55	ASTM C-661
Low Temperature Flex	-20 deg F pass ¼-in mandrel	ASTM D-816
Service Temperature	-40 deg F – 158° deg F continuous service	
Minimum Application Temperature	Above 30 deg F and rising	
VOC Content	26 g/L	

C. Prefabricated Drainage Mat**:** Preformed plastic sheet, one side smooth with concave dimples, other side bonded to geotextile fabric. Use W.R. Medows MEL-DRAIN or approved equal.

2.02 ACCESSORIES

A. Joint Tape: 6-in wide reinforcing fabric for corners, crack, and joint treatment.

1. REINFORCING FABRIC HCR by W. R. MEADOWS.

B. Reinforced Joint Tape for outside corners subject to backfill.

1. PRECON TAPE by W.R. MEADOWS.

C. Detailing Membrane: BEM by W. R. MEADOWS

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Examine substrate before beginning installation to verify that:

1. Concrete has been cured for minimum of 14 days.

2. Surfaces are light broom finish or smoother; dry, clean, firm, and free from laitance, frost, dust, dirt, oil, curing compounds or other foreign matter detrimental to performance of membrane.

3. Voids, cracks, holes, and other damaged surfaces have been repaired with materials compatible with membrane.

4. Joints and transitions between planes are sharply formed and free of broken edges or loose aggregate, and are completely free of preformed joint fillers, sealants, or back-up materials to depth at least twice width of joint.

3.02 PREPARATION

A. Protect adjacent surfaces not designated to receive waterproofing.

B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.

C. Do not apply waterproofing to surfaces unacceptable to manufacturer.

D. Clean concrete surfaces so they are free of all coatings, dirt, oil, paints and any other contaminants.

E. Patch all holes and voids and smooth out any surface misalignments.

F. Remove and patch all concrete form ties.

G. Treatment of Existing Cracks and All Non-Structural Joints

1. Identify and install detailing membrane in all cracks and all non-structural joints per manufacturer’s written instructions.

H. Treatment of Inside & Outside Corners

1. Install detailing membrane per manufacturer’s written instructions to create a minimum ¾” fillet in all inside corners.

3.03 MEMBRANE APPLICATION

A. General: Apply in accordance with manufacturer's recommendations and standard details.

1. Maintain membrane free of dirt, debris and traffic until protective cover is in place. Do not penetrate membrane.

2. Horizontal Applications: Cover with 2-in sand layer, free from debris.

3. Provide minimum cured membrane thickness of 60 mils dry.

3.04 CLEANING

A. Clean stains from adjacent surfaces as recommended by manufacturer. Remove foreign matter from finished membrane surfaces.

3.05 PROTECTION

A. Traffic: Do not allow traffic on uncured membrane surfaces.

B. Prefabricated Drainage Mat: Cover membrane with drainage mat as soon as possible.

C. Backfill immediately using care to avoid damaging waterproofing membrane system.

END OF SECTION

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SECTION 07 19 00 – WATER REPELLENTS

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide Surface Applied Water Repellants and appurtenant Work, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. Reference Specifications

01 33 00	Submittal Procedures
04 21 15	Masonry Veneer

C. Reference Standards

American Society of Testing and Materials (ASTM)	
ASTM C 140	Water Repellency in Water Absorption
ASTM D 3278	Standard Test Method for Flashpoint of Liquids by Small Sealed Closed-End Apparatus
ASTM E 514	Standard Test Method for Water Penetration and Leakage through Masonry
Environmental Protection Agency (EPA)	
Method 24	Surface Coatings

1.03 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Literature: Manufacturer's specifications, technical data, installation methods, and maintenance instructions.

C. Warranty: Submit a copy of the warranty.

D. Certifications:

1. Certification by the Surface Applied Water Repellant Manufacturer that the water repellant provided is suitable for, and compatible with, the required installation.

2. Certification by the Surface Applied Water Repellant Manufacturer that the water repellant is suitable for, and compatible with, the masonry veneer, mortar, and admixtures provided under Section 04 21 15 – Masonry Veneer.

3. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and Owner.

4. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and Owner.

5. Certification by the Manufacturer's field representative that surfaces have been prepared and the products have been applied in accordance with the Manufacturer's recommendations.

6. Certification by the Manufacturer that the products provided achieves a Class E rating, when tested in accordance with ASTM E 514.

7. Certification by the Manufacturer that the products supplied complies with local regulations controlling the use of volatile organic compounds (VOCs).

8. Certification by the Manufacturer's field representative that the products provided achieves a passing result when tested in accordance with RILEM Test Method II.4.

9. When requested by the Engineer, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

E. Application Schedule: Furnish a detailed and complete application schedule indicating location and detail of installation.

F. Samples: When requested by Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish and quality of each item. Approval of samples shall not relieve Contractor from compliance with the Contract Documents.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Surface Applied Water Repellants shall be provided by a single Manufacturer.

B. Manufacturer Qualifications:

1. Surface Applied Water Repellant Manufacturer shall have a minimum of 20 years of water repellant manufacturing experience.

2. Surface Applied Water Repellants Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

3. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications:

1. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installer shall be trained, certified, and authorized by the Manufacturer to install the Manufacturer's product, when applicable.

3. Installers without these qualifications will not be accepted.

D. Manufacturer's Technical Field Representative: The Contractor shall arrange for a Manufacturer's technical field representative to be on Site, at the beginning of water repellent application (and periodically throughout), to train the installers and to supervise the Work. The Manufacturer's technical field representative shall observe as necessary to certify in writing that the completed Work has been performed according to the Manufacturer's instructions.

E. Field Sample:

1. Coordinate field sample with other field samples required in other Sections.

2. Prior to installation, erect sample wall panel mock-up on Site using materials and joint details required for final Work. Provide special features as directed.

3. The field sample shall not exhibit any deterioration of color or finish of the substrate, including but not limited to discoloration, staining, streaking, and fading.

4. Apply material in accordance with the requirements in Part 3 – Execution, below.

5. Manufacturer's technical field representative shall be present to review technical aspects and conduct the field sample installation.

   a. Apply Surface Applied Water Repellant to 2 ft by 2 ft test panel area, in accordance with Manufacturer's written instructions, to determine coverage rates, effectiveness, aesthetics, and desired results.

   b. Allow 10 days or until test panels are thoroughly cured before evaluating final appearance and results.

   c. Conduct RILEM test method II.4 to evaluate water repellent performance.

   d. Do not begin full-scale application until test panels are inspected and approved by the Engineer.

   e. Do not begin full-scale application until test panels are inspected and approved.

6. Obtain the Engineer's acceptance of qualities of field sample before installation. Modify and/or reconstruct field sample at the direction of Engineer until acceptance. Retain field sample during construction as a standard for judging completed Work. Do not alter, move, or destroy field sample until directed by the Engineer.

7. Acceptance of field sample shall not relieve the Contractor from compliance with the Contract Documents.

1.05 SPECIAL WARRANTY PROVISIONS

A. The Contractor shall furnish Manufacturer's extended 10-year warranty to cover defects in materials, products, and manufacturing workmanship.

B. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover defects in installation and associated later.

C. All warranty items shall be non-prorated for the entire warranty period.

D. The term of the warranty shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Surface Applied Water Repellant shall be a water-based, clear silane/siloxane sealer designed to provide protection for split-faced, lightweight and standard concrete masonry units.

B. Surface Applied Water Repellant shall be suitable for, and compatible with, masonry veneer, masonry mortar, and admixtures in Section 04 21 15 – Masonry Veneer.

2.02 SURFACE APPLIED WATER REPELLANT

A. Manufacturer and Product, or Equal:

1. Subject to the requirements herein, provide Manufacturer and product listed below, or equal.

a. Master Builders Solutions, MasterProtect H 107.

2. Description:

a. Surface Applied Water Repellant shall comply with standard specification, ASTM D 3278 (>212 deg F [> 100 deg C]), ASTM C 140 (45 percent reduction in weight gain), ASTM E 514 (99 percent reduction in weight gain), and VOC content shall be less than 2.50 lb/gal (1.13 kg/liter) per EPA method 24.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Surface Applied Water Repellant shall be applied to above grade, exterior masonry veneer, exposed concrete masonry blocks, and all precast sills and caps.

B. Surface Applied Water Repellant shall also be applied elsewhere, where indicated on the Contract Drawings.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

C. Protect against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify coordination with adjacent Work.

1. Examine substrates, areas, and conditions where the product will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed the product.

a. Surfaces to receive the product shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the Surface Applied Water Repellants materials.

b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the applicable references and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, form release agents, and other substances shall be removed as recommended by the Surface Applied Water Repellant Manufacturer.

C. Substrate shall be swept to remove all loose materials prior to beginning application.

3.06 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.07 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Surfaces shall receive complete coats and coverage rates as recommended in writing by the Manufacturer.

3.08 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

3. The surfaces of materials adjoining the product shall be cleaned free of overspray and smears of the product or other soiling due to the installation of the product.

B. Upon completion of the application, the product and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, as determined by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. The Contractor shall make adjustments required and retest until accepted.

D. The product shall be protected from damage from subsequent construction operations.

E. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

F. When the product Work is completed, remove unused materials, containers, and equipment, and clean the Site of Surface Applied Water Repellant debris.

END OF SECTION

SECTION 07 21 13 – BOARD INSULATION

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes

1. Foundation insulation

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. Reference Specifications

01 33 00	Submittal Procedures
07 11 00	Dampproofing

C. Reference Standards

American Society for Testing and Materials (ASTM)3zx	
ASTM C 272	Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
ASTM C 518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 578	Rigid, Cellular Polystyrene Thermal Insulation
ASTM D 1621	Standard Test Methods for Compressive Properties of Rigid Cellular Plastics
ASTM D 4716	Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Certifications:

1. Certification by the Manufacturer that the foundation insulation is suitable for, and compatible with, the dampproofing provided under Section 07 11 00 – Dampproofing.

C. Application Schedule

1. Furnish a detailed and complete application schedule indicating location and detail of installation.

D. Samples

1. When requested by the Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish, and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility

1. Foundation insulation shall be provided by a single Manufacturer.

B. Qualifications

1. Manufacturer

a. Minimum of 10 years of foundation insulation manufacturing experience.

b. Minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

1.06 WARRANTY

A. Manufacturer Warranty

1. Furnish the Manufacturer's 15-year written thermal warranty.

2. Warranties shall be non-prorated for the entire warranty period.

PART 2 -- PRODUCTS

2.01 FOUNDATION INSULATION

A. Foundation insulation shall be suitable for, and compatible with, the dampproofing provided under 07 11 00– Dampproofing.

2.02 MANUFACTURER

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

    a. DuPont Styrofoam Perimate XPS Foam Insulation.

B. Description

1. Foundation insulation shall be a 2 1/8-in extruded closed cell polystyrene foam board with drainage grooves and with integral high-density skins of same material.

2. Foundation insulation shall comply with ASTM C 578 Type IV, and shall have a minimum R-value of 10.0 (5 per inch) at 75 deg F (23.9 deg C), sq ft × h × degrees F/Btu, in accordance with ASTM C 518. Foundation insulation shall have a minimum compressive strength of 30 psi in accordance with ASTM D 1621, maximum water absorption of 0.1 percent by volume, in accordance with ASTM C 272, and drainage capacity at 1200 psf, gradient 0.19 of 3 gal/min/ft in accordance with ASTM D 4716.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Install foundation insulation vertically to reach a depth of 3 ft 0-in below grade, or to depth shown on the Drawings (whichever is greater) to continuously insulate the exterior face of exterior foundation walls, and other surfaces and substrates where indicated, in strict accordance with Manufacturer's written instructions.

B. Foundation insulation shall also be installed elsewhere, where noted on the Drawings.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where foundation insulation will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed foundation insulation.

a. Surfaces to receive foundation insulation shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the foundation insulation materials.

b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor’s acceptance of the substrate, areas, and conditions.

3.05 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.06 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer’s written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Foundation insulation shall be set with top 2-in below finish grade and held firmly in place in the freshly dampproofed concrete with additional daubs of dampproofing mastic in strict accordance with the Manufacturer's instructions. Refer to Section 07 11 00 – Dampproofing.

3.07 CLEANING, FINISHING, AND PROTECTION

A. Foundation insulation shall be protected from damage from subsequent construction operations.

B. The Contractor shall make adjustments required until accepted.

C. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

D. When foundation insulation Work is completed, remove unused materials, containers, and equipment, and clean the Site of foundation insulation debris.

END OF SECTION

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SECTION 07 27 00 – AIR AND VAPOR BARRIER

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide Air and Vapor Barrier and appurtenant Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCES

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. American Association of Textile Chemists and Colorists (AATCC)

AATCC Test Method 127 “Water Resistance – Hydrostatic Pressure Test”

C. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential

D. American Society for Testing and Materials (ASTM):

ASTM C 920	Standard Specification for Elastomeric Joint Sealants
ASTM C 1305	Standard Test Method for Crack Bridging Ability of Liquid-Applied Waterproofing Membrane
ASTM C 1522	Standard Test Method for Extensibility after Heat Aging of Cold, Liquid-Applied Elastomeric Waterproofing Membrane
ASTM D 1970	Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep slope roofing Underlayment for Ice Dam Protection.
ASTM D 4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96	Standard Test Methods for Water Vapor Transmission of Materials.
ASTM E 783	Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
ASTM E 1105	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
ASTM E 1354	Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter

ASTM E 2178 Standard Test Method for Air Permeance of Building Materials

ASTM E 2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

E. Building Code: Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referred to herein as “the CODE”.

F. National Fire Protection Association (NFPA)

NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

1.3 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Literature: Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

C. Warranty: Submit a copy of the warranty.

D. Certifications:

1. Certification by the Air and Vapor Barrier Manufacturer that the Air and Vapor Barrier provided is suitable for, and compatible with, the required installation.

2. Certification by the Air and Vapor Barrier Manufacturer that the Air and Vapor Barrier is suitable for, and compatible with, the insulation provided under Section 04 21 15 – Masonry Veneer.

3. Certification of compatibility by the Air and Vapor Barrier Manufacturer, listing all materials on the project with which the product and accessories may come into contact.

4. Certification by the Air and Vapor Barrier Manufacturer that the products supplied comply with local regulations controlling the use of volatile organic compounds (VOCs).

5. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer’s products, and contact information of the consultant firm of record, general contractor and owner.

6. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

7. Certification by the Manufacturer’s field representative that surfaces have been prepared and the products have been applied in accordance with the Manufacturer’s recommendations.

8. When requested by Engineer, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

E. Application Schedule: Furnish a detailed and complete application schedule indicating location and detail of installation.

F. Samples: When requested by Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve Contractor from compliance with the Contract Documents.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Air and Vapor Barrier shall be provided by a single Manufacturer.

B. Manufacturer Qualifications:

1. Air and Vapor Barrier Manufacturer shall have a minimum of 5 years of Air and Vapor Barrier manufacturing experience.

2. Air and Vapor Barrier Manufacturer shall have a minimum of 5 similar successful projects over the most recent 5 years, employing similar products, materials, applications, and performance requirements.

3. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications:

1. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installers without these qualifications will not be accepted.

D. Manufacturer's Technical Field Representative: The Contractor shall arrange for a Manufacturer's technical field representative to be on Site for at least 3 days, beginning at the start of surface preparation and continuing through application, to train the installers and to supervise the Work. The Manufacturer's technical field representative shall observe as necessary to certify in writing that the completed Work has been performed according to the Manufacturer's instructions.

E. Field Sample – Refer to Section 04 21 15 – Masonry Veneer for required field sample.

1.5 SPECIAL WARRANTY PROVISIONS

A. Furnish Manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

C. Warranties shall be non-prorated for the entire warranty period.

D. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Air and Vapor Barrier shall be recommended by the Manufacturer for the installation indicated.

B. Air and Vapor Barrier shall be suitable for, and compatible with, the insulation, flashing, and accessories provided under Sections 04 21 15 – Masonry Veneer.

C. Air and Vapor Barrier shall be a fluid-applied membrane with accessory products of synthetic polymer, fire retardant composition for use as an air and vapor barrier in exterior walls in accordance with the CODE.

D. Air and Vapor Barrier shall bridge and seal the following air leakage pathways and gaps:

1. Connections of the walls to the roof air barrier

2. Connections of the walls to the foundations

3. Seismic and expansion joints

4. Openings and penetrations of window frames, door frames, store front, curtain wall

5. Masonry and other envelope systems

6. Door frames, piping, conduit, duct and similar penetrations

7. Masonry ties, screws, bolts and similar penetrations

8. All other air leakage pathways through the walls

2.2 AIR AND VAPOR BARRIER

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. **Carlisle Coatings and Waterproofing, Barritech NP-LT**, including primer and accessories as recommended by Manufacturer.

B. Description:

1. Installed product and accessories shall constitute a continuous air barrier, as described in ASHRAE Standard 90.1 and the CODE.

2. Installed product and accessories shall perform as a liquid water drainage plane flashed to discharge to the exterior any incidental condensation or water penetration.

3. Installed product and accessories shall exhibit an air leakage rate, infiltration and exfiltration modes, measured after pressure cycling, not to exceed 0.2 L/s*m^2 at 75 Pa [0.040 CFM/ft^2 at 1.57 PSF] according to ASTM E 2357.

4. Exterior wall assemblies incorporating the product and accessories shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.

5. Product shall be of fire-retardant, non-asphalt synthetic polymer composition.

6. Product shall be a nominal 0.040 inch (40 mils) thickness membrane, with dry film thickness of installed product measuring a minimum of 0.030 inch (30 mils) with a comb gauge or pin gauge.

7. Additional Performance Specifications

REQUIREMENT	RESULT	TEST METHOD
Air Permeance – on Porous Substrate	Not more than 0.02 L/s*m^2 at 75 Pa (0.004 CFM/ft^2 at 1.57 PSF)	ASTM E-2178, mod sprayed on CMU
Air Permeance – Free Film	Not more than 0.02 L/s*m^2 at 75 Pa (0.004 CFM/ft^2 at 1.57 PSF)	ASTM E-2178
Low Temperature Flexibility	No cracking at minus 20 degrees F, 180 degree bend over 1 inch mandrel	ASTM D 1970
Low-Temperature Crack Bridging	No cracking after 10 cycles at minus 15 deg F	ASTM C 1305, mod 40 mil membrane thickness
Long-Term Aging/ Flexibility	No cracking or tearing after aging	ASTM C 1522, mod 40 mil membrane thickness OR CGSB 71-GP-24M
Fastener Sealability	No water leaking through nail penetration after 24 h.	ASTM D 1970
Water Resistance	Product spray-applied to CMU and gypsum sheathing with joint shall resist a 55 cm (22 inch) column of water for 5 hours, no leaking or wet through.	AATCC-127 - mod, static head generated with 5”diameter PVC pipe sealed to specimen
Pull Adhesion	Not less than 16 lb_f per square inch (or report value at substrate failure) on glass-faced gypsum sheathing and concrete masonry unit (CMU)	ASTM D 4541, modified 4 inch wood puck
Water Vapor Permeance	Not more than 1 Perm	ASTM E-96, Method B
Surface Burning Characteristics.	Flame Spread Index: Not more than 25 Smoke Generation Index: Not more than 450	ASTM E 84, sample tested at full coverage, 40 mil dry film, cement board substrate
Measurement of Heat Release Rate by Cone Calorimeter	Effective Heat of Combustion: Not more than 8.2 MJ/kg Total Heat Released: not more than 12.9 MJ/m^2 Peak Heat Release: Not more than 195 kW/m^2	ASTM E 1354, horizontal orientation, 50 kW/m^2 heat flux

C. Accessories:

1. Accessories shall be as recommended by the air and vapor barrier system manufacturer and shall be provided from same manufacturer as air and vapor barrier membrane.

2. Sheet Detail Flashing: Foil composite faced rubberized asphalt flashing, minimum 0.040 inch (40 mils) thickness.

   a. Fire-Resist 705 FR-A by Carlisle Coatings & Waterproofing, Incorporated

3. Contact Adhesive:

   a. Carlisle Coatings & Waterproofing, Incorporated: CCW-702 Solvent-Based, CCW-702 LV VOC Compliant Solvent-Based, CCW-702 WB Water-Based, CAV-GRIP™ Aerosol Spray or Travel-Tack portable aerosol spray cans

4. Liquid Detail Flashing. Silane-terminated polyether, minimum 90% solids. ASTM C 920 Type S, Grade NS, Class 25, Use NT. 0.040 inch (40 mil) thickness application

   a. Barribond

5. Detail Sealant:

   a. Barribond by Carlisle Coatings & Waterproofing, Incorporated

6. Transition Membrane:

   a. CCW SURE-SEAL Pressure-Sensitive Elastoform by Carlisle Coatings & Waterproofing, Incorporated

7. Transition Membrane Primer:

   a. Carlisle Coatings & Waterproofing, Incorporated: SURE-SEAL HP-250 Primer, SURE-SEAL EP-95 Splicing Cement or SURE-SEAL Low VOC EPDM Primer

8. Reinforcing Fabric: Woven, synthetic polymer fabric

   a. DCH Reinforcing Fabric by Carlisle Coatings & Waterproofing, Incorporated

9. Glass Mat: Randomly-oriented glass strands held in binder soluble in wet air barrier membrane. Offered in rolls of various widths

   a. LiquiFiber

10. Fill Compound: 2-part, non-sag polyurethane sealant

    a. Carlisle Coatings & Waterproofing, Incorporated: CCW-703 V or CCW-201

PART 3 -- EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.2 APPLICATION SCHEDULE

A. Air and Vapor Barrier shall be installed on the cavity side of reinforced concrete block masonry in cavity wall construction behind the cavity wall insulation, per Section 04 21 15 – Masonry Veneer.

3.3 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.4 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where Air and Vapor Barrier will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed Air and Vapor Barrier.

    a. Surfaces to receive Air and Vapor Barrier shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the Air and Vapor Barrier materials.

    b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

2. Notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.5 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the applicable references and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, form release agents, and other substances shall be removed as recommended by the Air and Vapor Barrier Manufacturer.

C. Protrusions, bumps, ridges, and loose substrate surface materials shall be removed by sanding or grinding.

D. Remove mortar droppings on brick ties, shelf angles, brick shelves or other horizontal obstructions.

E. If the surfaces cannot be made smooth to the satisfaction of the Engineer, the Contractor shall alternatively apply a parge coat (typically one part cement to three parts sand) – to the satisfaction of the Air and Vapor Barrier Manufacturer - over the entire surface to receive Air Barrier Membrane

1. Parge coat and patching compounds shall be used per Air and Vapor Barrier Manufacturer's written instructions to fill cracks, holes, and depressions.

F. Fill cracks, gaps and joints with fill compound, detail sealant or other material approved by the Air and Vapor Barrier Manufacturer.

G. Fill rough gaps around pipe, conduit and similar penetrations with mortar, non-shrink grout, fill compound or polyurethane foam sealant shaved flush.

H. Apply a ¾ inch of fill compound or detail sealant at the intersection of the base of the wall and the footing.

I. Immediately before application of Air and Vapor Barrier materials, scrape surfaces to be covered free from foreign materials and brush clean.

J. Substrate shall be swept to remove all loose materials prior to beginning Air and Vapor Barrier installation.

3.6 DETAILING

A. Penetrations, junctures, terminations, and joints shall be sealed and flashed in accordance with the Air and Vapor Barrier Manufacturer's details and requirements.

3.7 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

1. Do not begin Air and Vapor Barrier until penetrations have been installed so that Air and Vapor Barrier will not be penetrated or damaged by subsequent Work.

2. Do not begin Air and Vapor Barrier before plumbing, electrical, mechanical, and structural items under or passing through Air and Vapor Barrier have been secured in proper positions and appropriately sealed and protected.

3.8 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Particular care shall be given to the application of Air and Vapor Barrier at construction joints.

C. Primer, if recommended by the Manufacturer for the application, shall be applied per the Manufacturer's recommended procedures.

D. Apply product by spray, roller, brush or other method as recommended in writing by the Air and Vapor Barrier Manufacturer. Apply product at thickness in accordance with Air and Vapor Barrier Manufacturer's written requirements.

E. Verify compliance with air barrier manufacturer's minimum required thickness by documenting product use per area. Perform and document wet mil thickness measurements every 100 square feet, or more frequently if required, to establish uniform and adequate coverage.

F. Installation shall produce complete coverage of the CMU back-up surface.

G. Product and accessories shall be fully-adhered to substrates. Defects such as holes, fishmouths, blistering, de-lamination, bridging or thin spots shall be repaired according to air barrier manufacturer's instructions.

H. Install cavity wall insulation in Section 04 21 15 – Masonry Veneer, against Air and Vapor Barrier.

3.9 CLEANING, FINISHING, AND PROTECTION

A. Air and Vapor Barrier shall be protected from damage from subsequent construction operations.

B. The Contractor shall make adjustments required until accepted.

C. Damaged or defective items shall be removed and replaced as determined by the Engineer.

D. When Air and Vapor Barrier Work is completed, remove unused materials, containers, and equipment, and clean the Site of Air and Vapor Barrier debris.

END OF SECTION

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SECTION 07 54 19 – SINGLE-PLY MEMBRANE ROOFING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide single-ply membrane roofing, and appurtenant Work, complete and in place, in accordance with the Contract Documents.

B. The Contractor shall furnish professional design and engineering services as required for Single-Ply Membrane Roofing.

1. Professional design and engineering services may be provided by the Manufacturer or by an independent licensed structural engineer retained by the Contractor, either of which shall comply with the requirements indicated.

C. The Contractor shall coordinate color samples with other Sections through the submittal process.

1.2 REFERENCES

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. American Architectural Manufacturer's Association (AAMA)

AAMA 2605	Voluntary Specification, Performance Requirements, and Testing Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

C. American Society for Testing and Materials (ASTM)

ASTM C 165	Standard Test Method for Measuring Compressive Properties of Thermal Insulation
ASTM C 209	Standard Test Methods for Cellulosic Fiber Insulating Board
ASTM C 518	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM D 297	Standard Test Method for Rubber Products - Chemical Analysis
ASTM D 412	Standard Test Method for Vulcanized Rubber and Thermoplastic Rubber and Thermoplastic Elastomers
ASTM D 471	Test Method for Rubber Properties, Effect of Liquids
ASTM D 573	Standard Test Method for Rubber Deterioration in an Air Oven
ASTM D 624	Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

ASTM D 746	Standard Test Method for Brittleness Temperature of Plastic and Elastomers by Impact
ASTM D 751	(Grab Method) Method of Testing Coated Fabrics
ASTM D 816	Standard Test Method for Rubber Cements
ASTM D 1079	Standard Terminology Relating to Roofing, Waterproofing, and Bituminous Materials
ASTM D 1149	Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber
ASTM 1204	Test Method for Linear Dimensional Changes on a Non-Rigid Thermoplastic Sheeting or Film at Elevated Temperatures
ASTM D 1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D 1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D 2126	Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D 2137	Standard Test Methods for Rubber Property-Brittleness Point of Flexible Polymers and Coated Fabrics
ASTM D 2240	Standard Test Method for Rubber Property-Durometer Hardness
ASTM D 4637	Standard Specification for EPDM Sheet used in Single Ply Roof Membrane
ASTM D 4811	Standard Specification for Non-Vulcanized Rubber Sheet used as Roof Flashing
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96	Standard Test Methods for Water Vapor Transmission of Materials

D. Building Code: Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referenced herein as “the Code.”

E. Factory Mutual (FM)

1. FM 1-90 SH (Severe Hail)

2. FM 4470

F. Federal Specification (FS)

1. FS HH-I-1972/Gen

2. FS HH-I-1973/3

G. ICC 500-2008:ICC/NSSA Standard for the Design and Construction of Storm Shelters

1. Refer to Structural Design Criteria Sheet GS-0001 for more information.

H. National Roofing Contractor's Association (NRCA)

1. National Roofing and Waterproofing Manual

I. Sheet Metal and Air Conditioning Manufacturers National Association (SMACNA)

1. Architectural Sheet Metal Manual (ASMM)

J. Underwriters Laboratories (UL)

1. UL 1256 Fire Test of Roof Deck Constructions

2. Class A Fire Classification

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Literature: Manufacturer's specifications, technical data, installation methods, maintenance instructions, and the following:

1. Manufacturer's full-range color charts, indicating custom color availability, for color selection by the Engineer.

C. Warranty: Submit a copy of the warranty.

D. Certifications

1. Certification of compliance with the requirements of paragraph 2.1.A.

2. Certification from the roofing manufacturer that the single-ply membrane roofing is suitable for, and compatible with, the required installation.

3. Certification from the roofing manufacturer that the single-ply membrane roofing is suitable for, and compatible with, the required flashing and metal work, insulation, and accessories.

4. Certification of manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, manufacturer's products, and contact information of the consultant firm of record, general contractor, and owner.

5. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor, and owner.

6. Certification from the manufacturer that the installer is trained, certified, and authorized by the single-ply roofing manufacturer to install the manufacturer's systems.

7. Certification of the manufacturer's pre-installation notice that has been accepted and approved by the manufacturer.

8. Certification from a recognized and authorized testing agency that the Single-Ply Membrane Roofing system for the OSB and RRR buildings meet the requirements of ICC 500-2008.

9. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

E. Shop Drawings and Calculations: Complete Shop Drawings showing location and detail of installation, and design calculations.

1. Shop Drawings and Calculations shall be prepared, approved, and stamped by a professional structural engineer licensed per local engineering laws.

2. Shop Drawings shall be drawn to sufficient scale, showing fully-dimensioned layout, including plans, sections, elevations, and details of single-ply membrane roofing, connections to the primary structure, insulation, joints, penetration details, preformed closures, flashing, trim, fastenings, system caulking sealants, gaskets, appurtenances, special project specific conditions, and relationship to adjacent materials.

   a. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories of the single-ply membrane roofing system.

   b. Design and detail penetrations, including hot pipe penetrations, to be weathertight. Coordinate locations of penetrations.

3. Include installation drawings with written procedures to clearly explain proper installation of fasteners, trim, gaskets and sealants. Installation drawings shall also include notation requiring the installer to coordinate with other trades.

4. Manufacturer shall review and provide comments on the Shop Drawings and calculations prior to submittal.

F. Samples: The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by The Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1. Six inch square sample of single-ply membrane roofing.

2. Six inch long sample of flashing and metal work.

3. Six inch square sample of insulation.

4. Representative sample of special joints, boots, fittings.

5. Samples of each type fastener required, identified as to use.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility

1. Single-ply membrane roofing, insulation, and acrylic coating shall be provided by a single manufacturer.

2. Flashing and metal work shall be provided by a single manufacturer.

B. Manufacturer Qualifications

1. Single-ply membrane roofing manufacturer shall have a minimum of 20 years of single-ply membrane roofing manufacturing experience.

2. Single-ply membrane roofing manufacturer shall have a minimum of 10 years experience specializing in the manufacturing of the roofing membrane specified.

3. Single-ply membrane roofing manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

4. System supplier shall have ISO 9002 certification.

5. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications

1. Installer shall have a minimum of 5 years experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installer shall be trained, certified, and authorized by the single-ply membrane manufacturer to install the manufacturer’s product.

3. Installers without these qualifications will not be accepted.

D. A professional structural engineer licensed per local engineering laws shall design the Single-Ply Membrane system and connections to the structure.

E. Performance Tests

1. Single-ply membrane roofing performance tests shall be conducted by, or witnessed by, a recognized independent laboratory or independent professional engineer. Test results shall be certified by the independent laboratory or by the independent professional engineer who conducted or witnessed the tests.

2. The single-ply membrane roofing, flashing and metal work, insulation, and accessories shall be designed, engineered, fabricated and installed in accordance with applicable UL and FM classifications, the Code, and ICC 500-2008.

F. Manufacturer's Technical Field Representative

1. The Contractor shall arrange for a manufacturer's technical field representative to be on Site for at least 3 days, beginning upon the Pre-Roofing Conference and continuing through installation, to provide instruction to the authorized installer and to supervise the Work. The manufacturer's technical field representative shall observe as necessary to certify in writing that the completed Work has been performed according to the manufacturer's instructions.

2. The Contractor shall provide for such service and inspection from the manufacturer as required in order to provide the warranted roofing system.

3. The Contractor shall complete any necessary repairs to the satisfaction of the roofing system manufacturer and of the Engineer as required for issuance of the warranty.

G. Pre-Roofing Conference

1. Well in advance of commencement of roofing operations, but after representative roofing substrate has been constructed and prepared for roofing, a pre-roofing conference shall be held to inspect the substrate and related work affecting the roofing work at the time it is proposed to be ready to receive insulation, roofing, and flashing. All parties having an interest in the roofing or work in the roofs shall be informed of the conference by the Contractor and shall be required to attend.

2. Parties to the conference shall include the following: Owner, Engineer, Contractor, roofing subcontractor and his/her foreman, roofing materials manufacturer representative, plumbing and heating and ventilating subcontractors, and a representative of any other trade classification having worked on a roof and deemed by the Engineer as necessary to attend.

3. The conference shall include an inspection by all parties of the substrate and its conformance with the Contract Drawings, the approved shop drawings, and the approved roofing manufacturer's specifications and written instructions. All objections to approval of the substrate shall be forwarded to the Engineer in writing. The Contractor shall coordinate efforts to remedy objections and prepare the substrate properly to receive the roofing and flashing so that the warranty may be issued. Work of this Section shall commence after remedies are made.

4. When substrate is acceptable to receive roofing materials, the roofing subcontractor shall sign a statement to this effect before roofing can commence.

1.5 SPECIAL WARRANTY PROVISIONS

A. Furnish manufacturer's 30-year written warranty to cover defects in materials, products, and manufacturing workmanship equal to **Elevate Red Shield Platinum**.

1. The warranty shall be single-source manufacturer's total systems, edge-to-edge, no dollar limit, non-prorated, written warranty on the roofing, insulation, flashing and metal work.

2. The warranty shall provide for repairs and/or replacement of roofing, insulation, flashing and metal work due to faulty materials supplied by the manufacturer and/or faulty workmanship.

3. Any clause referring to gale force wind, or wind speed less than the wind speed indicated, is not acceptable and will be rejected.

4. The warranty shall cover hail damage caused by hail of up to 2-in diameter and shall cover wind damage caused by forces from wind speeds of 110 miles per hour minimum (see additional requirements indicated). Note: the warranty requirements indicated shall not supersede more stringent criteria indicated herein.

B. Furnish manufacturer's 10-year written warranty to cover the acrylic coating against fading, chalking, peeling, flaking, crazing, or other similar failures.

C. The warranties shall be signed by the roofing materials manufacturer and notarized.

D. In the event the roof fails to perform as intended and as indicated, the warrantor shall provide the necessary labor and materials to make, at his/her expense and conforming to the Owner's schedule, repairs to the roof to enable it to perform as intended and as indicated.

E. Warranties shall be non-prorated for the entire warranty period.

F. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Structural Requirements

1. Single-ply membrane roofing including flashing and metal work, insulation, and accessories, related assemblies, components, appurtenances, and attachment details, shall comply with the Code and designed, engineered, manufactured, tested, and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

2. Typical Roofs: shall conform with the following:

a. Ultimate Wind Speed: 109 MPH

b. Nominal Wind Speed 85 MPH

c. Risk Category III

d. Wind Importance Factor 1.0

e. Exposure Category C

f. Internal Pressure Coefficient +/- 0.18

g. Refer to Structural Design Criteria Sheet S-001 for more information.

3. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

4. Single-ply membrane roofing including flashing and metal work, insulation, and accessories, shall be manufactured and installed to maintain the specified performance requirements, under the structural design criteria indicated, without defects, damage, or failure.

B. Single-ply membrane roofing system shall comply with FM 1-120 SH, UL Class A.

C. Single-ply membrane roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products

D. Single-ply membrane roofing system shall consist of 0.090 LSFR elastomeric sheet roofing adhered to coverboard substrate with manufacturer’s bonding adhesive. Coverboard shall be engineered composite board consisting of polyisocyanurate insulation and oriented strand board (OSB).

1. Insulation shall be secured to structural deck with manufacturer’s approved adhesive.

2. Membrane shall be fully adhered to coverboard.

3. Membrane shall be coated with manufacturer's approved acrylic coating.

E. Or-Equals: To establish equality under the General Conditions, the Contractor shall furnish satisfactory documentation from the manufacturer of the proposed "Or-Equal" product demonstrating that the product meets the indicated requirements. Submit:

1. A complete description of the “Or-Equal” including details referenced to the single-ply membrane roofing conditions on the Contract Drawings.

2. Independent test reports verifying compliance with specified performance requirements.

3. Calculations certified by a professional engineer registered in the State of Colorado, verifying that the proposed “Or-Equal” meets the required criteria.

4. A detailed listing of each specification item with which the “Or-Equal” does not fully comply.

2.2 SINGLE-PLY MEMBRANE ROOFING AND FLASHING MEMBRANE

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and products listed below, or equal, and conforming with the specified requirements for selection by the Engineer.

a. Elevate; RubberGard Platinum 90-mil EPDM Single-Ply Membrane System; Standard black color with Elevate Acrylitop PC-100 white coating specified in this Section.

b. Elevate; RubberGard Platinum ECOWHITE 90-mil EPDM Single-Ply Membrane System; Standard white color; if this product is selected, the Elevate Acrylitop PC-100 is NOT REQUIRED.

B. Description

1. 0.90 LSFR, Non-reinforced, cured, synthetic single-ply membrane composed of Ethylene Propylene Diene Termolymer (EPDM).

2. Reference Standards: ASTM D 4637-96, ASTM D 297, ASTM D 412, Die C, ASTM D 471, ASTM D 573, ASTM D 624, Die C, ASTM D 746, ASTM D 751, ASTM D 816, ASTM D 1149, ASTM D 2240, ASTM E 96.

3. Physical Properties and Performance Characteristics:

Specific Gravity	1.15 +/- 0.05
Tensile Strength, Minimum, psi (Mpa)	1425 (9.8)
Elongation, Minimum, %	450
Tear Resistance, lbf / in (N / M)	200 (933)
Ozone Resistance, 166 hours @ 100 pphm @ 104ºF with 50% extension	No Cracks
Heat Aging, 28 days @ 240ºF Tensile Strength, Minimum psi (Mpa) Elongation, Minimum %	 1415 (9.7) 290
Brittleness Point, max., ºF, (ºC)	-49 (-45)
Water Absorption, change in weight after immersion in water for 166 hours @ 158ºF, %	+1.8
Tolerance On Nominal Thickness, %	+/- 10

4. Single-Ply Roofing System Components

a. All roofing system components shall be as recommended and approved by the roofing system manufacturer to meet the warranty and performance criteria indicated.

b. Roof Flashing - Semi-cured 45 mil EPDM membrane laminated to 35 mil EPDM tape adhesive.

c. Elastomeric Uncured Flashing – 0.90 non-reinforced, self curing, synthetic, single-ply flashing composed of EPDM conforming to the following physical properties as indicated by ASTM D 4811-90.

1) Reference Standards: ASTM D 412, ASTM D 471, ASTM D 573, ASTM D 624, ASTM D 1149, ASTM D 1204, ASTM D 2137, ASTM D 4811-90.

d. Lap Splice Tape - 35 mil EPDM-based, formulated for compatibility with EPDM membrane and high-solids primer.

e. Adhesive Primer - High-solids, butyl based primer formulated for compatibility with EPDM membrane and tape adhesive.

f. Batten Covers - Cured 60 mil EPDM membrane laminated to 35 mil EPDM tape adhesive.

g. Splice Adhesive - Butyl-based, formulated for compatibility with EPDM membrane.

h. Bonding Adhesive - Neoprene-based, formulated for compatibility with EPDM membrane and a wide variety of substrate materials, including masonry, wood, and insulation facings.

i. Pourable Sealer - 2-part urethane, 2-color for reliable mixing.

j. Seam Plates, Batten Strips, and Insulation Plates - Steel with a Galvalume® coating. Corrosion-resistant to meet FM-4470 criteria.

k. Termination Bar - 1.3-in x 0.10-in thick aluminum bar with integral caulk ledge.

l. Roof Walkway Pads - EPDM Walkway Pads, 0.30-in x 24-in x 24-in with EPDM tape adhesive strips laminated to the bottom.

2.3 INSULATION PRODUCTS

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. Elevate HailGard

B. Description

1. Polyisocyanurate insulation shall be approved by the roofing membrane manufacturer for the specified warranty with a total insulation system average R-value = 30 per LTTR test method and meeting the additional requirements specified.

a. Polyisocyanurate insulation shall comply with both FM 4450 and UL 1256.

2. The insulation system shall be installed in more than one layer as required and installed with staggered joints between the layers.

a. Top Layer - Polyisocyanurate Roof Insulation with Laminated Coverboard

1) Coverboard: 7/16-in OSB laminated on the face of a closed cell polyisocyanurate foam core and a perforated black glass reinforced mat laminated to the back.

2) Nominal Thickness: As required to achieve the specified R-value, in combination with base layer (as required), and to meet the performance and warranty requirements indicated.

3) Nominal Size: 48-in x 96-in

4) Reference Standards: FS HH-I-1972/Gen, FS HH-I-1973/3, ASTM C 209, ASTM E 96, ASTM D 1621, ASTM D 1622, ASTM D 2126.

5) Performance Characteristics:

Density (ASTM D 1622)	2 pcf nominal
Compressive Strength (ASTM D 1621)	20 psi minimum (not including coverboard)
Water Vapor Transmission (ASTM E 96)	<1 perm
Water Absorption(ASTM C 209)	<1% by volume
Thermal Resistance (LTTR)	4-in = 22.3* minimum R-value (aged at 75 degrees F)
Thermal Barrier (The Code)	Not required
Service Temperature	-100 degrees F to 250 degrees F

*Note: This is a per unit R-value performance characteristic specific to the top layer of insulation only; see 2.3.B above for total system R-value required.

b. Base Layer - Polyisocyanurate Roof Insulation

1) Roof insulation consisting of closed cell polyisocyanurate foam core and a perforated black glass reinforced mat laminated to the face.

2) Provide tapered insulation as required for crickets, counterslopes, and etc.

3) Nominal Thickness: As required to achieve the specified R-value, in combination with top layer (as required), and to meet the performance and warranty requirements indicated.

4) Nominal Size: 48-in x 96-in.

5) Reference Standards: FS HH-I-1972/Gen, FS HH-I-1973/3, ASTM C 209, ASTM E 96, ASTM D 1621, ASTM D 1622, ASTM D 2126.

6) Performance Characteristics

Density (ASTM D 1622)	2 pcf nominal
Compressive Strength (ASTM D 1621)	20 psi minimum
Water Vapor Transmission (ASTM E 96)	<1 perm
Water Absorption(ASTM C 209)	<1% by volume
Thermal Resistance (LTTR)	4-in = 25.0* minimum R-value (aged at 75 degrees F)
Thermal Barrier (The Code)	Not required
Service Temperature	-100 degrees F to 250 degrees F

*Note: This is a per unit R-value performance characteristic specific to the base layer of insulation only; see 2.3.B above for total system R-value required

3. Insulation Adhesive

a. Manufacturer's approved adhesive suitable for bonding insulation to the structural deck indicated, and meeting the requirements indicated.

2.4 VAPOR BARRIER

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. Elevate V-Force Vapor Barrier Membrane

B. Description

1. Manufacturer's approved vapor barrier, compatible with structural substrate and roofing insulation.

2. Vapor barrier installed in roofing assemblies shall be 10-mil polyethylene sheet, with a vapor transmission rating less than 1.0 perms per ASTM E96, Test Method A.

3. All substrates shall be primed with **Elevate V-Force Primer**, or equal prior to vapor barrier installation.

2.5 ACRYLIC COATING

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. Elevate Acrylitop PC-100

B. Description

1. Manufacturer's approved acrylic coating, compatible with membrane and appurtenances.

2. Aesthetic acrylic roof coating installed over the membrane in combination with a membrane cleaner.

3. Color shall be selected and approved by the Engineer from manufacturer's full color range including custom colors, and may be required to exactly match other building components, as determined by the Engineer.

a. Tentative color selection: Colors shall exactly match colors indicated below, as selected and approved by the Engineer.

1) Color: White.

b. The Engineer reserves the option of changing this tentative color selection during the submittal process.

2.6 METAL EDGE, GUTTERS, DOWNSPOUTS, REGLET AND FLASHING SYSTEM

A. Metal Edge, Gutters, and Downspouts shall be as manufactured by **Metal ERA, Inc**., or equal.

1. Metal Edge, Gutters, and Downspouts shall be 0.063-in aluminum with allowance for expansion and contraction.

2. Provide assembly with factory fabricated mitered corners, mechanical fasteners, and other system appurtenances.

3. System shall carry a minimum FM Class I-90 approval.

B. Reglet and Flashing System

1. Reglet and Flashing System shall be 0.063-in aluminum spring lock flashing as indicated, with masonry reglet by **Metal ERA, Inc.**, **Fry Reglet**, or equal.

2. Provide with allowance for expansion and contraction, prefabricated weathertight flashing corners and other system appurtenances. Caulk in place with lead wool or wedges.

3. System shall carry a minimum FM Class I-90 approval.

C. Finish and Color

1. Finish system shall be 2.0-mil, PVF2 Kynar 500, formulated by a licensed formulator to contain 70 percent PVF resin and applied by a licensed applicator.

    a. Epoxy prime coat shall be applied to exposed sides to a dry film thickness of approximately 0.2-mil. One coat of PVF color coating shall be applied to exposed sides to provide a dry film thickness of not less than 0.8-mil, for a total of 1.0-mil total coating.

    b. The surface condition of this finish coat shall be 100 percent free of holidays, drip marks, scratches, roll marks, or abrasions that are visible from a distance of 5-feet in good light when in installed position. Surfaces shall be free of checking, crazing, peeling, or loss of adhesion.

    c. Finish shall meet or exceed AAMA 2605.

    d. Color shall be selected and approved by the Engineer from manufacturer's full color range including custom colors, and may be required to exactly match other building components, as determined by the Engineer.

        1) Tentative color selection: Colors shall exactly match colors indicated below, as selected and approved by the Engineer.

            a) Color: To Be Selected by the Engineer.

        2) Color shall be uniform with no variation in shade, and accessories of different color batches will not be acceptable.

        3) The Engineer reserves the option of changing this tentative color selection during the submittal process.

2.7 FABRICATION

A. The Contractor shall field verify size, location, and placement of single-ply membrane roofing, insulation, and appurtenances, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

PART 3 -- EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

    1. Materials shall be delivered to Site in a dry and undamaged condition and unloaded per the manufacturer's instructions. The installer shall inspect materials for damage and stains upon arrival to the Site.

B. Store materials carefully in accordance with the manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

1. Materials shall be stored out of contact with the ground in weathertight coverings to keep them dry per the manufacturer's recommendations. Storage accommodations shall provide good air circulation and protection from surface staining.

C. Handle materials in strict accordance with manufacturer's written instructions.

3.2 PROJECT CONDITIONS

A. Comply with manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.3 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. The Contractor shall inspect materials for damage and shall confirm conformance with these Specifications, erection drawings, and Shop Drawings prior to installation.

C. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

D. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where single-ply membrane roofing, insulation, flashing and metal work, and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed single-ply membrane roofing, insulation, flashing and metal work, and appurtenances.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other work for the installation of single-ply membrane roofing, insulation, flashing and metal work, and appurtenances. Coordinate delivery with other work to avoid delay.

b. Roofing base materials shall be dry throughout, clean, and free from depressions or projections.

c. Roof deck shall be dry, clean, and free from oily substances. Immediately before the application of insulation, thoroughly clean the surfaces to remove loose particles.

d. Examine roof deck to determine that it is sufficiently rigid to support roofers and their mechanical equipment and that deflection will not strain or rupture roof components or deform deck.

e. Verify that surfaces and site conditions are ready to receive work. Correct defects in the substrate before commencing with roofing work.

f. Examine roof substrate to verify that it is properly sloped to drains.

g. Fumes from adhesive solvents may be drawn into the building during installation through rooftop intakes. Appropriate measures must be taken to assure that fumes from adhesive solvents are not drawn into the building through air intakes.

h. The surface must be clean, dry, smooth, free of sharp edges, fins, loose or foreign materials, oil, grease, and other materials that may damage the membrane. All roughened surfaces, which could cause damage, shall be properly repaired before proceeding.

i. All surface voids of the immediate substrate greater than 1/4-in wide must be properly filled with an acceptable insulation or suitable fill material.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate the Contractor's acceptance of the substrate, areas, and conditions.

3.4 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

1. Protect metal, glass, plastic, and painted surfaces from adhesives and sealants.

2. Protect neighboring work, property, cars, and persons from spills and overspray from adhesives, sealants, and coatings and from damage related to roofing work.

3. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trade.

B. Notify the Engineer at least 48 hours before application of roofing commences. A representative of the roofing manufacturer shall be present while roofing is being applied to assure conformance with the Contract Documents and good workmanship requirements.

C. All surfaces shall be complete, with wood nailers, curbs, drains, hatches, and ready to receive finished roofing system, prior to the installation of products indicated herein.

D. Water cutoffs shall be made by extending the insulation and setting the end of the membrane in 6-in of plastic roofing cement. All temporary water cutoffs shall be removed prior to proceeding with the next work period by cutting off that portion of the membrane that has been in contact with plastic roofing cement, and disposing of it.

E. Wood Nailer Installation

1. Total wood nailer height shall match the total thickness of insulation being used and shall be installed with a 1/8-in gap between each length and at each change of direction.

2. Wood nailers shall be firmly fastened to the deck. Fasten wood nailers to resist a force of 200-lb/linear ft, and/or more stringent requirements indicated.

3.5 INSTALLATION

A. General

1. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, FM, NRCA, SMACNA, and with manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

2. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

3. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

4. Manufacturer shall provide detailed instructions covering the tools, fasteners, sealants, gaskets, and procedures required to assure performance of the single-ply membrane roofing assembly.

5. Work shall be coordinated as required to insure proper flashing and seals to adjoining construction.

6. Install vapor barrier with continuous and overlapping coverage over structural deck; overlap vapor barrier sheets by 6-inch minimum laps. Seal joints and penetrations with compatible vapor barrier tape. Then install roof insulation with continuous coverage over vapor barrier.

7. Insulation Installation

a. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.

b. Seal deck joints, where needed, to prevent bitumen drippage.

c. Lay roof insulation in courses parallel to roof edges.

d. Neatly fit insulation to all penetrations, projections, and nailers. Insulation shall be fit tightly, with gaps not greater than 1/4-in. All gaps greater than 1/4-in shall be filled with acceptable insulation. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 1/4-in. Tapered insulation shall be installed around roof drains so as to provide proper slope for drainage. Miter roof insulation edges at ridge, valley, and other similar non-planar conditions.

e. When installing multiple layers of insulation, all joints between layers shall be staggered at least 6-in.

f. Secure insulation into deck as determined and required by the roofing system manufacturer to meet the warranty and performance requirements indicated or required.

8. Roof Membrane Installation

a. The timing of roofing operations, with respect to adverse weather conditions, shall be subject to the approval of the Engineer. No roofing operations shall be started until surfaces to receive the same have been inspected and accepted as to quality and condition.

b. Good roofing practices shall be observed at all times subject to the approval of the Engineer.

c. Adhere membrane 100 percent to the properly prepared substrate with system adhesive applied at approved rate.

d. Overlap adjacent membrane sheets 6-in minimum, clean with system cleaner and apply system splicing cement at approved rate. While cement is drying (before lapping), apply a bead of system in-seam sealant in approved configuration and where required. Lap and splice the sheets. When set, clean edge, apply system lap sealant, and feather to completely cover splice edge.

e. Provide additional securement for membrane at perimeter, at roof openings, at vertical walls, and other protrusions using adhesives and fasteners as required to meet wind load requirements.

f. Use roof membrane material for high vertical conditions and specified EPDM flashing for required base flashing with the system uncured EPDM flashing at inside and outside corners and where required or ordered. Adhere with system adhesive all as required so warranty may be issued. Terminate base flashings to membrane with system termination details as approved.

g. Provide 6-in wide cover strips of the specified, pressure sensitive flashing, centered and fully adhered over all joints in membrane and flashing.

9. Flashing Installation - Penetrations

a. Flash all penetrations passing through the membrane.

b. The flashing seal must be made directly to the penetration.

c. Pipes, Round Supports, and similar - Flash with Pre-Molded EPDM Pipe Flashings.

d. Structural Steel Tubing - Use a field fabricated pipe-flashing detail provided that the minimum corner radius is greater than 1/4-in and the longest side of the tube does not exceed 12-in. When the tube exceeds 12-in use a standard curb detail.

e. PIPE CLUSTERS AND UNUSUAL SHAPED PENETRATIONS - Fabricate penetration pockets to allow a minimum clearance of 1-in between the

penetration and all sides. Secure penetration pockets per manufacturer's printed details. Fill penetration pockets with pourable sealer, so as to shed water. Pourable sealer shall be a minimum of 2-in deep.

f. Hot Pipes - Protect the rubber components from direct contact with steam or heat sources when the in-service temperature is in excess of 180 degrees F. In all such cases flash to an intermediate insulated "cool" sleeve per manufacturer's printed details.

g. Flexible Penetrations - Provide a weathertight gooseneck set in manufacturer's recommended seal and secured to the deck. Flash in accordance with manufacturer's printed details.

h. Scuppers - Set welded watertight scupper in manufacturer's recommended seal and secure to the structure. Flash in accordance with manufacturer's printed details.

i. Expansion Joints - Install as indicated in accordance with manufacturer's details.

10. Metal Edge, Gutters, Downspouts, Reglet and Flashing Installation

a. If metal work cannot be done when roofing requiring flashing is completed, provide temporary flashing or protection as required and ordered to prevent weather entry.

b. Install Metal Edge, Gutters, Downspouts, Reglet and Flashing system watertight with system fasteners, all as required to meet windload requirements indicated.

c. Coordinate the installation of the scuppers built into the masonry or concrete to ensure proper elevation for drainage and proper locations.

d. Install pipe flashings and accessories for positive anchorage to building and weathertight mounting.

e. Surfaces to be covered with metal shall be free from defects of every description and clean of dirt and other foreign matter before sheet metal work is started.

f. Provide flashings as indicated and in all locations where the use of flashing may reasonably be inferred as necessary to make the work of this Section complete in its intent to provide leakproof conditions throughout.

g. Seams, unless otherwise indicated, shall be flat locked and soldered. Tinning and soldering shall be done slowly with well-heated metal. Pre-tin all metal in areas to be soldered. When soldering, ample solder shall be used so that the seam shall show at least 1-in of evenly flowed solder. A liberal amount of flux shall be brushed into the seam.

h. Provide fabricated inside and outside corner pieces, soldered watertight. Screw fasten where shown and required with compatible screws and washers, color matched, with washers backed with 60 durometer neoprene.

i. Fabricate and install flashing in accordance with practices of ASMM of SMACNA.

j. Metal work when completed shall be thoroughly cleaned. Excess flux shall be neutralized by washing with a 5 to 10 percent solution of washing soda. After cleaning, metal shall be flushed with clean water.

11. Roof Walkway Installation

a. Install roof walkway pads at all access points to the roof and around all rooftop equipment in accordance with manufacturer's written instructions.

b. Adhere roof walkway pad material to the completed membrane in areas and traffic pattern indicated, following the system methods and allowing space between for drainage.

c. Where walkway pads are not indicated, adhere roof walkway pad material where directed by the Engineer.

12. Acrylic Coating Installation

a. Remove all debris from the roof surface as required. Clean the completed membrane in accordance with manufacturer's written instructions.

b. Install coating over the cleaned membrane with either a roller or sprayer in accordance with manufacturer's written instructions.

3.6 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, single-ply membrane roofing and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the manufacturer's written instructions.

C. The Contractor shall make adjustments required until accepted.

D. Single-ply membrane roofing and appurtenances shall be protected from damage from subsequent construction operations.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When single-ply membrane roofing Work is completed, remove unused materials, containers, and equipment, and clean the Site of single-ply membrane roofing debris.

3.7 ROOF MEMBRANE SPRAY TESTING

A. All roof areas shall be given a 24-hour watertightness test using an approved sprinkler system to completely wet roofing and flashing. Repairs if required shall be performed as directed by the Engineer.

3.8 FINAL ROOF INSPECTION

A. The Contractor shall arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to the Engineer. Notify the Engineer 48 hours in advance of date and time of inspection.

B. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements and warranty requirements.

C. Additional testing and inspecting, at the Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION

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SECTION 07 60 00 - FLASHING AND SHEET METAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide sheet metal and appurtenant Work, complete and in place, in accordance with the Contract Documents.

B. The principal items of sheet metal Work shall include sheet metal flashings, collars, pitch pockets (pans), equipment platforms, equipment (sleeper) supports at all roof penetrations which are not provided as part of the roofing system, and all other components necessary to make building weathertight.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: Manufacturer's specifications, literature, and published installation instructions, and maintenance instructions for all sheet metal products.

C. Shop Drawings: Show materials, gauges, finishes, layout, jointing, sizes, profiles, fabrication of special shapes, fasteners, and method of attachment to adjacent construction.

D. Samples: Color and other samples, where required for color selections and/or review by the Engineer.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Sheet metal shall be type 304 stainless steel, unless otherwise indicated. Sheet metal Work in connection with roofing shall be in accordance with roofing manufacturer's published specifications.

B. Material thickness shall be not less than thickness indicated. Where thicknesses are not indicated, the thickness shall be not less than that required by referenced standards found in Architectural Sheet Metal Manual (ASMM).

2.2 FASTENERS

A. Fastening devices shall be of the same material as the sheet metal being used or corrosion-resistant metal compatible with sheet metal being used. Fasteners exposed to the weather shall have neoprene washers of 0.04-in minimum thickness. A rubber-type washer shall be used beneath the aluminum washer or fastener head where weathertightness is required.

2.3 PLASTIC CEMENT

A. Plastic cement shall conform to ASTM D 2822 - Asphalt Roof Cement.

2.4 SEALING MATERIALS

A. Sealants shall be in accordance with Section 07 92 13 – Elastomeric Joint Sealants or shall be of the silicone type. Colors shall be selected by the Engineer from manufacturer's full range of standard colors.

B. Sealer tape shall be polyisobutylene sealer tape specifically formulated for setting flanges on bituminous roofing.

2.5 COATING MATERIALS

A. Asphaltic coating compound shall conform to ASTM D 1187 - Asphalt-Base Emulsions for Use as Protective Coatings for Metal.

2.6 SHOP FABRICATION REQUIREMENTS FOR DOWNSPOUTS AND COPING

A. Downspouts shall be of sizes indicated with wire basket type strainers of 14-gauge stainless steel wire or cast bronze.

B. All aluminum shall be welded where indicated. Welding shall conform to Reference Standards.

C. Elongated holes shall be provided where necessary for material expansion and where indicated in Reference Standards.

D. All Work and finishes shall be protected from scratches and abrasions.

E. Flashing, reglets and counter-flashing and associated flashing shall be fabricated by the same manufacturer (Hohmann & Barnard,Inc. or equal) and be installed as a complete flashing system. Flashing shall be creased longitudinally or otherwise formed with sufficient spring action to hold bottom edges firmly against base flashing or similar material.

F. Intersecting corners of copings shall be accurately fitted and welded. Corners may be shop-assembled, manufactured, or extruded units. Coping shall be per "Architectural Sheet Metal Manual" (ASMM; 5th ed. Chantilly, VA: Sheet Metal and Air Conditioning Contractors National Association (SMACNA), 1993), Figure 3-1, except modified as indicated, with Figure 3-2, Alternate 5 seams that allow for 1/4-inch expansion per each 10-ft of length. Coping shall be by Metal-Era or equal.

2.7 FABRICATED SHEET METAL WORK

A. Scuppers in walls shall be constructed of 0.040-inch aluminum similar to design shown on ASMM Figure 1-26 with all joints welded.

B. Downspouts with conductor head 1/2-inch below scupper and hangers shall be designed similar to design shown on ASMM Figures 1-32, 1-25, 1-35B, or 1-35D. Downspout and conductor head shall be constructed of 1/16-inch aluminum and shall have all joints welded except joint between head outlet pipe and downspout. Connectors shall be per Figure 1-33B, details 1 and 2, with funnel, Figure E (if possible), and with joint between gutter and outlet welded.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Materials shall be delivered to Site in manufacturer's original, unopened packages or bundles with labels intact and clearly identifying products.

B. Storage: All materials shall be carefully stored in accordance with the manufacturer's instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

3.2 GENERAL

A. The Contractor shall coordinate the flashing necessary with the different trades to make sure all items which penetrate the roof are provided with all necessary sheet metal items and Work, such as pipes, ducts, support racks, equipment platforms or sleepers, and supports. Sheet metal shop manufactured curbs, equipment supports, and equipment platforms shall be provided where prefabricated curbs, supports, or platforms are not required to be provided under other Sections.

B. All Work shall conform to Reference Standards. Flashing Work shall be coordinated with roofing Work. Sheet metal and roofing shall provide a weather-tight and watertight assembly.

C. Sheet metal Work shall be accurately formed to dimensions and shapes indicated. Work shall be fitted snugly, with straight, true lines with exposed faces aligned in proper plane, free from waves and buckles. Arises and angles shall have true and sharp lines, and surfaces shall be free from waves and buckles. Exposed edges shall be hemmed. Holes for fasteners within sheet metal Work exposed to temperature changes shall be elongated holes for material expansion and movement.

D. Sheet metal Work shall be furnished complete with supports, hangers, bracing, anchors, and other devices as required for reinforcement and proper attachment to adjacent construction. Fastenings shall be concealed wherever possible. Joints, fastenings, reinforcements, and supports shall be sized and located as required to preclude distortion or displacement due to thermal expansion and contraction.

E. Surfaces upon which sheet metal is to be placed shall be dry, smooth, even, and free of any projections and hollows. Sheet metal shall be laid with all joints true and even and firmly attached with all fastener heads flush with the top surface.

F. The underlayment shall be overlapped at least 2-inches so as to shed water and shall be secured along the lapped edges. Aluminum or stainless steel fasteners shall be used with aluminum sheet metal.

G. Dissimilar materials shall be isolated with 2 coats of asphaltic paint, asphaltic coating compound, or sealer tape. Only stainless steel fasteners shall be used to connect isolated dissimilar metals.

H. Joints shall be sized and spaced to permit sheet movement for thermal expansion and contraction of 1/4-inch per 10-ft length, on 100 degree F temperature difference. Holes for fasteners or anchors shall be elongated to provide for movement.

I. Roofing sheet metal items shall be built into the roofing in strict accordance with directions of roofing manufacturer.

3.3 INSTALLATION

A. Flashing at vertical surfaces shall be installed at intersections of roof with vertical surfaces and at projections through roof. Corner units shall be factory-fabricated and shall have mitered soldered or welded corner joints, and shall be installed with 3-inch (min) lap joint over flashing on each side.

B. Copings shall have joints at 10-ft (max) spacing and at 2-1/2 feet from corners. Joints shall be butted with 3/16-inch space centered over matching 8-inch long backing plate with sealer tape in laps. Corner units shall be welded or soldered units. Joints shall be provided with cover plates.

3.4 PROTECTIVE COATING

A. The Contractor shall provide protective coating, per Section 09 96 00 – High-Performance Coatings, on all installed visible sheet metal products that are not provided with pre-finish coating system. Color shall match the adjacent surface materials color. The Contractor shall obtain final color approval from the Engineer prior to finish coat application. Colors may vary for each adjacent material.

END OF SECTION

SECTION 07 92 13 – ELASTOMERIC JOINT SEALANTS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sealants and caulking.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. Reference Codes

01 33 00	Submittal Procedures

C. Reference Standards

American Society for Testing and Materials (ASTM)	
ASTM C 920	Elastomeric Joint Sealants
ASTM D 1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
Sealant, Waterproofing, and Restoration Institute (SWRI)	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. The Contractor shall coordinate color samples with other Sections through the submittal process, as required by the Engineer.

1.04 ACTION SUBMITTALS

A. Product Data

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions, and the following:

2. Joint width and depth tables.

3. Manufacturer’s full range color charts, indicating custom color availability, for color selection by Owner.

B. Certifications:

1. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

2. Certification by the Manufacturer's technical field representative that surfaces have been prepared and the products have been applied in accordance with the Manufacturer's recommendations.

3. Certification from an independent testing laboratory that the submitted materials meet the requirements of the references indicated.

C. Application Schedule

1. Furnish a detailed and complete application schedule indicating location and detail of installation.

D. Samples

1. When requested by the Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility

1. Sealants and Caulking shall be provided by a single Manufacturer, each.

B. Qualifications

1. Manufacturer

a. Sealants and caulking Manufacturer shall have a minimum of 20 years of sealants and caulking manufacturing experience.

2. Installer

a. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

C. Manufacturer's Technical Field Representative

1. The Contractor shall arrange for a Manufacturer's technical field representative to be on Site for at least 1 day, beginning at the start of surface preparation and continuing through application, to train the installers and to supervise the Work. The Manufacturer's technical field representative shall observe as necessary to certify in writing that the completed Work has been performed according to the Manufacturer's instructions.

D. Sealant and caulking Work shall comply with the following references:

1. SWRI.

2. ASTM C 920.

1.06 WARRANTY

A. Manufacturer

1. Furnish Manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. Special Warranty

1. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

C. Warranties shall be non-prorated for the entire warranty period.

D. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Sealant and caulking, including compressible filler and joint backing, shall be recommended by the Manufacturer for the installation indicated.

B. Sealant and caulking, including compressible filler and joint backing, shall be suitable for, and compatible with, the required installation.

C. Sealant and caulking, including compressible filler and joint backing, shall be suitable for, and compatible with, the substrates and surfaces indicated.

D. Colors for sealants and caulking above grade and exposed to view shall be selected by the Owner from Manufacturer's full color range, including custom colors.

2.02 INTERIOR AND EXTERIOR SEALANTS (HORIZONTAL OR SLOPED PLANES)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. MasterSeal SL2 by Master Builders Solutions, including primer as recommended by Manufacturer.

B. Description: Two part, pour grade polyurethane base, ASTM C 920, Type M, Grade P, Class 25, Use T, NT, M, A, and I.

2.03 INTERIOR AND EXTERIOR SEALANTS (VERTICAL PLANE)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. MasterSeal NP2 by Master Builders Solutions, including primer as recommended by Manufacturer.

B. Description: Multi-component, gun grade, polyurethane ASTM C 920, Type M, Grade NS Class 25, Use NT, T, M, A, G, and O.

2.04 COMPRESSIBLE FILLER

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer listed below, or equal:

a. Hohmann & Barnard.

B. Description:

1. Compressible filler shall be an impregnated preformed compressible sealant, produced by combining permanently elastic, high density open cell, polyurethane foam with stabilizing acrylics. Compressible filler shall be supplied pre-compressed in a tape form with a PSA on one side.

2. Compressible filler shall be compatible with sealant Manufacturer's product and shall not stain the sealant nor the materials to which applied.

2.05 JOINT BACKING (BACKER ROD)

A. Description:

1. Joint backing for joints in superstructure shall be approved, resilient, closed cell polyethylene rods of diameters to suit joint conditions. Joint backing shall comply with ASTM D 1752, Type II or III.

2. Where joint depth will not allow for a rod and still provide 3/8-in minimum depth of sealant, provide approved bond breaker tape at the bottom of the joint.

3. Joint backing shall be compatible with sealant Manufacturer's product and shall not stain the sealant nor the materials to which applied.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Joints noted as "caulk," "caulking," or "sealant" shall be caulked as specified herein.

B. Joints to be caulked or sealed include through-bolt holes, door frames, louver and ventilator frames, joints between openings where items pass through exterior walls, concrete masonry, or combination of these surfaces, and as otherwise indicated or required for watertightness, weatherproofing, or airtightness.

1. Sealants and caulking shall be provided at both exterior and interior surfaces of exterior wall penetrations.

C. Sealants and caulking shall be provided at exterior wall joints, between adjacent materials, joints between frames or louvers and adjacent materials, copings, caps, sills, masonry control joints, and other joints and penetrations indicated or required for the completion of the Work.

D. Sealants and caulking shall be provided at interior joints between frames and masonry, at tops of masonry walls, between masonry and structural concrete, floor joints in tile, joints in rooms to be airtight, and other joints and penetrations on the Contract Drawings or as required for the completion of the Work.

E. Sealants and caulking shall also be installed elsewhere, where indicated on the Contract Drawings.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions, and referenced standards, for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where sealants and caulking will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed sealants and caulking.

a. Surfaces to receive sealants and caulking, including compressible filler and joint backing, shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the sealant and caulking materials.

b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

c. Joint shapes and sizes shall be as indicated. Where not indicated, joint shapes and sizes shall be as necessary for job conditions, as directed by the Engineer.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the applicable references and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, form release agents, and other substances shall be removed as recommended by the sealant and caulking Manufacturer.

C. Protrusions, bumps, ridges, and loose substrate surface materials shall be removed by sanding or grinding.

D. Laitance, efflorescence, and loose mortar shall be removed from the joint cavity.

E. Ferrous metal surfaces shall be cleaned of rust, mill scale, and other coatings by wire brush, grinding, or sandblasting.

F. Protective coatings shall be removed from surfaces to receive sealants and caulking.

1. Solvents used to remove protective coating shall be as recommended by the sealant and caulking Manufacturer, shall be compatible with the adjacent materials and surfaces, shall not damage adjacent finishes, and shall be non-staining.

G. Bituminous or resinous materials shall be removed from surfaces to receive sealants and caulking.

H. Immediately before application of sealant and caulking materials, scrape surfaces to be covered free from foreign materials and brush clean.

I. Substrate shall be swept to remove all loose materials prior to beginning sealant and caulking installation.

3.06 PREPARATION

A. Sequence installation properly with the installation and protection of other WORK, so that neither will be damaged by the installation of the other.

3.07 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Primer, if recommended by the Manufacturer for the application, shall be applied per the Manufacturer's recommended procedures.

1. Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

C. Multi-component sealants shall be mixed according to Manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Sealant shall be installed to the required depth without displacing the backing. Unless otherwise indicated or recommended by the Manufacturer, the installed sealant shall be tooled so that the surface is uniformly smooth and free of wrinkles and to assure full adhesion to the sides of the joint. Sealants shall be installed free of air pockets, foreign embedded matter, ridges, and sags. Sealer shall be applied over the sealant if recommended by the sealant Manufacturer.

D. Sealant depth in joints shall be half of the width of joint, but not less than 1/8-in deep and ¼-in wide nor more than 1/2-in deep and 1-in. For joints greater than 1-in wide, provide sealant in a 2 to 1 width-to-depth ratio.

E. Joints shall have a rigid filler material installed to proper depth prior to application of sealant.

F. Masking film shall be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking shall be removed as soon as possible after joint has been filled and tooled.

G. Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

H. Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

I. A full bead of sealant shall be applied into the joint under sufficient pressure, with the nozzle drawn across sealant, to completely fill the void space and to ensure complete wetting of contact area to obtain uniform adhesion. During application, the tip of the nozzle shall be kept at the bottom of the joint thereby forcing the sealant to fill from the bottom to the top. Sealants shall be tooled immediately after exposure with a caulking tool or soft bristled brush moistened with solvent. The finished sealant-filled joint shall be slightly concave unless otherwise indicated.

3.08 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

3. The surfaces of materials adjoining caulked joints shall be cleaned free of smears of sealant or other soiling due to caulking operations.

B. Sealants and caulking shall be protected from damage from subsequent construction operations.

C. The Contractors shall make adjustments required until accepted.

D. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

E. When sealant and caulking Work is completed, remove unused materials, containers, and equipment, and clean the Site of sealant and caulking debris.

END OF SECTION

SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel doors and frames.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
08 71 00	Door Hardware
08 81 00	Glass Glazing
09 96 00	High-Performance Coatings

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Standards

American National Standards Institute (ANSI) / Steel Door Institute (SDI)	
ANSI A 115 -	Specification for Preparation of Steel Doors and Frames for Hardware
ANSI/SDI A 250.6 -	Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
ANSI A 250.8/SDI 100-	Recommended Specifications for Standard Steel Doors and Frames
ASTM International (ASTM)	
ASTM A 153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM A 653	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
Building Code	
Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code	
National Fire Protection Association (NFPA)	
NFPA 80	Fire Doors and Windows
NFPA 252	Standard Methods of Fire Tests of Door Assemblies
Steel Door Institute (SDI)	
Recommended Locations for Builders’ Hardware for Standards Steel Doors and Frames	
Underwriters’ Laboratories (UL)	

UL 10	Standard for Fire Test Door and Assemblies
UL 10C	Positive Pressure Fire Tests of Door Assemblies

1.03 SUBMITTALS

A. Product Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions.

B. Certifications:

1. Certification of compliance with the requirements of paragraph 2.1.A.

2. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and owner.

3. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

4. Submit certification from a recognized testing agency that fire doors have passed tests to meet fire ratings indicated.

5. Certification from the Manufacturer stating that galvanizing has been completed in accordance with these specifications.

6. Certification from the Manufacturer stating that the rust-inhibitive primer is compatible with painting systems in Section 09 96 00 – High-Performance Coatings.

C. Shop Drawings: Complete Shop Drawings showing location and detail of installation.

1. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each door and frame type, schedule of doors and frames, frame elevations and details, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

2. Include details of core and edge construction, through-door louvers, vision panels, and trim for openings.

D. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 6-in by 6-in frame corner construction, including galvanizing, welding, grinding, touch-up, and priming.

3. 6-in by 6-in door panel construction, including galvanizing, welding, grinding, touch-up, and priming.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Steel doors and frames shall be provided by a single Manufacturer.

B. Steel doors and frames shall conform to ANSI A 250.8/SDI 100, except where more stringent requirements are indicated herein.

C. Fire Rated Openings:

1. Steel doors and frames required to be fire-rated shall bear UL labels indicating the applicable fire ratings. Designs and construction of such products shall have specific UL approval according to current procedures for the fire rating. Assemblies shall be constructed to comply with NFPA 80, with the Code, and with other requirements indicated.

2. Steel doors and frame assemblies and components shall be compliant with positive pressure and S-label requirements. Steel doors and frames shall be coordinated with door hardware supplier to ensure that total opening installation is compatible with UL 10C and NFPA 252.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Structural Requirements:

1. Steel doors and frames, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

a. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials if required to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Refer to Section 08 71 00 – Door Hardware, for door hardware to be provided for Steel Doors and Frames.

2.02 STEEL DOORS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below:

a. Curries Co., (ASSA ABLOY Group); 747 Series modified by the Manufacturer with custom upgraded features as required to comply with the Specifications.

b. Steelcraft

c. Pioneer

d. Ceco

B. Description:

1. Provide flush design steel doors, 1 ¾-in thick, seamless hollow construction, unless otherwise indicated.

2. Exterior Doors: 14-gauge galvanized sheet steel, SDI Level 4 Classification

3. Interior Doors: 16-gauge galvanized sheet steel, SDI Level 3-Model; 2 Classification

4. Galvanized steel sheets shall be zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 653, G90 zinc coating, mill phosphatized.

5. For single-acting swing doors, vertical edge at lock edge shall be beveled 1/8-in in 2-in.

6. Doors shall be fabricated of 2 outer, galvanized, stretcher-leveled steel sheets not less than 16-gauge. Doors shall be constructed with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Weep hole openings shall be provided in the bottom of doors to permit escape of entrapped moisture.

7. Inside of doors shall be reinforced with vertical galvanized sheet steel Sections not less than 22-gauge. Vertical reinforcing shall be spaced 6-in on center and extend full door height. Spot-weld at not more than 5-in on center to both face sheets.

8. Insulate spaces between door ribs with one pound, nominal density fiberglass insulation. R-value of door shall be at least 2.78 hr/Btu/sq. ft./deg F.

9. Tops and bottoms of doors shall be reinforced with 16-gauge horizontal steel channels welded continuously to outer sheets. Top and bottom edges shall be closed to provide seal, as integral part of door construction while providing recesses for required hardware and appurtenances.

C. Glazing: Comply with requirements in Section 08 81 00 – Glass Glazing.

D. Through-Door Louvers: Provide through-door louvers of sizes indicated or required. Louvers shall be 18-gauge, cold-rolled galvanized steel sheet matching the doors. Fabricate units with stationary, sight-proof blades and channel shaped frames, not less than 1-in deep. Space louver blades not more than ¾-in on center. Assemble units by welding.

E. Transom Panels: Same materials and construction as indicated for exterior doors unless otherwise indicated.

F. Door Hardware Reinforcement:

1. Components shall be reinforced for hardware installation in accordance with ANSI/SDI A 250.6.

a. Lock and closer reinforcements shall be “box” or “channel” type.

b. Punch single leaf frames to receive 3 silencers. Double leaf frames shall receive one silencer per leaf at head.

c. Factory prepared hardware locations shall be in accordance with “Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames,” as adopted by SDI.

d. Supply welded in mortar guards at hardware cutouts in frames built into masonry or grouted in full.

2.03 STEEL FRAMES

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Curries Co., (ASSA ABLOY Group); Masonry/Flush Frame M Type (Equal Rabbet).

B. Description:

1. Provide hollow metal frames for doors, windows, lites, cased openings, and for other openings where indicated. Frames shall be 14-gauge galvanized sheet steel, 5 ¾- in wide by 2-in deep, unless otherwise indicated.

a. Stops shall be formed integral with the frame unless otherwise indicated.

b. Provide removable stops where indicated or required on secured room side of opening, formed of not less than 18-gauge steel sheets. Secure with oval head machine screws spaced uniformly not more than 12-in on center. Form corners with butted hairline joints.

1) Coordinate width of rabbet between fixed and removable stops with type of glass, panel, and type of installation indicated.

c. Galvanized steel sheets shall be zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 653, G90 zinc coating, mill phosphatized.

2. Frames shall be fabricated of welded unit construction, with corners mitered, reinforced, and face welded. No field-spliced frames will be allowed.

3. Frames set in masonry walls are shall be face-welded and ground smooth and re-primed at the welded area.

4. Provide temporary shipping bars to help protect from damage during transit and handling.

5. Temporary shipping bars shall be removed before setting frames.

6. Welds on frames shall be flush with neatly mitered or butted material cuts.

7. Frames shall be pretreated prior to priming at factory by washing, phosphatizing and by chromic seal. Primer shall be baked on.

C. Mullions and Transom Bars: Provide closed or tubular mullions and transom bars where indicated. Except where removable mullions or transom bars are indicated or required, fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.

1. Where installed in masonry, leave vertical mullions in frames open at top for grouting.

D. Jamb Anchors:

1. Masonry construction: Adjustable, flat, corrugated or perforated 'T' shaped with leg not less than 2-in wide by 10-in long or masonry “wire” type not less than 3/16-in diameter.

a. Provide at least 3 anchors equally spaced per jamb up to 7 ft 6-in in height. Provide 4 anchors equally spaced per jamb up to 8 ft in height, and one additional anchor equally spaced per jamb for each 24-in or fraction thereof over 8 ft in height.

2. In-place masonry or concrete construction: Anchor frame jambs with minimum 3/8-in countersunk flat head stove bolt and expansion shields 6-in from top and bottom and 26-in on center, unless otherwise indicated.

a. Reinforce frames at anchor locations.

1) Weld pipe spacers, or similar type spacers, per Manufacturer's standard design in back of frame soffit to protect frame profile during tightening of bolts and anchors.

b. Apply removable stop to cover anchor bolts where indicated.

3. Provide UL approved fixed anchors at fire rated openings.

E. Floor Anchors: Angle clip type.

1. 16-gauge minimum.

2. 2 fasteners per jamb.

3. Welded to the bottom of each jamb.

F. Preparation for Hardware:

1. Reinforcement: Components shall be reinforced for hardware installation in accord with ANSI/SDI A250.6.

2. Lock and closer reinforcements shall be “box” or “channel” type.

3. Punch single leaf frames to receive 3 silencers. Double leaf frames shall receive one silencer per leaf at head.

4. Factory prepared hardware locations shall be in accordance with “Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames,” as adopted by the SDI.

5. Supply welded in mortar guards at hardware cutouts in frames built into masonry or grouted in full.

G. Head Reinforcing: For frames over 4-ft 0-in wide in masonry wall openings, provide continuous steel channel or angle stiffener, not less than 12-gauge for full width of opening, welded to back of frame at head.

H. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.

I. Plaster Guards: Provide 26-gauge galvanized steel plaster guards or dust cover boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware installation.

2.04 FABRICATION

A. The Contractor shall field verify size, location, and placement of doors and frames, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

B. Doors and frames shall be fabricated to be rigid, neat in appearance, and free from defects, including warping, cupping, buckling, or other defects. Metal shall be accurately formed to required sizes and profiles.

C. Doors and frames shall be fit and assembled in the Manufacturer's plant. Weld exposed joints continuously; grind, dress, and make smooth, flush, and invisible. Metallic filler to conceal manufacturing defects is not acceptable.

D. Doors and frames shall be prepared to receive mortised and concealed door hardware, including cutouts, reinforcing, drilling, and tapping in accordance with final Door Hardware Schedule and templates provided by hardware supplier, and as indicated in the Contract Documents.

1. Comply with applicable requirements of ANSI A 115 for preparation for hardware on doors and frames.

2. Include thru-bolting holes as required per hardware template.

3. Do not include unnecessary cutouts in door faces not required by hardware template.

4. Doors and frames shall be reinforced to receive surface-applied hardware. Drilling and tapping for surface-applied door hardware may be done at Site.

E. Shop Surface Preparation and Priming:

1. Steel surfaces shall be cleaned of dust, dirt, mill scale, rust, oil, grease, and other foreign materials.

a. Zinc-rich primer shall be applied to damaged galvanized surfaces.

2. Pretreatment shall be applied to cleaned metal surfaces, using cold phosphate solution or hot phosphate solution.

3. One full shop coat of rust-inhibitive primer shall be applied within time limits recommended by pretreatment Manufacturer. A smooth coat of even consistency shall be applied to provide a uniform dry film thickness of not less than 2.0 mils.

F. Zinc-Rich Touch-up Primer: Use 95 percent metallic zinc dust primer in a vehicle compatible with the epoxy painting systems in Section 09 96 00 – High-Performance Coatings.

G. Supports and Anchors: Fabricate of not less than 16-gauge sheet metal. Galvanize after fabrication units complying with ASTM A 153, Class B.

H. Inserts, Bolts, and Fasteners: Hot-dip galvanize, complying with ASTM A 153, Class C or D, as applicable.

I. Rust-Inhibitive Primer:

1. Air-drying or baking type compatible with epoxy finish paint in Section 09 96 00 – High-Performance Coatings.

2. Provide non-standard primer if required to obtain compatibility.

J. Steel doors and frames shall be field painted per Section 09 96 00 – High-Performance Coatings.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Steel doors and frames shall be shipped and stored with temporary stiffeners and spacers in place to prevent distortion.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where doors and frames will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed doors and frames.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of steel doors and frames. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. The Contractor shall block and reinforce walls as required to support the Steel Doors and Frames and appurtenances.

E. Setting Masonry Anchorage Devices: Provide masonry anchorage devices where required for securing frames to in-place concrete or to existing masonry construction. Set anchorage devices opposite each anchor location, in accordance with details on Shop Drawings and anchorage device Manufacturer's instructions. Drilled holes shall be left rough, not reamed and free from dust and debris.

F. Glazing: Comply with installation requirements in Section 08 81 00 – Glass Glazing and with hollow-metal manufacturer's written instructions.

G. Placing Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged.

H. In new masonry construction, coordinate frame setting with and prior to the building of masonry walls. Provide the required anchors for building in place.

I. At in-place concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.

J. Remove spreader bars only after frames or bucks have been properly set and secured.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

   1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

   2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, doors and frames and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

   1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Adjusting and cleaning shall consist of ensuring smooth operation, lubricating and testing the doors and frames.

1. Doors and frames shall operate smoothly, quietly, and without squeaking and binding.

D. Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

E. Doors and frames shall be protected from damage from subsequent construction operations.

F. The Contractor shall make adjustments required and retest until accepted.

G. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

H. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

1. Remove and replace defective Work, including doors or frames that are warped, bowed, or otherwise unacceptable.

I. When door and frame Work is completed, remove unused materials, containers, and equipment, and clean the Site of door and frame debris.

END OF SECTION

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SECTION 08 23 00 – OVERHEAD COILING DOORS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Overhead coiling doors with operating assemblies, curtains, guides, hardware, and accessories as required for complete, operational installation.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage

B. Reference Standards

ASTM International (ASTM)	
ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653.	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM D3363	Standard Test Method for Film Hardness by Pencil Test.
National Electrical Manufacturers Association (NEMA)	
NEMA Standard KS 1	Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

1. Building Code: Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code”.

2. NEMA 4X – Enclosures intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water.

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions, and the following:

a. Complete operation instructions.

b. Manufacturer's full-range color charts, indicating custom color availability for color selection by the Owner.

2. Certificates:

a. Certification by the overhead coiling door Manufacturer that the overhead coiling doors provided are suitable for, and compatible with, the required installation.

b. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

B. Shop Drawings and Calculations:

1. Complete Shop Drawings showing location and detail of installation, and design calculations.

2. Shop Drawings and Calculations shall be prepared, approved, and stamped by a professional structural engineer licensed per local engineering laws.

3. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each overhead coiling door type, schedule of overhead coiling doors, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

a. Shop Drawings shall include material descriptions, door guides, finish, color, details of construction, installation, accessories, and operation of each overhead coiling door type.

C. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 3-in by 4-in color samples showing substrate, finish, and color.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Overhead coiling doors shall be provided by a single Manufacturer.

B. Qualifications:

1. Manufacturers:

a. Overhead coiling doors Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers:

a. Installer shall be trained, certified, and authorized by the Manufacturer to install the Manufacturer's product.

1.07 WARRANTY

A. Manufacturer Warranty:

1. For overhead coiling door and appurtenances furnish Manufacturer's 2-year written warranty to cover defects in materials, products, and manufacturing workmanship.

2. The Contractor shall furnish separate, but concurrently running, 2-year written warranty to cover labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Structural Requirements:

1. Overhead coiling doors, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

a. Refer to Section 01 33 17– Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Design Requirements:

1. The Contractor shall furnish professional design and engineering services as required for overhead coiling doors.

a. Professional design and engineering services may be provided by the Manufacturer or by an independent licensed civil engineer retained by the Contractor, either of which shall comply with the requirements indicated.

2. The Contractor shall coordinate color samples with other Sections through the submittal process.

2.02 OVERHEAD COILING DOORS

A. Manufacturers and Products:

1. Subject to the requirements indicated, provide Manufacturer and product listed below.

a. **Cornell Iron Works, Inc.; Thermiser ESD30 & ESD30W** – With Additional Options and Custom Features as specified herein.

b. The Cookson Company; Temp-Pro Rolling Service Door.

c. Wayne Dalton; Thermotite Model 800C

B. Description:

1. Overhead coiling doors shall be insulated slat, interior mounted, motor operated with chain-hoist override, with factory applied finish and color as indicated.

a. Steel Doors: Interlocking slats of galvanized steel skins conforming to Grade 40 galvanized steel zinc coating, in accordance with ASTM A653. Each slat shall be formed of exterior 20-gauge, interior 24-gauge, galvanized steel sheets.

2. Fabricate interlocking sections with end-locks on slats to maintain slat alignment, prevent wear, and to comply with requirements.

C. Insulation:

1. 7/8-in foamed in placed, closed cell polyurethane insulation enclosed in each slat.

2. Total slat R-value: 8.0 hr/Btu/sq ft/deg F minimum.

D. Bottom Bar:

1. Reinforced extruded aluminum interior face with full depth insulation and exterior skin slat to match curtain material and gauge.

2. Finish and color of interior and exterior surfaces shall match slats.

3. Provide with Manufacturer’s standard cylinder lock option.

E. Guides:

1. Minimum of 3/16-in galvanized structural steel and with sufficient depth to retain the curtains in the guides against the design loads. Provide aluminum guides for aluminum doors.

2. When wind-locks are necessary in order to comply with the requirements, provide wind-lock bars of same material as the guides.

3. Provide removable guide stoppers to prevent over-travel of curtain and bottom bar.

4. For steel door guides only – Top 16 ½-in of coil side guide angles shall be removable for ease of door installation and as needed for future door service.

5. Provide wind-locks of same material to comply with requirements.

6. Provide a padlockable chain keeper on guide.

F. Counterbalance, Brackets, and Hood:

1. Fabricated in accordance with the Manufacturer's standard practice.

2. The coil shall be housed in a 24-gauge galvanized steel sheet metal hood with reinforced top and bottom edges.

3. Provide minimum ¼-in steel intermediate-support brackets as required to prevent excessive sag.

4. Finish shall match the slats.

G. Weatherstripping:

1. Bottom bar: At motor operated doors, provide weatherseal with sensing feature, neoprene extending full width of door.

2. Guides: Provide replaceable vinyl strip sealing against fascia side of door.

3. Lintel: provide nylon brush seal fitted at door header to impede airflow.

4. Hood: provide neoprene / rayon baffle to impede airflow above coil.

H. Locking: Pad-lockable slide bolt on fascia side of bottom bar at each jamb extending into slots in guides.

2.03 FINISH AND COLOR

A. Steel Components:

1. Galvanizing:

a. Sheet steel shall be provided with a zinc coating at not less than 0.90-oz/sq-ft of steel and in a manner as to provide a ductile coating, tightly adhered to base metal and conforming to bond tests converted in accordance with ASTM A 653.

b. Structural shapes and similar heavy steel shall be hot-dipped galvanized per ASTM A123 and ASTM A153, as applicable. Provide phosphate coating for paint adhesion at the factory.

B. Steel Door Finish:

1. Provide Manufacturer's fusion bonded thermosetting powder cost finish applied to a minimum 2.5 mils cured film thickness.

2. Pencil hardness to be rated H or better per ASTM D3363.

C. Color:

1. Color shall be selected and approved by the Owner from Manufacturer's full color range including custom colors and may be required to exactly match other building components, as determined by the Owner.

a. Tentative color selection: To be Selected.

1) The Owner reserves the option of changing this tentative color selection during the submittal process.

2.04 OPERATION

A. General:

1. Provide UL listed electric door operator assembly of the size and capacity recommended in writing by the door Manufacturer; complete with electric motor and factory-prewired motor controls, worm-gear reduction unit, solenoid operated brake, clutch, and control station.

2. Provide auxiliary reduced drive chain hoist with electrically interlocked floor level disconnect for manual operation. Hoist wheel shall be easily moveable to right or left hand side of the unit.

B. Electric Door Operators (Basis of Design: Chamberlain Liftmaster, Model GH with options and custom features as specified herein.)

1. Provide 208-volt, 3-phase motors NEMA 4X rated. Motors shall be high starting torque, continuous duty, industrial type, protected against overload by a current sensing or thermal overload device. Speed reduction shall be worm-gear-in-oil-bath gear reducer with synthetic "All Climate" oil. Door drive shall utilize minimum #50 roller chain and sprockets.

2. Operator shall be equipped with an electrically interlocked floor level disconnect and chain hoist for manual operation and an electric solenoid-actuated brake to stop the motor and hold the door in position.

3. Operator shall be capable of driving the door at a speed of 8 to 9-in per second. Fully adjustable, driven linear type limit switch mechanism shall synchronize the operator with the door. Low friction nylon limit nuts fitted on threaded steel shaft, rotating on iolite self-lubricating bronze bushings.

4. The motor shall be removable without affecting the limit switch settings.

5. Coordinate wiring requirements and current characteristics of motors with the building electrical system; see Division 16 Sections of these specifications.

C. Remote Control Station:

1. Provide momentary-contact, 3-button control stations with push button controls labeled “open,” “close,” and “stop.” Install at location as shown, scheduled, or as directed by the Engineer.

2. Provide interior units full-guarded type, surface-mounted, heavy-duty, weatherproof, NEMA 4X enclosures.

D. Weather/Sensing Edge:

1. Provide automatic reversing control by an automatic sensing switch within neoprene or rubber astragal extending full width of door bottom bar. Contact before door fully closes shall cause door to immediately stop downward travel and reverse direction to the fully opened position. Provide retracting safety cord and reel connection to control circuit.

2.05 FABRICATION

A. The Contractor shall field verify size, location, and placement of overhead coiling doors, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

1. Overhead coiling doors shall be assembled before shipment to the Site.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer’s written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer’s written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where doors and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed doors and appurtenances.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of overhead coiling doors. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. The Contractor shall block and reinforce walls as required to support the overhead coiling doors and appurtenances.

E. Horizontal lines shall be level, and vertical lines shall be plumb.

F. Anchors for guides, brackets, and other fasteners shall be provided as required.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, overhead coiling doors and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Adjusting and cleaning shall consist of ensuring smooth operation, lubricating and testing the overhead coiling doors and appurtenances.

1. Overhead coiling doors shall operate smoothly, quietly, and without squeaking and binding.

D. Overhead coiling doors shall be protected from damage from subsequent construction operations.

E. The Contractor shall make adjustments required and retest until accepted.

F. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

G. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

H. When overhead coiling doors Work is completed, remove unused materials, containers, and equipment, and clean the Site of overhead coiling doors debris.

END OF SECTION

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SECTION 08 51 13 – ALUMINUM WINDOWS

PART 1 -- GENERAL

1.01 SUMMARY

A. Aluminum windows and window accessories.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
07 92 13	Elastomeric Joint Sealants
08 81 00	Glass Glazing

C. Reference Standards

American Architectural Manufacturer's Association (AAMA)	
AAMA 2605	Voluntary Specification, Performance Requirements, and Testing Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA 1503	Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
American National Standards Institute (ANSI)	
ANSI A 117.1	Accessible and Useable Buildings and Facilities
ASTM International (ASTM)	
ASTM A 36	Structural Steel
ASTM B 209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes
ASTM B 308	Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded
ASTM C 509	Cellular Elastomeric Pre-formed Gasket and Sealing Material
ASTM C 864	Dense Elastomeric Compression Seal Gaskets, Setting Blocks and Spacers
ASTM E 283	Standard Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen

ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
American Welding Society (AWS)	
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as the Code.
Federal Specification (FS)	
FS TT-P-645	Primer, Paint, Zinc Chromate, Alkyd Type
Society for Protective Coatings (SSPC)	
SSPC Paint 12	Cold-Applied Asphalt Mastic (Extra Thick Film)
Flat Glass Marketing Association (FGMA) Glazing Manual	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

a. Manufacturer's full-range color charts, indicating custom color availability for color selection by the Owner.

2. Certificates:

a. Certification of compliance with the requirements of paragraph 2.1.A.

b. Certified copies of recent test reports of systems similar to the design for this project substantiating performance of system in lieu of re-testing. Other supportive data shall be included as necessary.

c. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of five (5) similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general Contractor, and owner.

B. Shop Drawings and Calculations:

1. Complete Shop Drawings showing location and detail of installation, and design calculations.

2. Shop Drawings and Calculations shall be prepared, approved, and stamped by a professional civil engineer licensed per local engineering licensing laws.

3. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each window frame type, schedule of window frames, frame elevations and details, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

    a. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories of each aluminum window type.

    b. Shop Drawings shall include thermal breaks, details of special shapes, location and types of exposed fasteners and joints, and joint sealant.

    c. Shop Drawings shall indicate typical glazing details, locations of various types and thickness of glazing, and internal sealant requirements and details as recommended by the glazing sealant manufacturer.

1.05 CLOSEOUT SUBMITTALS

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Aluminum windows shall be provided by a single manufacturer.

B. Qualifications:

1. Manufacturers:

    a. Aluminum window manufacturer shall have a minimum of five (5) similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers:

    a. Installer shall have a minimum of five (5) years' experience in the successful completion of at least five (5) projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

3. Licensed Professionals:

    a. A professional civil engineer licensed per local engineering licensing laws shall design the aluminum windows and connections to the structure.

C. Installation shall be in accordance with the AAMA "Metal Curtain Wall, Window, Storefront and Entrance Guide Specification Manual," the SFM-1 "Aluminum Storefront and Entrance Manual," and other applicable references and with manufacturer's written instructions.

D. Testing Requirements: Components shall be provided that have been previously tested by an independent testing laboratory.

E. Welding shall be performed by AWS qualified welders.

F. In addition to requirements indicated, Contractor shall comply with applicable provisions of the Aluminum Curtain Wall Design Guide Manual for design, materials, fabrication, and installation of component parts.

1.07 WARRANTY

A. Manufacturer Warranty

1. Furnish manufacturer's 2-year written warranty to cover defects in materials, products, and manufacturing workmanship.

2. Furnish manufacturer's extended 20-year warranty to cover the finish.

a. Warranty shall include provisions for failures of the finish including, but not limited to, chalking, crazing, peeling, and fading.

3. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

4. Warranties shall be non-prorated for the entire warranty period.

5. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Structural Requirements:

1. Aluminum windows, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

a. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Aluminum windows shall be recommended by the manufacturer for the installation indicated.

C. Aluminum windows shall be suitable for, and compatible with, the required installation.

D. Design Requirements:

1. The Contractor shall furnish professional design and engineering services as required for aluminum windows.

    a. Professional design and engineering services may be provided by the manufacturer or by an independent licensed civil engineer retained by the Contractor, either of which shall comply with the requirements indicated.

2. Contractor shall coordinate color samples with other Sections through the submittal process.

3. Supports, anchorage, and accessories shall be provided as required for complete assembly.

4. Aluminum window system manufacturer shall furnish the systems herein, including necessary modifications to meet the indicated requirements and to maintain visual design concepts as approved by the Engineer.

5. Perimeter conditions shall allow for installation tolerances, expansion and contraction of adjacent materials, and sealant manufacturer's recommended joint design.

6. Contractor shall not assume glazing, sealant and interior finishes contribute to framing member strength, stiffness, or lateral stability.

7. Assemblies shall be free from vibration harmonics, rattles, wind whistles, and noise due to thermal movement, thermal movement transmitted to other building elements, and wind pressure. Assemblies shall be free from loosening, weakening, or fracturing of attachments by components.

8. Attachment considerations are to take into account Site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening, or fracturing connection between units and building structure or between units themselves.

9. System shall drain any water entering system to the exterior of system.

10. Concealed fastening shall be provided.

11. Uniform color and profile appearance shall be provided at components exposed to view.

E. Performance Requirements:

    1. Fixed Windows:

Air Infiltration (ASTM E 283)	Maximum 0.06 cfm/sq ft surface area, at differential static pressure of 6.24 psf
Water Infiltration (ASTM E 331)	No water penetration at test pressure of 8 psf
Maximum Deflection (ASTM E 330)	L/175 of span at structural design criteria indicated, allowable stress with a safety factor of 1.65

2. Operable Windows:

Air Infiltration (ASTM E 283)	Maximum 0.030 cfm/sq ft surface area, at differential static pressure of 1.57 psf
Water Infiltration (ASTM E 331)	No water penetration at test pressure of 10.0 psf
Maximum Deflection (ASTM E 330)	When closed and locked, maximum deflection of L/175 at pressure difference of 65 psf

F. Thermal Requirements:

1. Fixed Windows:

a. Thermal Transmittance Performance (AAMA 1503): U-Value 0.63.

b. Condensation Resistance Factor (CRF) 63.

2. Operable Windows:

a. Thermal transmittance performance (AAMA 503.1): U-Value 0.70.

b. Condensation resistance factor (CRF): 49.

G. Aluminum window systems shall accommodate expansion and contraction movement due to surface temperature differentials without causing buckling, stresses on adjacent work, undue stress on structural elements, damaging loads on fasteners, reduction of performance, stress on glazing, failure of joint seals, or other visual or technical detrimental effects.

2.02 ACCEPTABLE MANUFACTUERS

A. Manufacturer and Product:

1. Subject to the requirements indicated, provide manufacturer and product listed below.

a. Fixed Windows – Kawneer Co. Inc.; Trifab Versaglaze 451T Center Glazed Storefront System (with Thermal Break).

b. Operable Windows (Project-out Windows) – Kawneer Co. Inc.; 8225 TL Series Project-out Windows.

c. Equal products by Wausau Window and Wall Systems, or Tubelite Inc.

2.03 ALUMINUM WINDOWS

A. ASTM B 221, alloy 6063-T5 for extrusions; ASTM B 209, alloy 5005-H34 for sheets; or other alloys and temper recommended by manufacturer appropriate for the finish.

B. Internal reinforcing shall be ASTM A 36 for carbon steel; or ASTM B 308 for structural aluminum.

1. Shapes and sizes to suit installation.

2. Steel shall be galvanized and apply shop-coat steel components after fabrication with alkyd type zinc chromate primer complying with FS TT-P-645.

C. Inserts and anchoring devices shall be manufacturer's standard formed or fabricated assemblies, steel or aluminum, of shapes, plates, bars, or tubes.

1. Steel shall be galvanized and apply shop-coat steel components after fabrication with alkyd type zinc chromate primer complying with FS TT-P-645.

D. Fasteners shall be aluminum, non-magnetic stainless steel or other materials warranted by manufacturer to be non-corrosive and compatible with components being fastened.

1. Exposed fasteners shall not be used.

2. For concealed locations, manufacturer's standard fasteners shall be provided.

3. Provide nuts or washers of design having means to prevent disengagement; deforming of fastener threads is unacceptable.

E. Operable windows shall conform to the requirements of ANSI Standard A 117.1.

2.04 ACCESSORIES

A. Sill Extensions: Sill extensions shall be a one-piece extruded 0.060 aluminum.

B. Sill extension finish shall be the same as window, custom color to match adjacent exterior wall, as approved by Engineer.

C. Expansion anchor devices: Lead-shield or toothed-steel, drilled-in, expansion bolt anchors.

D. Shims: Non-staining, non-ferrous, type as recommended by system manufacturer.

E. Protective Coatings: To separate dissimilar materials, provide cold applied asphalt mastic complying with the SSPC Paint 12, compounded for 30-mil thickness for each coat; or alkyd type zinc chromate primer complying with FS TT-P-645.

1. Glazing Gaskets:

2. Compression type design, replaceable, molded or extruded neoprene, or ethylene propylene diene monomer (EPDM).

3. Glazing gasket shall comply with ASTM C 509 or ASTM C 864

4. Profile and hardness shall be as necessary to maintain uniform pressure for watertight seal.

5. Provide in manufacturer's standard black color.

6. Factory molded corners shall be required at exterior.

F. Internal Sealant: Types recommended by sealant manufacturer to remain permanently elastic, tacky, non-drying, non-migrating and weather tight.

G. “Anti-walk” Edge Blocking: “W” shaped EPDM blocks for use in keeping glazing material stationary under vibration or seismic loading. Edge blocking may be used for pressure plate systems.

H. Weatherstripping: Extruded EPDM elastomeric conforming to ASTM C 509 or C 864.

I. Baffles at Weepholes for Aluminum Framed Systems: Type as recommended by system manufacturer and shown in published installation instructions.

2.05 FINISH AND COLOR

A. Finish system shall be 2.0-mil, PVF2 Kynar 500, formulated by a licensed formulator to contain 70 percent PVF resin and applied by a licensed applicator.

1. Epoxy prime coat shall be applied to exposed sides to a dry film thickness of approximately 0.2-mil. One coat of PVF color coating shall be applied to exposed sides to provide a dry film thickness of not less than 0.8-mil, for a total of 1.0-mil total coating.

2. The surface condition of this finish coat shall be 100 percent free of holidays, drip marks, scratches, roll marks, or abrasions that are visible from a distance of 5 ft in good light when in installed position. Surfaces shall be free of checking, crazing, peeling, or loss of adhesion.

3. Finish shall meet or exceed AAMA 2605.

4. Color shall be selected and approved by the Owner from manufacturer’s full color range including custom colors, and may be required to exactly match other building components, as determined by the Owner.

a. Tentative color selection: Colors shall exactly match colors indicated below, as selected and approved by the Engineer.

1) PPG Industries, Inc., UC 101565 Duranar, Moosgrau as selected and approved by the Engineer.

b. Color shall be uniform with no variation in shade, and aluminum windows or accessories of different color batches will not be acceptable

c. The Owner reserves the option of changing this tentative color selection during the submittal process.

2.06 FABRICATION

A. The Contractor shall field verify size, location, and placement of aluminum windows, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

1. Aluminum windows shall be assembled before shipment to the Site.

B. Accurate relation of planes and angles shall be maintained, with hairline fit of contacting members.

C. The Contractor shall make provisions in framing for minimum edge clearance, nominal edge cover, and nominal pocket width for thickness and type of glazing or infill used in accordance with recommendations of manufacturer and the Flat Glass Marketing Association (FGMA) Glazing Manual.

1. Refer to Section 08 81 00 – Glass Glazing.

D. Welding shall comply with AWS recommendations.

1. Recommended electrodes and methods shall be used to avoid distortion and discoloration.

2. Grind exposed welds smooth and flush with adjacent surfaces; restore mechanical finish.

E. Holes or slots, deflector plates, water deflectors, and sealant shall be provided to accommodate internal weep and drainage to the exterior.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with manufacturer's written instructions.

3.02 PROJECT CONDITIONS

A. Comply with manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

1. Systems and components shall be inspected before installation.

2. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

3. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

B. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where aluminum windows and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed aluminum windows.

    a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other work for the installation of aluminum windows. Coordinate delivery with other work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate the Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. The Contractor shall block and reinforce walls as required to support the aluminum windows and appurtenances.

E. Horizontal lines shall be level, and vertical lines shall be plumb.

F. Sill extensions shall be provided at exterior aluminum window installations.

G. Tolerances:

    1. Limit variations from plumb and level:

        a. ⅛-in in 20 ft vertically and horizontally.

        b. ¼-in in 40 ft either direction.

    2. Limit offsets in theoretical end-to-end and edge-to-edge alignment:

        a. Allow 1/16-in where surfaces are flush or less than ½-in out of flush and separated by not more than 2 in.

b. 1/8-in for surfaces separated by more than 2-in.

3. Step in Face: 1/16-in maximum.

4. Jog in Alignment: 1/16-in maximum.

5. Location: ¼-in maximum deviation of any member at any location.

6. Tolerances are not accumulative.

H. Sealants:

1. Internal metal-to-metal joints shall be caulked, where required to provide the required performance as components are installed.

2. Perimeter members shall be sealed per manufacturer's installation instructions or as required for unique job conditions. Set other members with internal sealant and baffles as required by manufacturer's installation instructions. Use ultraviolet resistant sealant as recommended in writing by sealant manufacturer.

3. Contractor shall coordinate installation of perimeter sealant and backing materials between assemblies and adjacent construction in accordance with requirements of Section 07 92 13 – Elastomeric Joint Sealants.

4. Seal locations necessary to create and secure continuous enclosure even though Drawings may not indicate locations to be sealed.

5. Seal joints to prevent migration of water vapor or air to interior of building.

I. Glazing:

1. Glazing gaskets and sealant shall be installed in accordance with manufacturer written instructions without exception, including surface preparations.

2. “Anti-walk” edge blocking shall be utilized on vertical edges of glazing.

3. Refer to Section 08 81 00 – Glass Glazing for additional requirements.

3.06 CLEANING

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, aluminum windows and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the manufacturer's written instructions.

C. Aluminum windows shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required and retest until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When aluminum window Work is completed, remove unused materials, containers, and equipment, and clean the Site of aluminum window debris.

END OF SECTION

SECTION 08 62 23 – TUBULAR DAYLIGHTING DEVICES

PART 1 -- GENERAL

1.1 SCOPE

A. Provide tubular daylighting devices and appurtenant Work, complete and in place, in accordance with the Contract Documents.

B. Work includes:

1. Design
2. Coordination with Contractor for standard product adjustments
3. Submittals
4. Special tools and maintenance equipment
5. Shop fabrication and testing
6. Delivery to Magna Water District (Owner)
7. Delivery inspection
8. Installation verification
9. Warranty

1.2 REFERENCE SPECIFICATIONS

A. Use this Section with the Contract Documents and following other Sections to establish the total requirements.

1. 01 33 00 – Submittal Procedures
2. 01 42 19 – Reference Standards
3. 01 60 00 – Products, Materials, Equipment, and Substitutions
4. 07 54 19 – Single-Ply Membrane Roofing

1.3 APPLICABLE CODES AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening applies.

B. American Architectural Manufacturer's Association (AAMA):

AAMA A440	Standard/Specification for Windows, Doors, and Unit Skylights; 2011

C. American Society for Testing and Materials (ASTM):

ASTM A 463	Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process
ASTM A 653	Standard Specification for Steel Sheet, Zinc Coated (Galvanized), by the Hot Dip Process
ASTM A 792	Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B 209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM D 635	Test Method for Rate of Burning and/or Extent of Time of Burning of Self-Supporting Plastics in a Horizontal Position
ASTM D 1929	Test Method for Ignition Properties of Plastics
ASTM D 2843	Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics
ASTM F 1642	Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loading
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 108	Standard Test Methods for Fire Tests of Roof Coverings
ASTM E 283	Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 308	Standard Practice for Computing the Colors of Objects by Using the CIE System
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 547	Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain walls by Cyclic Air Pressure Difference
ASTM E 1886	Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missiles and Exposed to Cyclic Pressure Differentials
ASTM E 1996	Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricane

ASTM F 2912 Standard Specification for Glazing and Glazing Systems Subject to Airblast Loading

D. Occupational Safety and Health Association (OSHA):

OSHA 29 CFR 1910.23 (e)(8) (Guarding Requirements for Skylights); 1926 Subpart M (Fall Protection); 1926.501(b)(4)(i); 1926.501(i)(2); 1926.501(b)(4)(ii).

E. Building Code: Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as the CODE.

1.4 SUPPLIER SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures.

B. Additional Submittals

1. Product Data: Manufacturer's data sheets on each product to be used, including:

a. Preparation instructions and recommendations.

b. Storage and handling requirements and recommendations.

c. Data sheets showing roof dome assembly, flashing base, reflective tubes, diffuser assembly, and accessories.

d. Installation requirements.

2. Shop Drawings. Submit shop drawings showing layout, profiles, and product components, including rough opening and framing dimensions, anchorage, roof flashings and accessories.

3. Verification Samples: As requested by the Contractor.

4. Test Reports: Independent testing agency or evaluation service reports verifying compliance with specified performance requirements.

1.5 QUALITY ASSURANCE

A. Follow approved Quality Assurance/Quality Control Program

B. Designate a project manager for the duration of the project to coordinate with the Contractor.

C. Manufacturer Qualifications: Provide all primary products specified in this section by supplied by a single manufacturer with a minimum of twenty years' experience in the top lighting industry. Make secondary products acceptable to the primary manufacturer.

D. Installer Qualifications: Install all products by a single installer with a minimum of five years demonstrated experience, with adequate equipment, skilled workers, and practical experience to meet the project schedule.

E. Provide skylights conforming with authorities having jurisdiction designed to meet design criteria of the project location and the following:

1. Skylights certified by NFRC.

2. Skylights tested and labeled in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.

3. Skylights with Factory Mutual (FM) Approval Class Number 4431.

4. Meet or exceed OSHA 200 pound (90 kg) Drop Tests expressed in 29 CFR 1910.23(e)(8)

5. Skylights provide minimum 69 psf (3.30 kPa) design load.

1.6 WARRANTY

A. Daylighting Device: Manufacturer's standard warranty for 10 years.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. See 01 60 00 – Products, Materials, Equipment, and Substitutions.

B. Deliver products in a cool dry location protected from the weather and in the manufacturer's original unopened containers until ready for installation.

C. Store products in manufacturer's unopened packaging until ready for installation.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

1. AAMA/WDMA/CSA 101/IS2/A440, Class CW-PG70, size tested 21-inch (530 mm) diameter, Type TDDOC and Type TDDCC.

a. Air Infiltration Test:

1) Provide air infiltration not exceeding 0.30 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E283.

b. Water Resistance Test:

1) Passes water resistance; no uncontrolled water leakage with a pressure differential of 10.7 psf (512 Pa) or 15 percent of the design load (whichever is greater) and a water spray rate of 5 gallons/hour/sf for 24 minutes when tested in accordance with ASTM E547 and ASTM E331.

c. Uniform Load Test: All units tested with a safety factor of (3) for positive pressure and (2) for negative pressure, acting normal to plane of roof in accordance with ASTM E330.

1) No breakage, permanent damage to fasteners, hardware parts, or damage to make daylighting system inoperable or cause excessive permanent deflection of any section when tested at a Positive Load of 150 psf (7.18 kPa) or Negative Load of 70 psf (3.35 kPa).

2. Hurricane Resistance:

    a. Meets ASTM E1886 and ASTM E1996 for missile and cyclic pressure differential testing for TDI Windstorm zones.

3. Fire Testing:

    a. Fire Rated Roof Assemblies:

        1) When used with the Dome Edge Protection Band, all domes meet fire rating requirements as described in the International Building Code for Class A, B, and C roof assemblies.

        2) When used with Dome Edge Protection Band and Rooftop Fire Glazing, all domes meet prescriptive method of Option 1 of IBC 708A.2.1 and IWUIC 101.2

    b. When used with the Dome Edge Protection Band, all domes meet fire rating requirements as described in the International Building Code.

    c. Self-Ignition Temperature - Greater than 650 degrees F per ASTM D1929.

    d. Smoke Density: Rating no greater than 450 per ASTM E84 in way intended for use. Classification C.

    e. Rate of Burn and/or Extent: Maximum Burning Rate: 2.5 inches/min (62 mm/min) Classification CC-2 per ASTM D635.

    f. Rate of Burn and/or Extent: Maximum Burn Extent: 1 inch (25 mm) Classification CC-1 per ASTM D635.

4. Fall Protection Performance:

    a. Passes fall protection test: No penetration of dome or curb cap when subject to 400 lb (160 Kg)/42-inch (1066 mm) impact drop test when tested in accordance with OSHA 29 CFR 1926.506(c) Safety Net Systems.

    b. Passes fall protection test: California State OSHA Fall Protection Code of Regulations, Title 8, Section 3212 (e)(1) Skylight Screens.

5. Blast Resistance: ASTM F1642, ASTM F2912, GSA-TS01-2003, and UFC 4-010-01:

    a. Airblast Loading ASTM Hazard Rating: Passes: No Hazard Rating

    b. Airblast Loading UFC Level of Protection: Passes Medium Level of Protection

    c. Dynamic Overpressure Loading ASTM Hazard Rating: Passes: No Hazard Rating

    d. Dynamic Overpressure Loading UFC Level of Protection: Passes Medium Level of Protection

2.2 MANUFACTURERS

A. Acceptable Manufacturer: Solatube International, Inc., which is located at: Solatube International 2210 Oak Ridge Way; Vista, CA 92081-8341; Toll Free Tel: 888-765-2882; Tel: (760) 477-1120; Fax: (760) 597-4488; Email: request info (sales@solatube.com); Web:http://www.solatube.com

2.3 TUBULAR DAYLIGHTING DEVICES

A. Tubular Daylighting Devices General: Transparent roof-mounted skylight dome and self-flashing curb, reflective tube, and ceiling level diffuser assembly, transferring sunlight to interior spaces; complying with ICC AC-16.

B. SolaMaster Series: Solatube Model 750 DS, 21-inch (530 mm) Daylighting System:

1. Model:

a. Solatube Model 750 DS-O Open Ceiling. AAMA Type TDDOC.

2. Capture Zone:

a. Roof Dome Assembly: Transparent, UV and impact resistant dome with flashing base supporting dome and top of tube.

1) Outer Dome Glazing: Type DA, 0.125 inch (3.2 mm) minimum thickness injection molded acrylic classified as CC2 material; UV inhibiting (100 percent UV C, 100 percent UV B and 98.5 percent UV A), impact modified acrylic blend.

a) Raybender 3000: Variable prism optic molded into outer dome to capture low angle sunlight and limit high angle sunlight.

b. Tube Ring: 0.090 inch (2.3 mm) nominal thickness injection molded ASA. Prevents thermal bridging between base flashing and tubing and channel condensed moisture. Attached to base of dome ring with butyl glazing rope 0.24-inch (6 mm) diameter; to minimize air infiltration.

c. Dome Seal: Adhesive backed weatherstrip, 0.63 inch (16 mm) tall by 0.28 inch (7 mm) wide.

3. Dome Options:

a. Dome Edge Protection Band: Type PB, for fire rated Class A, B or C roof applications. Galvanized steel. Nominal thickness of 0.039 inch (1 mm). For use with all flashing types.

4. Flashings:

a. Roof Flashing Base:

1) One Piece: One-piece, seamless, leak-proof flashing functioning as base support for dome and top of tube. Sheet steel, corrosion resistant conforming to ASTM A653/A653M or ASTM A463/A463M or ASTM A792/A792M, 0.028 inch (0.7 mm) plus or minus .006 inch (.015 mm) thick.

a) Base Style: Type F11, Self-Mounted, 11 inches (279 mm) high.

5. Transfer Zone:

a. Extension Tubes: Aluminum sheet, thickness 0.018 inch (0.5 mm) conforming to ASTM B 209.

1) Reflective Tubes:

a) Reflective extension tube, Type EXX and Type EL with total length of run as indicated on the Drawings.

b) Interior Finish: Spectralight Infinity with INFRAREDuction Technology combining ultra-high Visible Light reflectance with Ultra-low Infrared (IR) reflectance.

2) Tube Options

a) Open ceiling trim ring: Type R, ABS Plastic, White; nominal thickness of 0.04 inch (1 mm).

6. Delivery Zone:

a. Diffuser Assemblies for Tubes Not Penetrating Ceilings (Open Ceiling): Solatube Model 750 DS-O. 21-inch (530 mm) diameter diffuser attached directly to bottom of tube.

1) Lens: Type L5 (Wide), OptiView Micro-replicated lens design to maximize light output and diffusion. Visible Light Transmission shall be greater than 90 percent at 0.022 inch (0.6 mm) thick. Classified as CC2.

2) Diffuser Seal: Open cell foam, acrylic adhesive backed, 0.75 in (19 mm) wide by 0.125 in (3.2 mm) thick to minimize condensation and bug, dirt and air infiltration per ASTM E283.

3) Diffuser Trim Ring: Injection molded acrylic. Nominal wall thickness 0.172 inches (4.4 mm).

2.4 ACCESSORIES

A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type recommended by manufacturer, or injection molded nylon.

B. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.

C. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or recommended by manufacturer.

PART 3 -- EXECUTION

3.1 DELIVERY

A. See 01 60 00 – Products, Materials, Equipment, and Substitutions.

B. Coordinate delivery schedule with the Contractor to minimize on site storage.

C. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

D. Store materials in a dry area, protected from freezing, staining, contamination or damage.

E. Pre-Installation Meeting: Develop a pre-installation meeting on the project site minimum one week before beginning work of this Section. Invite the Contractor, Architect or Owner's Representative and representatives of all related trades to:

1. Coordinate between the at least the following trades.

a. Roofing to install the flashing, skylight, and LED Light Kit (when specified)

b. Electrical to wire components and program lighting controls.

2. Verify project requirements and site logistics.

3. Assess integrity of the roofing system and building structure.

4. Review manufacturer's installation instructions and warranty requirements.

3.2 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Examine openings, substrates, structural support, anchorage, and conditions for compliance with requirements for installation tolerances and other conditions.

C. If substrate and rough opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.3 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Coordinate requirements for power supply, conduit, and wiring.

C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.4 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Coordinate installation with substrates, air and vapor retarders, roof insulation, roofing membrane, and flashing to ensure that each element of the Work performs properly, and that finished installation is weather tight.

1. Install flashing to produce weatherproof seal with curb and overlap with roofing system termination at top of curb.

2. Provide thermal isolation when components penetrate or disrupt building insulation. Pack fibrous insulation in rough opening to maintain continuity of thermal barriers.

3. Coordinate attachment and seal of perimeter air and vapor barrier material.

C. Where metal surfaces of tubular unit skylights will contact incompatible metal or corrosive substrates, including preservative-treated wood, provide permanent separation as recommended by manufacturer.

D. Align device free of warp or twist, maintain dimensional tolerances.

E. Inspect installation to verify secure and proper mounting. Test each fixture to verify operation, control functions, and performance. Correct deficiencies.

3.5 CLEANING

A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

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SECTION 08 71 00 – DOOR HARDWARE

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Door hardware

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. Reference Specifications

01 33 00	Submittal Procedures

C. Reference Standards

Americans with Disabilities Act (ADA)	
ADAAG	Americans with Disabilities Accessibility Guidelines
American National Standards Institute (ANSI)	
ANSI A 117.1	Accessible and Usable Buildings and Facilities
ANSI A 156.1	Butts and Hinges
ANSI A 156.3	Exit Devices
ANSI A 156.4	Door Controls – Door Closers
ANSI A 156.5	Auxiliary Locks and Associated Products
ANSI A 156.6	Architectural Door Trim
ANSI A 156.7	Template Hinge Dimensions
ANSI A 156.8	Door Controls – Overhead Stops
ANSI A 156.13	Mortise Locks and Latches
ANSI A 156.15 -	Closer Holder Release Devices
ANSI A 156.16	Auxiliary Hardware
ANSI A 156.18	Material and Finishes
ANSI A 117.1	Accessible and Usable Buildings and Facilities
Builders' Hardware Manufacturers' Association (BHMA)	
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as "the Code

Door and Hardware Institute (DHI)	
	Recommended Procedure for Processing Hardware Schedules and Templates" and "Architectural Hardware Scheduling and Format.
National Fire Protection Association (NFPA)	
NFPA 80	Fire Doors and Windows
NFPA 101	Life Safety Code
Underwriters' Laboratories (UL)	
UL 10B	Standard for Fire Test Door and Assemblies
UL 10C	Positive Pressure Fire Tests of Door Assemblies

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions.

B. Certificates:

1. Certification by the door hardware Manufacturer that the door hardware provided is suitable for, and compatible with, the required installation.

2. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and owner.

3. Certification of supplier's qualifications demonstrating compliance with the qualifications requirements indicated.

4. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

5. Submit certification from a recognized testing agency that fire doors have passed tests to meet fire ratings indicated.

6. Certification for hardware in fire rated openings indicating compliance with UL 10C and the Code.

7. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

2. Furnish a complete, detailed hardware schedule. The hardware schedule shall indicate groups, type, style, function, Manufacturer's name, catalog number, location, and finish of each item to be provided, in accordance with the DHI "Architectural Hardware Scheduling Sequence and Format." The hardware schedule shall include the following additional information:

   a. List each door opening, organized into "hardware sets" indicating complete designations of every item required for each door opening to function as intended.

   b. Location of each hardware set cross-referenced to floor plans and schedules on the Drawings.

   c. Door sizes shall be noted on the hardware schedule, and hardware shall be in strict accordance with height, width, and thickness requirements.

   d. Special mounting instructions or requirements that vary from standard.

   e. Handing and degree of swing of each door.

   f. Keying information.

   g. Fastenings and other pertinent information.

   h. Explanation of all abbreviations, symbols, and codes contained in schedule.

   i. The hardware schedule shall also include a complete template list showing template references and data for each item requiring preparation of doors and frames.

   j. Submit separate detailed keying schedule for approval indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.

D. Samples:

1. When requested by the Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1.05 CLOSEOUT SUBMITTALS

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Door hardware shall be provided by a single Manufacturer, each.

B. Qualifications:

1. Manufacturers:

a. Door hardware Manufacturer shall have a minimum of 20 years of door hardware manufacturing experience.

b. Door hardware Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

c. Manufacturers without these qualifications will not be accepted.

2. Suppliers:

a. Supplier shall be a recognized architectural door hardware supplier who has maintained an office and has been furnishing hardware in the project's vicinity for a period of at least 2 years.

b. Supplier shall employ at least one Architectural Hardware Consultant (AHC) who shall be responsible for the preparation and execution of the Work of this Section and who shall be available to the Owner, the Engineer, and the Contractor during business hours for consultation about the project's hardware and requirements.

c. Supplier shall be a certified direct distributor and be a full sales and service organization for the Manufacturers proposed.

d. Suppliers without these qualifications will not be accepted.

3. Installers:

a. Installer shall have a minimum of 5 years’ experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

b. Installer shall be trained, certified, and authorized by the Manufacturer to install the Manufacturer’s product.

c. Installers without these qualifications will not be accepted.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Furnish Manufacturer's written warranty to cover defects in materials, products, and manufacturing workmanship. The term of the warranty shall be as indicated below:

    a. Mortise Locksets: 5 years.

    b. Exit Devices: 5 years.

    c. Door Closers: 10 years.

2. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Door hardware shall be recommended by the Manufacturer for the installation indicated.

B. Door hardware shall be suitable for, and compatible with, the required installation.

C. Door hardware shall be best grade, entirely free from imperfections in manufacture and finish. Qualities, weights, and sizes specified herein are the minimum that will be accepted.

D. Hand of door shall be as indicated. If door handing changes prior to fabrication, the Contractor shall make necessary adjustments at the direction of the Engineer.

E. The Work hereunder shall include fabrication and mounting templates as needed for fabricators and for control of application of hardware items.

    1. In addition thereto, the Contractor shall provide trim, attachments, and fastenings indicated or required for proper and complete installation.

F. Door hardware shall be coordinated with other Work requiring door hardware or attaching to it. Copies of schedules, templates, etc., shall be furnished in ample time to avoid fabrication and construction delays. Each item of hardware shall be identified according to the approved list and schedule. Hardware shall be made to template.

G. The Contractor shall furnish the hardware supplier with Shop Drawings from other trades with which hardware must be coordinated. After checking these Shop Drawings, the Contractor shall promptly supply necessary template information to all concerned as may be required to facilitate the progress of the job.

    1. Furnish all templates and schedules required by the Manufacturers of the doors and frames to enable the Manufacturers to make proper provision in their Work to receive the door hardware. All locks, lock strikes, and flush bolts shall be made to ANSI standard dimensions.

2. Procedures for template information shall be in accordance with the handbook, “Recommended Procedure for Processing Hardware Schedules and Templates.”

2.02 HINGES

A. Manufacturer or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

a. McKinney.

b. Pemko.

B. Description:

1. Hinges shall conform to ANSI A 156.1/BHMA A 2111 and shall be 5-knuckle design, heavy weight (0.180-in minimum), ball bearing type, with flush tips.

2. Two hinges shall be provided for each door leaf up to and including 5-feet (1.5 m) in height and an additional hinge shall be added for each 2½-feet (.76 m) or fractions thereof of additional door height.

3. Hinges shall be 4½ in by 4½-in, except at doors exceeding 36-in in width.

a. Doors exceeding 36-in in width shall have 5-in by 4½-in hinges.

4. Hinges on exterior doors shall be provided with non-removable pins (NRP).

5. Provide hinges with countersunk, Phillips flat-head screws unless otherwise indicated.

2.03 CYLINDERS AND KEYING

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Sargent, Signature High Security Cylinders

B. Description:

1. Locks and cylinders shall be master keyed to the Owner’s requirements as directed by the Engineer.

2. The Contractor shall have the hardware supplier submit a keying schedule for approval prior to placing an order for the locks and keying of cylinders. The keying schedule shall be coordinated between the Owner, the Engineer, the Contractor, and the hardware supplier.

C. Keying:

1. Locks and cylinders shall be construction master-keyed. Locks and cylinders to be master-keyed or grandmaster-keyed as directed by the Owner. The factory shall key locks and cylinders. Furnish the following key amounts:

    a. 2 change keys per lock.

    b. 3 grand master keys.

    c. 6 master keys per master level.

    d. 6 construction/temporary keys.

2. Master keys and all high-security or restricted keyway blanks shall be sealed in tamper-proof packaged boxes when shipped from the factory. The boxes shall be shrink-wrapped and imprinted to ensure the integrity of the packaging.

2.04 SURFACE MOUNTED OVERHEAD CLOSERS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

    a. Sargent 351 Series.

B. Description:

1. Closers shall be ANSI A 156.4, Grade 1 Certified.

2. Closers shall have non-ferrous covers, one-piece, aluminum alloy bodies forged steel arms, and separate valves for adjusting and backcheck, closing and latching cycles, and adjustable spring to provide up to 50 percent increase in spring power.

3. Closers shall be furnished with parallel arm mounting on doors and shall be mounted to permit 180-degree door swing wherever wall conditions permit. Furnish without hold open arms unless otherwise indicated. Closers shall not be installed on exterior or corridor side of doors; install closers on door unless otherwise approved in writing by the Engineer.

4. Closers shall be powder coated to match door hardware with a special rust inhibitor (SRI) pretreatment, as recommended in writing by the Manufacturer, applied prior to the powder coating.

5. Where closers or other items have lever or similar arms, attachment to doors shall be with sex bolts only.

6. Closers for out-swinging exterior doors shall be top-jamb-mounted and furnished with adapter plates.

7. The Contractor shall be responsible to provide the correct arm with the closers.

8. Closers shall be provided with sex bolts for fastening through doors, frames and transoms.

2.05 MORTISE LOCKSETS AND LATCHSETS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Sargent 8200 Series.

B. Description:

1. Locksets shall be ANSI A 156.13 Series 1000 Grade 1. Functions shall be manufactured in a single sized case formed from minimum 12-gauge steel. Lockset shall have a field-adjustable, beveled armored front, with a 0.125-in (3.2 mm) minimum thickness and shall be reversible without opening the lock body. The lockset shall be 2 ¾-in backset with a one-piece ¾-in anti-friction stainless steel latchbolt. The deadbolt shall be a full 1-in throw made of stainless steel and have two hardened steel roller inserts. To ensure proper alignment, all trim, shall be thru-bolted and fully interchangeable between rose and escutcheon designs.

2. Function of locksets shall be appropriate for doors use. Hardware supplier shall verify lock functions with the Owner and the Engineer prior to ordering material.

3. Lock strikes shall be non-handed, boxed type of sufficient length and having curved lips to protect the trim and jambs and be so shaped as to avoid the possibility of tearing clothing. Strikes shall be provided with metal strike boxes.

4. Locks shall be provided with the same cylinder and keyway for master keying. They shall be the product of the same Manufacturer as the locksets unless otherwise indicated. The correct cylinders with necessary modifications and components such as cams, collars, rings, retainers, plates, fasteners, etc., shall be provided for other specialty hardware such as exit devices, store front locksets, and sliding door locks where the hardware manufacture specified is different than cylinder Manufacturer.

5. Exit doors shall be openable at all times from the inside without the use of key or any special knowledge or effort.

2.06 STRIKES

A. Manufacturer:

1. To be provided by exit device and lockset and latchset device Manufacturer.

B. Description:

1. Strikes shall be compatible with the installation required.

2. All strikes shall be non-handed with a curved lip.

2.07 EXIT DEVICES

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

    a. Sargent, 80 Series.

B. Description:

1. Exit devices shall be certified to meet ANSI A 156.3 Grade 1.

2. Exit devices shall be listed by Underwriters Laboratories and shall bear the UL label for life safety in full compliance with NFPA 80 and NFPA 101.

3. Mounting rails shall be formed from a solid single piece of stainless steel, brass, or bronze no less than 0.072-in thick. Push rails shall be constructed of 0.062-in thick material. Painted or anodized aluminum shall not be considered heavy duty and are not acceptable. Hex key dogging shall be standard for all life safety panic hardware. Lever trim shall be available in finishes and designs to match that of the specified locksets.

2.08 LOCK GUARDS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

    a. McKinney.

B. Description: Provide high security, corrosion resistant, surface mounted lock guards with concealed fasteners compatible with the installation, at each exterior door.

2.09 DOOR TRIM AND PROTECTIVE PLATES

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

    a. McKinney.

    b. Pemko.

B. Description:

1. Kickplates shall be 0.050-gauge, 2-in less width of door, beveled on 3 sides, and 10-in high, except where necessary to clear a louver in which case they shall be 8-in high.

2. Push plates, pull plates, door pulls, and miscellaneous door trim shall be as indicated.

2.10 WALL MOUNTED DOOR STOPS

A. Manufacturer, or Equal:

1. 1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

a. McKinney.

B. Description:

1. Where a door is indicated to open against a wall, wall mounted doorstops, in the form of wall bumpers, shall be provided. Provide convex or concave design as indicated.

2. Wall mounted doorstops shall be non-ferrous, and of the type given in the hardware schedule.

3. Provide door stops with the proper fasteners, as required by the substrate to which stops are to be secured.

2.11 OVERHEAD STOPS WITH HOLD OPEN FUNCTION

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal:

a. Rixson.

B. Description:

1. Overhead type door holders shall be of correct size for door, 90 degree openable and allowing for checkmating. Interior doors shall be provided with overhead stops if wall type stops cannot be used.

2. Track, slide, arm, and jamb bracket shall be constructed of extruded bronze and shock absorber spring shall be of heavy tempered steel.

3. Overhead stops shall be of non-handed design.

2.12 WEATHERSTRIPPING, GASKETING AND SEALS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

a. McKinney.

b. Pemko.

B. Description:

1. Provide continuous weatherseal on exterior doors.

2. Provide continuous light or sound seals on interior doors where indicated.

3. Provide UL rated fire and smoke seals on all fire rated doors. Provide intumescent seals as required to meet UL 10C and the Code. Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by Manufacturer.

2.13 THRESHOLDS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

a. McKinney.

b. Pemko.

B. Description:

1. Provide threshold at each exterior door, and at other locations where indicated. Provided in size and configuration indicated, fabricated to accommodate door hardware and to fit door frames.

2. Thresholds shall be aluminum unless otherwise noted.

3. Threshold units shall comply with ADAAG and ANSI A 117.1.

4. At Fire Rated doors, provide UL rated thresholds.

5. Where adjacent floor material differs, provide threshold as appropriate.

6. Provide marble threshold at toilet rooms.

2.14 SILENCERS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal:

a. McKinney.

b. Pemko.

B. Description: Interior door frames shall be provided with rubber silencers, 3 for each single door and 2 for each pair of doors.

2.15 FASTENERS

A. Provide necessary screws, bolts, and other fasteners of suitable size and type to secure the hardware into position. The fasteners shall match the hardware in material and finish.

B. The hardware provided, such as expansion bolts, sex bolts, toggle bolts and other approved anchorages shall be coordinated with the job and to each setting condition.

C. Phillips head screws shall be used at exposed conditions. Machine screws shall be used at metal doors and frames.

D. Required screws shall be supplied as necessary for securing door hardware in the appropriate manner. Thru-bolts shall be supplied for exit devices and door closers where required by the Code and where the appropriate blocking or reinforcing is not present in the door to preclude their use.

2.16 FINISHES

A. Door hardware shall be 630/US 32D (stainless steel satin finish) unless otherwise indicated.

B. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI A 156.18 including coordination with traditional U.S. finishes shown by certain Manufacturers for their products.

C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with Manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Locks, exit devices, door closers, overhead door holders, hinges, kickplates, pulls and push plates, thresholds, and other similar items shall be individually packed in separate, suitable, original, containers as furnished by the hardware Manufacturers. Each container shall be clearly marked with item numbers, article numbers, and names corresponding to those listed in the hardware schedule.

a. Small miscellaneous items that would not require specific location identifications, such as wall mounted stops and silencers may be quantity packed if properly labeled with item numbers and other identification.

2. The Contractor shall check the hardware upon delivery with the aid of a representative of the hardware supplier’s firm.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

1. The Contractor shall make certain that the building is secured and free from weather elements prior to installing interior door hardware.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where door hardware will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed door hardware.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of door hardware. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, ADAAG, ANSI A 117.1 and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

1. Mount hardware units at heights indicated in the following applicable publications, except as specifically indicated or required to comply with the governing regulations.

a. The Contractor shall comply with DHI recommended locations for hardware as applicable for specified doors.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing Work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, door hardware and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Adjusting and cleaning shall consist of ensuring smooth operation, lubricating and testing the door hardware.

1. Door hardware shall operate smoothly, quietly, and without squeaking and binding.

a. The Contractor shall adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

b. Latches and bolts shall be installed to automatically engage in keepers, whether activated by closers or by manual push. In no case should additional manual pressure be required to engage latch or bolt in keepers.

c. Closers and hinges shall be carefully adjusted to operate the doors noiselessly and evenly, and hinges shall be installed so as not to bind. Closers, closer arms, and hold-open arms shall be attached with sex bolts.

d. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

D. Door hardware shall be protected from damage from subsequent construction operations.

E. The Contractor shall make adjustments required and retest until accepted.

F. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

G. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

H. When door hardware Work is completed, remove unused materials, containers, and equipment, and clean the Site of door hardware debris.

I. The hardware Supplier shall do a final inspection prior to Substantial Completion to ensure that all hardware has been correctly installed and is in proper working order and shall provide a written report of this inspection to the Engineer the file.

3.07 HARDWARE SCHEDULE

A. The following schedule is furnished for whatever assistance it may afford the Contractor. The Contractor shall not consider it as entirely inclusive. Should any particular door or item be omitted in any scheduled hardware group, the Contractor shall provide door or item with hardware same as required for similar purposes as accepted by the Engineer, and at no additional cost to the Owner. Quantities listed are for each pair of doors, or for each single door.

B. Abbreviations:

1. BO – By Others.

2. KX – Knox Company.

3. MC – McKinney.

4. RX – Rixson.

5. SA – Sargent.

6. PMD – painted to match door.

7. W/SS – with security studs.

C. Hardware Schedule:

1. ES – Single Exterior Doors:

Quantity	Device	Description
Per Spec.	Hinges	
1	Exit Device (ANSI 08)	8313 ET
1	Closer	
1	Kickplate	
1	Threshold	Pemko 2005AV Mill Aluminum
1	Weatherstrip/Gasketing	Pemko S88D at Head and Jambs
1	Door Top Drip	Pemko 346 at Door Head
1	Door Bottom	Pemko 321DN Annodized Aluminum

2. IS – Interior Single Doors (Closet)

Quantity	Device	Description
Per Spec.	**Hinges**	
1	Latchset (F01) (passage)	
Per Spec.	Continuous Sounds Seals	
1	Threshold (where indicated)	Mill Aluminum, See Details

END OF SECTION

SECTION 08 81 00 – GLASS GLAZING

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Glass and glazing accessories.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. Reference Specifications

01 33 00	Submittal Procedures
08 11 13	Hollow Metal Doors and Frames

C. Reference Standards

ASTM International (ASTM)	
ASTM C 1036	Flat Glass
ASTM C 1048	Heat Treated Flat Glass, Kind HS, FT Coated and Uncoated Glass
ASTM E 2190	Standard Specification for Insulating Glass Unit Performance and Evaluation
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code
Glazing Association of North America (GANA)	
Insulating Glass Certification Council (IGCC)	
National Fire Protection Association (NFPA)	
Underwriters’ Laboratories (UL)	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, maintenance instructions, and the following:

a. Step-by-step glass, glazing, setting, and sealing procedures.

b. Manufacturer's full-range color charts, indicating custom color for color selection by Engineer.

B. Certificates:

1. Certification of compliance with the requirements of paragraph 2.1.A.

2. Certified copies of recent test reports of systems similar to the design for this project substantiating performance of system in lieu of re-testing. Other supportive data shall be included as necessary.

3. For insulating glass units, furnish CBA certification from the IGCC.

4. Certification that the glazing materials have been tested in accordance with the ASTM test methods indicated.

5. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

2. Shop Drawings shall indicate thickness, dimension, U-values, R-values, and related data.

3. Include detail glazing methods, framing, and tolerances to accommodate thermal movement.

D. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 12-in by 12-in samples of each glass type.

3. 12-in by 12-in samples of each laminated panel type.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Glass shall be provided by a single Manufacturer.

2. Accessories shall be provided by a single Manufacturer, each.

B. Qualifications:

1. Manufacturers:

a. Glass Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers:

a. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

3. Certifications:

a. Insulating glass units shall be certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGCC) and tested in accordance with the ASTM test methods indicated.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Glass: Furnish Manufacturer's 10-year written warranty to cover defects in materials, products, and manufacturing workmanship.

2. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover the installation and associated labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Structural Requirements:

1. Glazing products, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Glazing shall be recommended by the Manufacturer for the installation indicated.

C. Glazing and accessories shall be suitable for, and compatible with, the required installation.

D. The Contractor shall coordinate color samples with other Sections through the submittal process.

2.02 ACCEPTABLE MANUFACTURERS:

A. Subject to the requirements indicated, provide Manufacturer and product listed below:

1. Viracon, VE4-55

2. Vitro Architectural Glass

3. AGC Glass Company

2.03 ARCHITECTURAL GLASS

A. Each piece of glazing shall bear the Manufacturer's label showing the strength, grade, thickness, type and quality of the material. Labels shall remain in place until the glass has been set and inspected by the Engineer except that safety and insulating glass shall have permanently etched labels.

B. When material is not cut to size by the Manufacturer and is furnished from local stock, the glass and glazing Contractor shall submit an affidavit stating the strength, grade, thickness, type, quality, and Manufacturer of the material furnished.

C. Float glass and annealed glass shall conform to ASTM C 1036, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing, and light-reducing), and Quality q3.

D. Heat treated glass shall conform to ASTM C 1048, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing, and light-reducing), and Quality q3, Kind HS/FT.

1. Heat-treated flat glass shall be by horizontal (roller hearth) process with inherent rollerwave distortion parallel to the bottom edge of the glass as installed.

2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements.

3. For uncoated glass, comply with requirements for Condition A.

4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).

5. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is required, including, but not limited to glass in doors, and glass in lites adjacent to doors.

6. In addition to conforming to ASTM C 1048, heat treated glass shall conform to flatness tolerances indicated below:

    a. Bow and warp are defined as deviation of a glass surface from a true plane, with glass freestanding or installed in a frame and positioned in a vertical plane. Localized bow refers to any straight-line segment on a glass surface with length of 12-in. Overall bow refers to any straight-line segment on glass surface that extends between opposite edges and is perpendicular to at least one edge. Length of line segment is gauge length. Localized bow shall not exceed 0.0625-in. Overall bow shall not exceed: 0.041-in per foot for gauge length zero to 36- in; 0.031-in per foot for gage length 36-in to 60-in; one half of the values listed in ASTM C1048-97b, Table 2 for gauge lengths exceeding 60-in. Where heat-treating results in parallel ripple or waves, maximum peak-to-valley deviation shall not exceed 0.003. Requirements for localized bow and overall bow shall also be satisfied. Direction of ripples shall be consistent throughout the installation.

2.04 INTERIOR GLASS (Non-Fire Rated Openings):

A. Description:

1. Acoustical insulating units, thickness as indicated, comprised of 2 clear liters, FT glass.

2. 1 1/16-in total thickness, comprised of one lite ¼-in thick, one lite 5/16-in thick, with 1/2-in air space.

    a. Sound Transmission Class (STC): 40

2.05 ACCESSORIES

A. Glazing compound for non-fire rated glazing shall be Dow, 999-A Glazing Silicone, or equal.

1. Glazing compound shall be acetoxy cure silicone for adhesion to glass and metals. One-part sealant that cures in the presence of atmospheric moisture to produce a durable and flexible glazing and curtainwall seal.

B. Glazing compound for fire rated glazing shall be Dap 33, or equal.

1. Glazing compound shall meet the Code, and NFPA requirements for a hard-setting glazing compound with 90 percent inert and non-flammable components.

C. Glazing Tape shall be Tremco, No. 440, or equal.

1. Glazing tape shall be compatible with the glazing compound.

D. Setting blocks shall be 85 +/-, 5 durometer and spacer blocks, 50 durometer, shall be closed cell neoprene.

E. Additional material to complete glazing installation shall be as recommended in writing by the Manufacturer.

F. Seals against moisture intrusion as recommended by the Manufacturer. Provide with polyurethane and silicone-based sealants with a 20-year life.

2.06 FABRICATION

A. The Contractor shall field verify size, location, and placement of glazing, shall advise Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

1. Glass shall be assembled before shipment to the Site.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where glazing and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed glazing

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of glazing. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate the Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION – GENERAL

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as determined by the Engineer.

B. The Contractor shall provide for a complete installation. Glazing shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. Glazing shall be performed in accordance with the GANA standards.

D. Frame elements shall have been painted where required and shall be thoroughly cleaned before glazing commences.

E. Separate dissimilar metals using gasketed fasteners and blocking to eliminate the possibility of electrolytic reaction.

3.06 INSTALLATION OF INTERIOR GLAZING – NON-FIRE RATED OPENINGS

A. Install continuous glazing strip against rabbet.

B. Set glass in place on setting blocks and install another continuous glazing strip around perimeter of glass.

C. Install glazing beads, setting against glazing strips firmly in order to place a small amount of pressure against the strips.

3.07 CLEANING

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, glazing and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Clean glazing compound from frames around glazing installed under this Section upon completion of the Work.

3. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

4. Weep holes and drainage channels must be unobstructed and free from dirt and sealant.

C. Glazing shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required and retest until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When glazing Work is completed, remove unused materials, containers, and equipment, and clean the Site of glazing debris.

END OF SECTION

SECTION 08 91 00 – LOUVERS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. The Contractor shall provide louvers and appurtenant Work, complete, in place, and operational in accordance with the Contract Documents.

2. The Contractor shall furnish professional design and engineering services as required for louvers.

   a. Professional design and engineering services may be provided by the Manufacturer or by an independent licensed civil engineer retained by the Contractor, either of which shall comply with the requirements indicated.

3. The Contractor shall coordinate color samples with other Sections through the submittal process.

4. The Contractor shall coordinate the requirements herein with the building heating, ventilating, and cooling system; see Division 23 Sections of these Specifications.

5. The Contractor shall coordinate wiring requirements and current characteristics of motor operators with the building electrical system; see Division 26 Sections of these Specifications.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Standards

Air Movement and Control Association (AMCA)	
Standard 500	Test Methods for Louvers, Dampers and Shutters
Standard 511	Certified Ratings Program for Air Control Devices
American Architectural Manufacturer's Association (AAMA)	
AAMA 2605	Voluntary Specification, Performance Requirements, and Testing Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
ASTM International (ASTM)	
AAMA 2605	Voluntary Specification, Performance Requirements, and Testing Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

ASTM B 211	Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B 209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM D 822	Standard Practice for Filtered Open Flame Carbon Arc Exposures of Paint and Related Coatings
ASTM D 2244	Standard Practice for Calculation of Tolerances and color Differences from Instrumentally Measured Color Coordinates
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code
Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA)	
	Architectural Sheet Metal Manual (ASMM)

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions, and the following:

   a. Performance data in accordance with AMCA Standards 500 and 511.

   b. AMCA licensed data demonstrating that each louver meets the criteria herein.

   c. Manufacturer’s full-range color charts, indicating custom color availability at no additional cost to the Owner, for color selection by the Owner.

   d. Certificates:

2. Certification by the louver Manufacturer, that the louvers provided are suitable for, and compatible with, the required installation.

3. Certification of compliance with the requirements of paragraph 2.1.A.

4. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer’s products, and contact information of the consultant firm of record, general contractor and owner.

5. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

6. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

B. Shop Drawings and Calculations:

1. Complete Shop Drawings showing location and detail of installation, and design calculations.

2. Shop Drawings and Calculations shall be prepared, approved, and stamped by a professional civil engineer licensed per local engineering licensing laws.

3. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each louver type, schedule of louvers, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

a. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories of each louver type.

C. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 3-in by 4-in color samples showing substrate, finish, and color.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QULAITY ASSURANCE

A. Single Source Responsibility:

1. Louvers shall be provided by a single Manufacturer, unless otherwise indicated.

B. Qualifications:

1. Manufacturers:

a. Louver Manufacturer shall have a minimum of 20 years of louver manufacturing experience.

b. Louver Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

c. Manufacturers without these qualifications will not be accepted.

2. Installers:

a. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

b. Installers without these qualifications will not be accepted.

3. Licensed Professionals:

a. A professional civil engineer licensed per local engineering licensing laws shall design the louvers and connections to the structure.

C. Fabrication practices, construction details, and installation procedures shall conform to the practices of SMACNA as recommended in the ASMM, as applicable and as required.

D. Louvers shall bear AMCA Certified Ratings Seals for air performance and water penetration ratings

1.07 WARRANTY

A. Manufacturer Warranty:

1. Furnish Manufacturer's extended 20-year written warranty for the finish. Warranty shall include provisions for failures of the finish including, but not limited to, chalking, crazing, peeling, and fading.

a. Finish coating shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D 4214

b. Finish color shall not change color or fade in excess of 5 NBS units as determined by ASTM D 2244 and ASTM D 822.

2. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Structural Requirements:

1. Louvers, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

a. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Louvers shall be recommended by the Manufacturer for the installation indicated.

C. Louvers shall be suitable for, and compatible with, the required installation.

D. Design Requirements:

1. Louver system Manufacturer shall furnish the systems herein, including necessary custom modifications to meet the indicated requirements and to maintain the visual design requirements as approved by the Engineer.

2. Stationary components of louvers shall be of all-welded design.

3. Aluminum Sheet: ASTM B 209, Alloy 3003 and 5005 with temper as required for forming or as otherwise recommended by the metal producer to provide the required finish.

4. Aluminum Extrusions: ASTM B 211, Alloy 6063-T5, 6063-T6, or 6061-T6, unless otherwise indicated.

5. Supports, anchorage, and accessories shall be provided as required for complete assembly.

6. Perimeter conditions shall allow for installation tolerances, expansion and contraction of adjacent materials, and sealant Manufacturer's recommended joint design.

7. The Contractor shall not assume sealant and interior finishes contribute to framing member strength, stiffness, or lateral stability.

8. Assemblies shall be free from vibration harmonics, rattles, wind whistles, and noise due to thermal movement, thermal movement transmitted to other building elements, and wind pressure. Assemblies shall be free from loosening, weakening, or fracturing of attachments by components.

9. Attachment considerations are to take into account Site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening, or fracturing connection between units and building structure or between units themselves.

10. System shall drain any water entering system to the exterior of system.

11. Concealed fastening shall be provided.

12. Uniform color and profile appearance shall be provided at components exposed to view.

E. Expansion and Contraction Requirements: Louver systems shall accommodate expansion and contraction movement due to surface temperature differentials without causing buckling, stresses on adjacent Work, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other visual or technical detrimental effects.

2.02 DRAINABLE STATIONARY LOUVERS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Combination wall louvers shall be Ruskin Model ELF 6375DXH.

B. Description

1. Drainable stationary louvers shall have drain gutter in each blade and downspouts/drainage channels in jambs and mullions. Stationary blades shall be contained within a single 6 in louver frame. Components (heads, jambs, blades, and mullions) shall be factory assembled by the louver Manufacturer. Waterstop at sill shall be factory caulked water tight.

2. Heads, sills, jambs, mullions, and sills shall be one-piece structural aluminum members with integral caulking slot and retaining beads. Material thickness shall be 0.125 in. Mullions shall be sliding interlock with internal drains. Blades shall be one-piece aluminum extrusions with gutters designed to catch and direct water to jamb and mullion drains. Compression gaskets shall be provided between bottom of mullion or jamb and top of sill to insure leak tight connections.

a. Continuous, 0.125 in thick perimeter angles of same material as louvers shall be provided for attachment on inside to adjacent construction. At louvers over 6 ft wide, center vertical aluminum angle support and approved aluminum blade braces shall be provided, each blade. Secure top and bottom and to each brace and blade.

3. Frame: 6-in deep, 6063-T5 extruded aluminum, with .125-in nominal wall thickness. Downspouts/drainage channels and caulking surfaces shall be provided.

4. Blades: Stationary drainage blades, 6063-T5 extruded aluminum with .081-in nominal wall thickness, positioned at 37½ degree angle and spaced approximately 6 1/8 in on center.

C. Performance

1. AMCA Performance:

a. A 4 ft by 4 ft unit shall be licensed to bear the AMCA seal, and shall conform to the following:

Free Area	Minimum 9.08 sq. ft
Percent Free Area	Minimum 57 percent

Velocity at the Point of Beginning Water Penetration of 0.01 oz/sq. ft.	1023 FPM (312 MPM)

2.03 ACCESSORIES

A. Sill Extensions/Flashing:

1. Except for FRP stationary blade louvers, sill extensions/flashing shall be one-piece, extruded 0.060, aluminum.

    a. Sill extensions/flashing for FRP stationary blade louvers shall be one-piece fiberglass reinforced plastic to match the FRP louver.

2. Sill extension/flashing finish shall be the same as louver, custom color to match adjacent exterior wall, as approved by the Engineer.

B. Insulated Blank-Off Panels:

1. Insulated blank-off panels shall be provided where required to seal-off louver area not connected to ductwork or to cover areas not required for free air. Insulated blank-off panels shall be provided by the louver Manufacturer and shall consist of 2-in glass fiberboard insulation encapsulated and sealed completely in 0.032-in aluminum skins, securely fastened to louvers and ductwork.

2. Insulated blank-off panel finish shall be same as louvers, flat black in color, unless otherwise indicated.

C. Screens:

1. Bird Screen: Each exterior louver shall be provided with ¾-in by 0.051-in mesh aluminum wire bird screen secured within rewireable extruded aluminum frame as approved. Attach to interior face of louver, unless otherwise noted.

2. Insect Screen: For exterior louvers not connected to ductwork, provide separate fiberglass insect screen, frame, and accessories mounted to interior face of bird screen.

    a. Insect screen shall be installed such that it is removable to allow for frequent maintenance and cleaning.

3. Screens shall be secured to louver frames with removable machine screws, spaced at each corner and at 12-in on center, minimum, between corners

4. Screens and frames shall have same finish as louvers, color shall be black.

5. Fasteners: Fasteners shall be structural-grade aluminum. Provide materials, types, gauges, and lengths to suit unit installation conditions. Phillips flat-head machine screws shall be used for exposed features, unless otherwise indicated.

6. Anchor and inserts: Anchors and inserts shall be non-ferrous metal for exterior installations and elsewhere as required for corrosion resistance. Steel expansion bolt devices shall be used for drilled-in-place anchors. Concrete inserts shall be provided as required.

2.04 FINISH AND COLOR

A. Finish system shall be 1.2-mil, PVF2 Kynar 500, formulated by a licensed formulator to contain 70 percent PVF resin and applied by a licensed applicator.

1. The surface condition of this finish coat shall be 100 percent free of holidays, drip marks, scratches, roll marks, or abrasions that are visible from a distance of 5 ft in good light when in installed position. Surfaces shall be free of checking, crazing, peeling, or loss of adhesion.

2. Finish shall meet or exceed AAMA 2605.

3. Color shall be selected and approved by the Owner from Manufacturer's full color range including custom colors, and may be required to exactly match other building components, as determined by the Owner, at no additional cost to the Owner.

a. Tentative color selection: To be Selected.

b. The Owner reserves the option of changing this tentative color selection during the submittal process.

2.05 FABRICATION

A. The Contractor shall field verify size, location, and placement of louvers, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

1. Louvers shall be assembled before shipment to the Site.

2. Accurate relation of planes and angles shall be maintained, with hairline fit of contacting members.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where louvers and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed louvers.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of louvers. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. The Contractor shall block and reinforce walls as required to support the louvers and appurtenances.

E. Horizontal lines shall be level, and vertical lines shall be plumb.

F. Sill extensions shall be provided at exterior louver installations.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, louvers and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Louvers shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required and retest until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When louver Work is completed, remove unused materials, containers, and equipment, and clean the Site of louver debris.

END OF SECTION

SECTION 09 96 00 – HIGH-PERFORMANCE COATINGS

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide protective coatings, complete and in place, in accordance with the Contract Documents.

B. Definitions

1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means Dry Film Thickness.

C. The following surfaces shall not be coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Drawings.

2. Stainless steel

3. Machined surfaces

4. Grease fittings

5. Glass

6. Equipment nameplates

7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the Drawings are used to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 60 00	Products, Materials, Equipment, and Substitutions

B. Reference Standards

ASTM International (ASTM)	
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D3276	Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D4060	Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D6386	Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
American Water Works Association (AWWA)	
ANSI/AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
NACE International (NACE)	
NACE RP0287-02	Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
Occupational Safety and Health Administration (OSHA)	
OSHA 29CFR1910.1200	Hazard Communication
Society for Protective Coatings (SSPC)	
SSPC Guide 12	Guide for Illumination of Industrial Painting Projects
SSPC PA 1	Shop, Field, and Maintenance Coating of Metals
SSPC PA Guide 11	Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
SSPC SP 1	Solvent Cleaning
SSPC SP 2	Hand Tool Cleaning
SSPC SP 3	Power Tool Cleaning
SSPC SP 5/NACE No. 1	White Metal Blast Cleaning
SSPC SP 6/NACE 3	Commercial Blast Cleaning
SSPC SP 7/NACE 4	Brush-off Blast Cleaning (NACE No. 4)
SSPC SP 10/NACE 2	Near-White Blast Cleaning
SSPC SP 11	Power Tool Cleaning to Bare Metal
SSP SP 13	Surface Preparation of Concrete

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submittals shall include the following information and be submitted at least 30 Days prior to commencing protective coating Work:

1. Materials List: A copy of a coating materials list showing the manufacturer and the product number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submitting samples.

2. Manufacturer's Information: For each coating system to be used, the following data:

a. Manufacturer's data sheet for each proposed product.

b. Manufacturer’s statements on the suitability of the proposed products for the intended use. Include in the statement confirmation that the coating manufacturer’s technical engineering representative inspected all existing substrate and/or surfaces with existing coatings and confirmed that the proposed products, application procedures and surface preparation requirements are compatible with the coatings required by this Section.

c. Technical and performance information that demonstrates compliance with the system performance and material requirements.

d. Paint manufacturer's instructions and recommendations on surface preparation and application.

e. Colors available for each product (where applicable).

f. Compatibility of shop and field applied coatings (where applicable).

g. Safety Data Sheet for each product proposed.

C. Samples

1. Samples of paint, finishes, and other coating materials shall be submitted on 8-1/2 inch by 11-inch sheet metal. Each sheet shall be completely coated over its entire surface with one protective coating material, type, and color.

2. Two sets of color samples to match each color selected by the Owner from the manufacturer's standard color sheets. If custom mixed colors are indicated, the color samples shall be made using color formulations prepared to match the color samples furnished by the Owner.

3. One 5-pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

D. Experience Requirements of the Field Applicator:

1. Submit a project organization chart showing the full name and clear lines of responsibility and duties for all personnel scheduled to perform work (including office managers, quality control supervisor and safety supervisor) on the project.

2. Submit for documentation a statement on company letter head indicating the name of the Quality Control Supervisor (QCS) who has been given written authority by executive management to perform the duties of the QCS position for the project. Include in the statement the date of last successful completion of training to perform the QCS position. Acceptable coating inspection training programs include at a minimum: SSPC (PCI, NBPI, BCI) Level 1, KTA Level 1, GPI (Level 1), NACE (CIP Level 1, Frosio) or equivalent formal in-house inspection training conforming to ASTM D3276.

3. Submit for documentation the set of procedures that have been implemented for conducting and documenting training (as needed) and for qualifying trainees, newly hired craft workers and newly hired experienced workers. Include documentation of annual proficiency evaluation system for all craft workers.

4. Submit for documentation up-to-date experience, training certificates, and licenses for all personnel scheduled to perform work on the project.

5. Submit for documentation a statement on company letter head that key personnel (including but not limited to, project management and QCS) have reviewed the project contract documents and specifications in effect at contract award. Include in the statement confirmation that the project contract documents, and specifications have been distributed to all affected personnel within the organization scheduled to perform work on the project. Include in the statement the procedure for recording receipt and distribution of specifications and contract documents and all changes and revisions to contract documents. Include in the statement the procedures for documenting verbal responses from the Owner for requests for clarification.

6. Submit references of successfully completed projects for industrial coating projects completed within the last 18 calendar months. Acceptable references shall include contact information for owner staff having direct connection with the project, copies of facility owner project performance evaluations, letters of commendation from the owner or prime contractor, statements of final payment, and punch list acceptance.

E. Quality Assurance Plan

1. Submit for review the written project-specific Quality Control Program to be followed. Primary duties and responsibilities of the QCS as outlined in the Quality Control Program shall include but are not limited to the following:

    a. Ensuring that qualified personnel perform the Work on the project.

    b. Ensure that proper inspection forms and recording procedures are used for job quality monitoring (including those required herein).

    c. Ensure correct and properly operating and calibrated equipment is used.

    d. Review and sign off on Daily Inspection Reports (DIRs) on a timely basis (QCS must sign off or authorize review of DIRs by other competent QC personnel).

e. Ensure that Work is inspected for conformance with the contract requirements, good painting practice, and internal Quality Control (QC) procedures.

f. Ensure that nonconforming work and rework is properly documented.

g. Develop and/or review Inspection and Test Plans.

h. Conduct and/or review internal audits.

2. Submit for documentation written project-specific procedures for all production processes to be used on the project. The procedures shall include, but are not limited to the following:

   a. Standard company or contract specific procedures are available to and used by on-site personnel for verifying that coating and related operations are performed in accordance with contract requirements and industry best practices.

   b. Inspection procedures or project specific inspection plans ensuring that all work is properly performed and documented daily during coating operations or documented in accordance with contract requirements, are available to site personnel, and are used to perform in-process inspections of work at key hold points.

   c. Abrasive blasting (dry or wet) and related processes

   d. Water jetting and related processes

   e. Hand and power tool cleaning and related processes

   f. Coating mixing and related processes

   g. Coating application (e.g., brush, roller, spray, mitt) and related processes

   h. Top coating procedures (e.g., conditions when meeting and exceeding recoat windows)

   i. Curing process for materials applied

   j. Erecting, moving, and tearing down containment

   k. Field audits performed on site confirming equipment is in good operating condition

3. Submit for review and documentation Daily Inspection Reports (DIRs) to Engineer on a weekly basis. All DIRs and testing results shall be maintained on file for the duration of the project. DIRs must be signed and dated by the Contractor and formally reviewed by the QCS. DIRs and other daily reports shall record project relevant observations including:

   a. Compressed air cleanliness

   b. Air temperature (dry and wet bulb)

c. Relative humidity

d. Dew point

e. Substrate surface temperature

f. Abrasive cleanliness

g. Surface preparation cleanliness specified and achieved

h. Surface profile specified and achieved

i. Illumination of work area (foot candles for surface preparation, coating application, and inspection) in accordance with SSPC Guide 12 recommendations or contract requirements.

j. Batch numbers of coatings and thinners

k. Mixing of coatings (in accordance with coating manufacturer's mixing instructions)

l. DFT readings for each applied coating meeting specification requirements.

m. Inspection instruments used (manufacturer, model, and serial number)

n. Storage temperature and storage conditions to include min/max daily, or as required.

1.04 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. Nonconforming work, identified by Contractor QC personnel, Owner, Engineer or Owner's Representative performing QA on behalf of the Owner shall be documented and repaired.

B. Inspection: An inspection may be conducted during the eleventh month following completion of coating Work. The Contractor and a representative of the coating material manufacturer shall attend this inspection. Defective Work shall be repaired in accordance with these specifications and to the satisfaction of the Owner. The Owner may, by written notice to the Contractor, reschedule the inspection to another date within the one-year correction period or may cancel the inspection altogether. The Contractor is not relieved of its responsibilities to correct defects, whether or not the inspection is conducted.

1.05 COMPLIANCE WITH VOLATILE ORGANIC COMPOUND (VOC) LIMITS

A. All paint and coating products shall comply with the applicable limits on volatile organic compounds (VOCs) as established by the United States Environmental Protection Agency and by state and local air quality regulating agencies. It shall be the Contractor's responsibility to verify compliance of all paints and coatings.

B. Listed products in this specification are based on a maximum VOC level of 250 g/L. If local limits on VOCs are higher or lower, the Contractor shall propose substitute products that are compliant with local limits and equivalent in performance to the listed product. The Engineer shall determine if the proposed product is equivalent or equal to the named product in accordance with the requirements of Section 01 60 00 - Product, Materials, Equipment, and Substitutions.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Suitability: The Contractor shall use suitable coating materials as recommended by the manufacturer.

B. Material Sources: Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and the Contractor shall propose a substitution product of equal quality that does comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. Compatibility: In any coating system 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. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

D. Containers: Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.

E. Colors: Colors and shades of colors of coatings shall be as indicated or selected by the Owner. Each coat shall be of a slightly different shade to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the Owner.

F. Substitute or "Or-Equal" Products

1. To establish equality under Section 01 60 00 - Products, Materials, Equipment and Substitutions, the Contractor shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or-equal" product that the material meets the indicated requirements and is equivalent or better in the following properties:

    a. Suitability for the intended service

    b. Compatibility with other coatings

    c. Resistance to chemical attack

    d. Minimum and maximum recoat times

e. Minimum and maximum cure time for immersion

f. Abrasion resistance per ASTM D4060 using CS17 Wheel

g. Maximum and minimum dry film thickness per coat

h. Temperature limitations during application and in service

2. Protective coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. When requested, the Contractor shall provide the Engineer with the names of not less than 10 successful applications and case histories of the proposed manufacturer's products that comply with these requirements.

3. If a proposed substitution requires changes in the Work, the Contractor shall bear such costs involved as part of the Work.

2.02 INDUSTRIAL COATING SYSTEMS

A. System 1 - Acrylic Polymer

1. Materials

Primer	Manufacturer's recommendation
Finish Coat	1 component water-based acrylic
Type	Pure acrylic emulsion
Demonstrated suitable for	ferrous and nonferrous surfaces in industrial exposure, producing high gloss surface that is resistant to mild corrosion and chemical fumes, has good color and gloss retention, good weathering, and sunlight resistance
VOC Content, max (g/L)	250

2. Application and manufacturers

Prime Coat (DFT = 2 to 4 mils)	**Finish Coat (DFT = 2 to 4 mils)**	**Total System DFT**
PPG Pitt Tech Plus	PPG Pitt Tech Plus	4 to 8 mils
Tnemec Series 115 Unibond	Tnemec Series 1028 Enduratone for Gloss finish (use Series 1029 for Semi-Gloss finish)	
Carboline Rust Bond	Carbocrylic 3359 Series	
Sherwin Williams Pro Industrial Procryl	Sherwin Williams Pro Industrial Acrylic	

B. System 2 – Not Used

C. System 3 – Not Used

D. System 4 - Epoxy/Polyurethane

1. Materials

Primer type	2 component epoxy
VOC Content, max (g/L)	250
Finish type	2 component aliphatic polyurethane
VOC Content, max (g/L)	250
Demonstrated suitable for	ferrous surfaces, superior color and gloss retention, exceptional resistance to weathering, chemical fumes, and splash

2. Application and manufacturers

Prime Coat (DFT = 3 - 5 mils)	**Finish Coat (DFT = 3 - 4 mils)**	**Total System DFT**
Carboline Carboguard 890	Carboline Carbothane 134 VOC	6 - 9 mils
Devoe Devran 224V	Devoe 379H	
Tnemec Hi-Build Epoxoline II Series L69	Tnemec Endura-Shield Series 1094 for Gloss finish (use Series 1095 for Semi-Gloss finish)	
PPG Amerlock 2/400 (VOC)	Amershield VOC	
Sherwin Williams Macropoxy 646	S W Hi-Solids Polyurethane	

E. System 5 – Not Used

F. System 6 – Not Used

G. System 7 – Not Used

H. System 8 - Epoxy, Equipment

1. Materials

Primer Type	2 component epoxy
Demonstrated suitable for	Rust inhibitive, outstanding chemical, abrasion, and weathering resistance, resistance to splash, washdown, and condensation. Immersion capability is not required
VOC content, max (g/L)	250
Finish Type	2 component epoxy, available in many colors
Demonstrated suitable for	Outstanding chemical, abrasion, and weathering resistance, resistance to splash, washdown, and condensation. Immersion capability is not required
VOC content, max (g/L)	250

2. Application and manufacturers

Prime Coat (DFT = 4 - 5 mils)	**Finish Coat (DFT = 4 - 5 mils)**	**Total System DFT**
Devoe Bar-Rust 231	Devoe 224V	8 - 10 mils
PPG- Amerlock 2/400 VOC	Amerlock 2/400 VOC	
Tnemec Series L69	Tnemec Series L69	
Carboline Carboguard 890 Series	Carboline Carboguard 890 Series	
Sherwin Williams Macropoxy 646	Sherwin Williams Macropoxy 646	

I. System 9 – Not Used

J. System 10 - Acrylic, Concrete

1. Materials

Filler-Sealer Type	Epoxy or acrylic masonry sealer, for concrete and CMU, for wet and dry conditions
Primer	as recommended by manufacturer
VOC Content, max (g/L)	250
Finish Type	single component waterborne pure acrylic emulsion, industrial grade, high molecular weight
VOC Content, max (g/L)	250
Demonstrated suitable for	concrete under mild to moderate exposure conditions, splash but not immersion

2. Application and manufacturers

Prime Coat (Filler-Sealer)	**Finish Coat (DFT = 5 - 7 mils) (2 or more coats)**	**Total System DFT**
Tnemec EnviroFill Series 130	Tneme-Crete 180 Series	5 - 7 mils plus primer
PPG- Amerlock 400BF and/or Amercoat 965	PPG Pitt-Tech Plus	
Carboline Sanitile 500	Carboline - Carbocrylic 3359 Series	
Sherwin Williams Pro Industrial Heavy Duty Block Filler	Sherwin Williams Pro Industrial Acrylic	
Devoe Tru-Glaze 4015	Devoe Devcryl 1449	

K. System 11 – Breathable Acrylic, Concrete

1. Materials

Filler-Sealer Type	Acrylic masonry sealer, for concrete and CMU, for wet and dry conditions

Primer	as recommended by Manufacturer
VOC Content, max (g/L)	450
Finish Type	single component waterborne acrylic
VOC Content, max (g/L)	450
Demonstrated suitable for	Masonry under mild to moderate exposure conditions, splash but not immersion

2. Application and Manufacturers (or equal)

Prime Coat (Filler-Sealer)	Finish Coat (DFT = 5 - 7 mils) (2 or more coats)	Total System DFT
as recommended by Manufacturer	**Tnemec Enviro-Crete Series 157**	6 - 9 mils plus primer

L. System 12 – Not Used

2.03 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. System 100 - Amine Cured Epoxy

1. Material

Type	high build, amine cured epoxy
VOC content, max (g/L)	250
Demonstrated suitable for	steel, long-term immersion in water and wastewater, resistant to corrosion, chemical fumes, good color retention

2. Application and manufacturers

Products **(3 coats or more)**	**Total System DFT**
PPG- Amercoat 133	15 to 17 mils For non-submerged valves and other equipment, DFT = 10 to 12 mils
Carboline Carboguard 891 VOC	
International Bar-Rust 233H	
Hi-Build Epoxoline II Series L69 for wastewater	
Sherwin Williams Macropoxy 646 PW	

B. System 101 – Not Used

C. System 102 – Not Used

D. System 103 – Not Used

E. System 104 – Not Used

F. System 105 – Not Used

G. System 106 - Fusion Bonded Epoxy

1. Material

Type	100 percent solids fusion bond epoxy
Demonstrated suitable for	fluidized bed or electrostatic spray application, recommended for pumps, valves, pipe appurtenances, tanks, pipe hangers, flow meters, and hydrants
Certification requirement	NSF 61

2. Application in accordance with AWWA C213 and the following:

Product	**Surface and DFT**
3M Scotchkote 134 or 206N	Valves 12-mils
	All others 16-mils

H. System 107 – Not Used

I. System 108 - Polyurethane, Concrete

1. Materials

Filler-sealer type	epoxy material with portland cement and aggregate
Primer type	Phenolicamine or polyamidoamine epoxy
VOC content, max (g/L)	250
Finish type	aromatic elastomeric polyurethane
Demonstrated suitable for	concrete and concrete block masonry, long term immersion in water and wastewater and service where subject to splash and spill of water and wastewater treatment chemicals
VOC content, max (g/L)	250
Certification requirement, where coating will be in contact with potable water	NSF 61/600

2. Application and manufacturers

Filler-Sealer	**Primer** **DFT = 3 - 7-mils**	**Finish Coat** **DFT = 100 - 125-mils, 75 mils for potable water**
Carboline – Carbocrete 4010	Carboline -Carboguard 1340 WB (if needed)	Carboline -Reactamine 760
Tnemec MortarClad 218	Tnemec Pota-Pox L140 (potable water) Epoxoprime 201 (wastewater)	Elasto-Shield 406 (max 75 mils for potable water)
PPG-Amercoat 100A	Amerlock 2/400	Amerthane 490

Sherwin Williams Steel Seam FT 910	Sherwin Williams Macropoxy 5000 Dura-Plate UHS Primer (potable water)	Sherwin Williams Polycote 115
International Ceilcote 400 Corocrete	Polibrid 670-S	Polybrid 705

J. System 109 - Epoxy, Concrete, Manhole Liner

1. Materials

Filler-sealer type	Epoxy material with portland cement and aggregate
Primer type	100 percent solids epoxy
VOC content, max (g/L)	250
Finish type	Amine cure epoxy/aggregate-filled epoxy
Demonstrated suitable for	Sewer manhole & wastewater facility, long term immersion in wastewater service where subject to chemical and bacteriological attack found in municipal sanitary sewer system

2. Application and manufacturers

Filler-Sealer	**Primer** **DFT = 5 – 10 mils**	**Finish Coat** **DFT = 125 – 150 mils**
PPG Raven 210	PPG Raven 155	PPG Raven 405 FS
Sauereisen Filler Compound 209 or 209FS	Per Sauereisen	SewerGard 210
Sherwin Williams Duraplate 2300	Sherwin Williams Macropoxy 5000	Sherwin Williams Duraplate 6100
		Quadex Structure Guard Epoxy

2.04 SPECIAL COATING SYSTEMS

A. System 200 - PVC Tape: Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.

B. System 201 – Not Used

C. System 202 – Not Used

D. System 203 - Epoxy Surfacing on Concrete Floors

1. Material

Type	2 component epoxy floor surfacing

Demonstrated suitable for	concrete, resistance to abrasion and many acids and alkalis such as liquid alum, sodium hydroxide, and sulfuric acid
VOC Content, max (g/L)	250

2. Application and manufacturers

Primer/Sealer	**Finish Coat (1/4-inch thick)**
PPG Flooring - Concrete Epoxy Primer	PPG Flooring - Self Leveling Epoxy
Tnemec Power-Tread 237	Tnemec Power-Tread 237
Carboline Semstone 110	Carboline Semstone 145 SL
International Ceilcote 680(M)*	International Ceilcote 625 Ceilflor Series
Sherwin Williams General Polymers TPM 12	Sherwin Williams Resulflor Screed TG46

E. System 204 - Water Retardant, Concrete

Type	silane-modified siloxane
Demonstrated suitable for	repelling water from vertical concrete and masonry surfaces
VOC Content, max (g/L)	250
Products, or equal	Sherwin Williams H&C Super V (315 g/l) or Loxon 7 percent Siloxane Water Repellent (0 VOC
	Tnemec Series 633 Prime A Pell H2O

F. System 205 - Polyethylene Encasement: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

G. System 206 – Not Used

H. System 207 - Not Used

I. System 208 - Aluminum Metal Isolation

1. Material

Type	high build polyamide epoxy with chemical and abrasion resistance
Demonstrated suitable for	concrete and aluminum substrates, to isolate aluminum from contact with concrete and the resulting chemical degradation
VOC content, max (g/L)	250

2. Application and manufacturers

Coating (DFT = 16 - 20 mils)
PPG- Amercoat 240
Sherwin Williams Macropoxy 646

Tnemec Epoxoline Series L69
Carboline - Carboguard 890 Series
Devoe Bar-Rust 231

PART 3 -- EXECUTION

3.01 MANUFACTURER'S SERVICES

A. The Contractor shall require the protective coating manufacturer to furnish a qualified technical representative to visit the Site for technical support as may be necessary to resolve field problems.

B. For submerged and severe service coating systems, the Contractor shall require the paint manufacturer to furnish the following services:

1. The manufacturer's representative shall provide at least 8 hours of on-Site instruction in the proper surface preparation, use, mixing, application, and curing of the coating systems.

2. The manufacturer's representative shall observe the start of surface preparation, mixing, and application of the coating materials for each coating system.

3.02 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on coating Work.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. Damage to other surfaces resulting from the Work shall be cleaned, repaired, and refinished to original condition at no additional cost to the Owner.

3.03 STORAGE, MIXING, AND THINNING OF MATERIALS

A. Manufacturer's Recommendations**:** Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.

B. Coating materials shall be used within the manufacturer's recommended shelf life.

C. Storage and Mixing: Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

3.04 PREPARATION FOR COATING

A. General: Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The Contractor shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Protection of Surfaces Not to be Coated: Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

C. Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

D. Care shall be exercised not to damage adjacent Work during blasting operations. Spraying shall be conducted under carefully controlled conditions. The Contractor shall be fully responsible for and shall promptly repair any and all damage to adjacent Work or adjoining property occurring from blasting or coating operations.

E. Protection of Painted Surfaces: Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly-coated surfaces.

3.05 ENVIRONMENTAL REQUIREMENTS

A. No coating work shall be performed under the following conditions:

1. Surface or ambient temperatures exceed the manufacturer’s recommended maximum or minimum allowable.

2. Dust or smoke laden atmosphere.

3. Damp or humid conditions, where the relative humidity is above the manufacturer’s maximum allowable.

4. Substrate and ambient temperatures are less than 5°F above the dew point and are decreasing. Dew point shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of Commerce, Weather Bureau psychrometric tables. Elcometer 319 Dew Point meter or equal may also be used.

5. Ambient temperature that is expected to drop below 50 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.

3.06 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification:

1. Solvent Cleaning (SSPC SP 1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC SP 2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC SP 3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. White Metal Blast Cleaning (SSPC SP 5/NACE 1): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC SP 6/NACE 3): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC SP 7/NACE 4): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. Near-White Blast Cleaning (SSPC SP 10/NACE 2): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. Power Tool Cleaning to Bare Metal (SSPC 11) When viewed without magnification, the surface shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portion of pits if the original surface is pitted. The surface profile shall not be less than 1 mil (25 microns).

9. Surface Preparation of Concrete (SSPC-SP 13/NACE 6): Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.07 FERROUS METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these requirements and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. The Shop Painting Facility shall use a minimum blast material mixture of 75 percent grit and 25 percent shot material to achieve the proper surface profile.

C. The Field Coating Applicator shall abrasive blast the shop coated surfaces per SSPC SP 7/NACE 4. The previously shop-painted surfaces shall be abraded prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.

D. Grease, oil, and welding fluxes shall be removed by wiping with MEK or naphtha cleaning or with trisodium phosphate detergent per SSPC SP 1.

E. All sharp edges shall be rounded or chamfered and all burrs, rust, scale, welding slag, and spatter shall be removed, and the surface prepared by SSPC SP 2 hand tool cleaning, and SSPC SP 3 power tool cleaning.

F. The Contractor shall test the surfaces for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any blasted surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter ($\mu g/cm^2$). A test shall be conducted for every 100 square feet (ft2) of surface area to be coated at locations determined by the Inspector.

G. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the Contractor shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate’s surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.

H. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. Abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

I. The Contractor shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

J. Compressed air for air blast cleaning shall be supplied at adequate pressure from well-maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.

K. Surfaces shall be cleaned of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

L. Enclosed areas and other areas where dust settling is a problem shall be vacuum-cleaned and wiped with a tack cloth.

M. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

N. If the required abrasive blast cleaning will damage adjacent Work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP 2 or SSPC SP 3 may be used.

O. Shop-applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast-iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP 1 before the abrasive blast cleaning has been started.

P. Shop primed equipment shall be solvent-cleaned in the field before finish coats are applied.

3.08 FERROUS METAL SURFACE PREPARATION (GALVANIZED)

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC SP 1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system, followed by brush off blast cleaning per SSPC SP 7/NACE 4.

B. Any high spots, sharp protrusions, and rough edges, such as the metal drip line, shall be smoothed to avoid paint film gaps in the areas of the high spots. Surfaces shall be hand tool cleaned per SSPC SP 2 and power tool cleaned per SSPC SP 3.

C. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer. Galvanized metals may be cleaned with suitable organic solvent such as a rust inhibitor or aqueous alkaline solution per ASTM D6386.

D. The surfaces of galvanized steel exposed to chemical splashing or within a wastewater head space shall be abraded per SSPC SP 11 or SP 7 prior to coating.

3.09 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS

A. General: Grease, oil, heavy chalk, dirt, or other contaminants shall be removed by solvent or detergent cleaning prior to abrasive blast cleaning. The generic type of the existing coatings shall be determined by laboratory testing.

B. Abrasive Blast Cleaning: The Contractor shall provide the degree of cleaning indicated in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC SP 6/NACE 3. Areas of tightly adhering coatings shall be cleaned to SSPC SP 7/NACE 4, with the remaining thickness of existing coating not to exceed 3-mils.

C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings the Contractor shall apply intermediate coatings per the manufacturer's recommendation for the indicated coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.

D. Unknown Coatings: Coatings of unknown composition shall be completely removed prior to application of new coatings.

E. Water Abrasive or Wet Abrasive Blast Cleaning: Where indicated or where Site conditions do not permit dry abrasive blasting for industrial coating systems due to dust or air pollution considerations, water abrasive blasting or wet abrasive blasting may be used. In both methods, paint-compatible corrosion inhibitors shall be used, and coating application shall begin as soon as the surfaces are dry. Water abrasive blasting shall be done using high pressure water with sand injection. In both methods, the equipment used shall be commercially produced equipment with a successful service record. Wet blasting methods shall not be used for submerged or severe service coating systems unless indicated.

3.10 CONCRETE AND CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. Surface preparation shall not begin until at least 30 Days after the concrete or masonry has been placed. All water retaining structures shall be successfully leak tested prior to coating application.

B. At the discretion of the Inspector, the Contractor shall test the surfaces for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter (µg/cm2). A test shall be conducted for every 100 square feet (ft2) of surface area to be coated at locations determined by the Inspector.

C. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the Contractor shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate's surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.

D. In accordance with ASTM D4262, test to determine the pH of the concrete surface after the surface has been thoroughly blasted and cleaned. If the pH is outside the range recommended by the coating manufacturer, then the surface must be neutralized by removing concrete until the surface pH of 7 or greater is obtained prior to any coating application. One pH test shall be performed every 200 square feet, or less, and at locations determined by the Inspector.

E. The Contractor shall test for capillary moisture in accordance with ASTM D4263. Moisture tests shall be taken every 200 square feet or less and at locations determined by the Inspector. If capillary moisture is present, the coating manufacturer shall be consulted to determine primer requirements and special coating application criteria.

F. For below grade structures with surface areas greater than 2,000 square feet, the Contractor shall install three anhydrous calcium chloride test kits on bare concrete to measure the Moisture Vapor Transmission Rate (MVTR) on a flat horizontal surface. Testing and calculations shall be performed according to ASTM F1869. The MVTR shall be less than 3 lbs per 1,000 square feet per 24 hours. If the MVTR is greater than 3 lbs per 1,000 square feet per 24 hours, the Contractor shall apply a concrete sealant to reduce the MVTR through the concrete. The test kits shall be undisturbed for a minimum of 60 hours.

G. Surface Voids: Bugholes, honeycomb, or other surface voids greater than 1/4 inch in depth or 1/4 inch in diameter shall be filled in with a resurfacing mortar prior to the application of any primer or finish coat.

H. Holes or other joint defects in masonry shall be filled with mortar and repainted. All voids and cracks shall be repaired as specified. Loose or spatter mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.

I. Coating Pipe Penetrations: A 1/4-inch wide by 3/8-inch deep saw cut shall be made around the circumference of the pipe as it penetrates the concrete. Prior to the coating application, the saw cut shall be dried and vacuumed to remove all dust and residue.

J. Coating Floor/Wall Joints: A 1/4-inch wide by 3/8-inch deep saw cut shall be made on the vertical and horizontal concrete surfaces around the perimeter of the floor. The saw cut shall be 2 inches from the joint on both sides. Prior to the coating application, the saw cut shall be dried and vacuumed to remove all dust and residue.

K. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC-SP 1 before abrasive blast cleaning.

L. New concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, and deteriorated concrete, and to roughen the surface equivalent to 80 Grit sandpaper or ICRI No. 310.2 Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays Concrete Surface Profile No. 4.

M. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.

N. Secondary Containment: Treat cracks, construction joints, expansion joints and inside corners according to the coating manufacturer’s recommendations.

3.11 PLASTIC, FIBER GLASS AND NONFERROUS METALS SURFACE PREPARATION

A. Plastic and fiber glass surfaces shall be sanded or brush off blast cleaned prior to solvent cleaning with a chemical compatible with the coating system primer.

B. Non-ferrous metal surfaces shall be solvent-cleaned SSPC SP 1 followed by sanding or brush-off blast cleaning SSPC SP 7/NACE 4.

C. Surfaces shall be clean and dry prior to coating application.

3.12 ARCHITECTURAL CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. The mortar surfaces shall be cured at least 14 Days before surface preparation Work is started.

B. Dust, dirt, grease, and other foreign matter shall be removed prior to abrasive blasting.

C. The masonry surfaces shall be prepared in accordance with the material manufacturer's printed instructions.

3.13 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, items of equipment or parts of equipment which are not submerged in service shall be shop-primed and then finish-coated in the field after installation with the indicated or selected color. The methods, materials, application equipment, and other details of shop painting shall comply with this Section. If the shop primer requires top coating within a specific period of time, the equipment shall be finish-coated in the shop and then be touched up after installation.

B. Items of equipment or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have surface preparation and coating performed in the field.

C. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP 1 and SP 2. Damaged shop coating shall be cleaned in accordance with SSPC SP 3, Power Tool Cleaning, and recoated with the primer specified.

D. For every 500 square feet, or less, of steel surface blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed. For each test area, the three replica tape thickness values shall be recorded and must be within 10 percent of the coating manufacturer’s recommended profile. If the surface profile does not meet the manufacturer’s recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the Contractor shall reblast the affected areas.

E. For certain pieces of equipment, it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the indicated quality in the field. Such equipment shall be primed and finish-coated in the shop and touched up in the field with the identical material after installation. The Contractor shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.

F. For certain small pieces of equipment, the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

G. Shop-painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being top coated or less time if recommended by the coating manufacturer.

H. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

I. The Contractor shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.

3.14 APPLICATION OF COATINGS

A. The application of protective coatings to steel substrates shall be in accordance with SSPC PA 1 - Paint Application Specification No. 1.

B. Cleaned surfaces and each coat shall be inspected prior to applying each succeeding coat. The Contractor shall schedule such inspection with the Engineer in advance.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Contractor shall use an independent stripe coat per SSPC PA Guide 11 for these areas. Particular care shall be used to ensure that the specified coverage is secured on the edges and corners of all surfaces.

F. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.

H. Coatings shall not be applied under the following conditions:

1. Temperatures exceeding the manufacturer's recommended maximum and minimum allowable.

2. Concrete surfaces will be in direct sunlight during application or within 3 hours after application.

3. Dust or smoke laden atmosphere.

4. Damp or humid weather.

5. Substrate or air temperature is less than 5 degrees F above the dew point.

6. Air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.

7. Wind conditions are not calm.

I. Dew point shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.

J. Unburied steel piping shall be abrasive blast cleaned and primed before installation.

K. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

3.15 CURING OF COATINGS

A. The Contractor shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.16 SHOP AND FIELD INSPECTION AND TESTING

A. General: The Contractor shall give the Engineer a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.

B. Such Work shall be performed only in the presence of the Engineer, unless the Engineer has granted prior approval to perform such Work in its absence.

C. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, shall not relieve the Contractor of its responsibility to perform the Work in accordance with these Specifications.

D. Scaffolding shall be erected and moved to locations where requested by the Engineer to facilitate inspection. Additional illumination shall be furnished on areas to be inspected.

E. Inspection Devices: The Contractor shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film thickness gauges shall be made available for the Engineer's use while coating is being done, until final acceptance of such coatings. The Contractor shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the Engineer.

F. Holiday Testing: The Contractor shall test for continuity all coated ferrous surfaces inside a steel reservoir, other surfaces that will be submerged in water or other liquids, surfaces that are enclosed in a vapor space in such structures, and surfaces coated with any of the submerged and severe service coating systems. Areas that contain discontinuities shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then be retested.

1. Coatings with thickness exceeding 20-mils total DFT: Pulse-type holiday detector such as **Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20,** or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.

2. Coatings with thickness of 20-mils or less total DFT: **Tinker & Rasor Model M1** non-destructive type holiday detector, **K-D Bird Dog,** or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10- and 20-mils, a non-sudsing type wetting agent, such as **Kodak Photo-Flo** or equal, shall be added to the water prior to wetting the detector sponge.

G. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC Paint Application Specification No. 2 using a magnetic type dry film thickness gauge such as **Mikrotest Model FM, Elcometer Model 111/1EZ,** or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

H. Surface Preparation: Confirm proper surface profile with Testex Press-O-Film replica tape in accordance with NACE RP0287-02.

3.17 COATING SYSTEM SCHEDULE, FERROUS METAL - NOT GALVANIZED

	Item	**Surface Prep.**	**System No.**
FM-1	Surfaces of pipe and/or equipment located outdoors, exposed or covered.	Commercial blast cleaning SSPC SP 6/NACE 3	(4) epoxy / polyurethane
FM-2	Surfaces of equipment and ferrous surfaces submerged or intermittently submerged in wastewater including all surfaces lower than 2 feet above high water level in hydraulic structures, and all surfaces inside enclosed hydraulic structures and vents (excluding shop-coated valves, couplings, pumps).	White metal blast cleaning SSPC SP 5/NACE 1	(100) amine cure epoxy
FM-3	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FM-4	Ferrous surfaces in water passages and submerged surfaces of all pumps which have discharge size of 4 inches or larger.	White metal blast cleaning SSPC SP 5/NACE 1	(100) amine cure epoxy
FM-5	Ferrous surfaces of sleeve couplings.	Solvent cleaning SSPC SP 1, followed by white metal blast cleaning SSPC-SP 10/NACE 2	(106) fusion bonded epoxy
FM-6	Buried surfaces that are not indicated to be coated elsewhere.	Near white metal blast cleaning SSPC SP 10/NACE 2	(100) amine cure epoxy

FM-7	Surfaces of indoor equipment / piping / valves, not submerged	Commercial blast cleaning SSPC SP 6/NACE 3	(8) epoxy, equipment
FM-8	Buried pipe couplings, valves, and flanged joints, including factory-coated surfaces.	As specified by reference specification	(205) polyethylene encasement

3.18 COATING SYSTEM SCHEDULE, FERROUS METAL - GALVANIZED: PRETREATMENT COATINGS, BARRIER COATINGS, OR WASHES SHALL BE APPLIED AS RECOMMENDED BY THE COATING MANUFACTURER. ALL GALVANIZED SURFACES SHALL BE COATED EXCEPT FOR THE FOLLOWING ITEMS WHICH SHALL BE COATED ONLY IF REQUIRED BY OTHER SECTIONS: (1) FLOOR GRATINGS AND FRAMES, (2) HANDRAILS, (3) STAIR TREADS, (4) CHAIN LINK FENCING AND APPURTENANCES.

	Item	**Surface Prep.**	**System No.**
FMG-1	Exposed steel joist (trusses) and exposed structural steel roof framing	Per manufacturer's printed instructions	(1) acrylic polymer

3.19 COATING SYSTEM SCHEDULE, NON-FERROUS METAL, PLASTIC, FIBER GLASS

A. Where isolated non-ferrous parts are associated with equipment or piping, the Contractor shall use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames or hatches. Only primers recommended by the coating manufacturer shall be used.

	Item	**Surface Prep.**	**System No.**
NFS-1	Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPC	(208) aluminum metal isolation
NFS-2	Buried non-ferrous metal pipe.	Removal of dirt, grease, oil	(200) PVC tape

3.20 COATING SYSTEM SCHEDULE - CONCRETE

	Item	**Surface Prep.**	**System No.**
C-1	Floor slab indoors in the Grit Washing Facility, including the grit washing room and electrical room	Per paragraph 3.10	(203) epoxy surfacing on concrete floors
C-2	Non-submerged surfaces of influent pump station (above the wet well water line).	Per paragraph 3.10	(108) polyurethane, concrete
C-3	Interior surfaces of sewer manholes, including sidewalls, bottom, and metal appurtenances. Submerged surfaces of influent pump station (below water line).	Per paragraph 3.10	(109) epoxy, concrete

3.21 COATING SYSTEM SCHEDULE - CONCRETE BLOCK MASONRY

	Item	**Surface Prep.**	**System No.**
CBM-1	Interior surfaces of the Grit Washing Facility.	Per paragraph 3.10	(10) acrylic, concrete
CBM-2	Exterior wall surfaces of the Grit Washing Facility parapet, where indicated on architectural drawings.	Per paragraph 3.10	(11) breathable acrylic, concrete
CBM-3	Exterior surfaces of the Grit Washing Facility, above grade.	Per paragraph 3.10	(204) water-repellent

3.22 COATING SYSTEM SCHEDULE – MISCELLANEOUS SURFACES

	Item	**Surface Prep.**	**System No.**
MS-1	Interior and exterior steel and hollow metal doors as indicated on the architectural finish schedules.	Per manufacturer's printed instructions	(1) acrylic polymer

END OF SECTION

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SECTION 10 14 00 – SIGNAGE

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Building signages

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

B. Reference Standards

Americans with Disabilities Act (ADA): ADA Accessibility Guidelines (ADAAG)	
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referred to herein as “the Code.”
National Fire Protection Association (NFPA)	
NFPA 704	Identification of the Hazards of Materials for Emergency Response
Occupational Safety and Health Administration (OSHA)	

1.03 SUBMITTALS

A. Product Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions, and the following:

a. Manufacturer’s full range color charts, indicating custom color availability for color selection by Owner.

B. Certificates:

1. Certification by the building signage Manufacturer that the building signage provided is suitable for, and compatible with, the required installation.

2. Certification by the building signage Manufacturer that the building signage provided is suitable for, and compatible with, the substrates and surfaces indicated.

3. Certification of Manufacturer qualifications demonstrating compliance with the qualification's requirements indicated.

4. When requested by the Engineer, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

2. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each building signage type, schedule of building signage, mounting details, location and installation requirements, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim.

D. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. Full-size sample of each typical building signage type.

1.05 CLOSEOUT SUBMITTALS

A. Warranty:

1. Submit copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Building signage shall be provided by a single Manufacturer, unless otherwise indicated.

B. Qualifications:

1. Manufacturers:

a. Building signage Manufacturer shall have a minimum of 10 years of building signage manufacturing experience.

b. Manufacturers without these qualifications will not be accepted.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Furnish Manufacturer's 15-year written warranty to cover defects in materials, products, and manufacturing workmanship.

    a. Warranty shall include coverage against chipping, fading, rusting, shattering, or peeling.

2. Warranties shall be non-prorated for the entire warranty period.

3. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Building signage shall be recommended by the Manufacturer for the installation indicated.

B. Building signage shall be suitable for, and compatible with, the required installation.

C. Building signage shall be suitable for, and compatible with, the substrates and surfaces indicated.

2.02 MEN'S AND WOMEN'S RESTROOM SIGNS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

    a. SignEtch I Series by ASI-Signage

B. Description:

1. Signs shall consist of raised braille characters and conform to ADAAG.

2. Signs shall be 8-in by 8-in by 0.125-in aluminum with brushed square edges. Raised surfaces shall have a brushed finish and recessed surfaces shall be painted black, or color as selected by the Owner. Signs shall be provided with a top coat of urethane spray containing UV inhibitors and antioxidant compounds, and shall be rated for interior and exterior use.

3. Unless otherwise noted, all lettering shall be Helvetica Medium in both upper and lower case, as specified and scheduled.

4. Signs shall be mounted as scheduled, as recommended in writing by the Manufacturer, and as approved by the Engineer.

2.03 RESTRICTIVE/CAUTION SIGNS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

    a. Seton UltraTuff by Seton

b. Branford, Connecticut

B. Description:

1. Signs shall be constructed of a printed polyester film permanently bonded to a rigid fiberglass panel and over-laminated with Tedlar by Seton, or approved equal, and a total thickness of 0.11-in minimum.

2. Signs shall be 14-in wide by 10-in tall in rounded corners. Color of signs and letters shall be in accordance with OSHA standards. All other aspects of the Restrictive/Caution Signs shall be in accordance with OSHA standards. If OSHA standards do not apply, the color shall be red with white letters, 1-in high.

3. Signs shall be wall and door surface mounted per Manufacturer standard. Signs shall be mounted as scheduled, as recommended in writing by the Manufacturer, and as approved by the Engineer.

4. Sign sizes shall be adjusted to suit the number of letters in each sign with a 1 ½-in minimum border all around. Two lines are permitted. Center justify the letters.

2.04 HAZARD IDENTIFICATION SYSTEM

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

a. Seton

b. Branford, Connecticut

B. Description:

1. System shall confirm to NFPA 704.

2. System shall use a diamond-shaped symbol divided into four smaller diamonds.

a. Health hazard diamond (left): blue background with a rating number in contrasting color.

b. Flammability hazard diamond (top): red background with a rating number in contrasting color.

c. Instability hazard diamond (right): yellow background with a rating number in contrasting color.

d. Special hazard diamond (bottom): white background with a rating number in contrasting color.

3. Colors used for the diamonds shall provide an adequate contrast so that the rating numbers are easily identified.

4. Signs mounted on walls and doors shall be high performances plastic signs.

5. Signs adhered to drums and containers shall be vinyl.

6. Unless otherwise noted, exterior signs shall be a minimum of 15-in by 15-in and interior signs shall be a minimum of 10-in by 10-in.

2.05 BUILDING SIGNS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Seton Identification Products; Fiberglass, Style No. M0027.

B. Description:

1. Signs shall be high performance fiberglass, constructed of a printed polyester film permanently bonded to a rigid fiberglass panel and over-laminated with a total thickness of 0.10-in minimum.

2. Signs shall be suitable for interior or exterior use, and resist UV light, dirt, and harsh chemicals.

3. Signs shall be 14-in wide by 10-in tall with rounded corners. Colors, letters, and other aspects of the signs shall be in accordance with OSHA standards. If OSHA standards do not apply, the color shall be red selected by the Engineer, unless otherwise indicated.

4. Sign sizes shall be adjusted to suit the number of letters in each sign with a 1 ½-in minimum border. Two lines are permitted. Letters shall be left justified.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 LOCATIONS

A. Signage shall be installed at the locations indicated or as otherwise required by the Code, ADAAG, NFPA 704, and OSHA. Where a conflict occurs between the requirements of this Section and the references herein, the more stringent shall apply, as directed by the Engineer.

B. Where not indicated, signs shall be installed as directed by the Engineer.

C. Signs shall be mounted 60-in above the floor, unless otherwise indicated.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where building signage will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed building signage.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of building signage and appurtenances. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.06 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, NFPA 704, OSHA, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. Horizontal lines shall be level, and vertical lines shall be plumb.

E. The Contractor shall block and reinforce walls as required to support building signage, and appurtenances.

3.07 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, building signage and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Building signage shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When building signage Work is completed, remove unused materials, containers, and equipment, and clean the Site of building signage debris.

3.08 MEN’S AND WOMEN’S RESTROOM SIGN SCHEDULE

3.09 RESTRICTIVE/CAUTION SIGN SCHEDULE

Quantity	**Sign Wording**	**Location**
8 English	DANGER Equipment may start without warning	To be located by the Engineer.

Quantity	Sign Wording	Location
6 English	NOTICE No Smoking	On all exterior doors at the Grit Washing Facility. Located as directed by the Engineer.
6 English	EXIT	Locate on inside of each exit door. Others to be located by the Engineer.
2 English	CAUTION Non-Potable Water Do not drink	Locate at hose bibs where water is non-potable.
4 English	CAUTION Floor Loading Capacity 150 pounds per square foot	Posted in the Grit Washing Facility and directed by the Engineer.
4 English	CAUTION Vehicle Loading HS20-44	Posted in the Grit Washing Facility.

3.10 BUILDING SIGN SCHEDULE

Quantity	Sign Wording	Location
1	To Be Determined	To Be Determined

END OF SECTION

SECTION 10 44 00 – FIRE PROTECTION SPECIALTIES

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fire extinguishers

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. Reference Specifications

01 33 00	Submittal Procedures

C. Reference Standards

Building Code	
	Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referenced herein as “the Code”.
National Fire Protection Association publications (NFPA)	
NFPA 10	Standard for Portable Fire Extinguishers
Underwriter’s Laboratories (UL)	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Certificates:

1. UL certification for each fire extinguisher unit provided.

2. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated.

3. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

2. Shop Drawings shall include mounting and bracket details.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Fire extinguishers shall be provided by a single Manufacturer.

B. Qualifications:

1. Manufacturers:

a. Fire extinguisher Manufacturer shall have a minimum of 20 years of fire extinguisher manufacturing experience.

b. Manufacturers without these qualifications will not be accepted.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Fire extinguishers, accessories, and installation shall comply with the Code, NFPA 10, and with the Manufacturer's published recommendations and specifications.

2.02 FIRE EXTINGUISHERS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from one of the Manufacturers listed below, or Equal.

a. J.L Industries, Inc.

b. Larsen’s Manufacturing Co.

c. General Fire Extinguisher Co.

B. Description:

1. Fire extinguishers in every location, except in rooms or spaces containing electrical switchgear, motor control centers, variable frequency drives, generator rooms, etc., shall be 20 lb capacity, 6A:120BC (ABC), UL-rated, chemical multipurpose type.

2. Fire extinguishers in rooms or spaces containing electrical switchgear, motor control centers, variable frequency drives, generator rooms, etc., shall be 20 lb capacity 10 BC, UL-rated, carbon dioxide type.

3. Fire extinguishers shall be provided with severe duty corrosion resistant finish, red enamel steel cylinders.

4. Fire extinguishers shall be provided with mounting brackets, which support the bottom and sides of extinguishers, and are specially designed for the extinguisher, as recommended in writing by the Manufacturer.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 LOCATIONS

A. The Contractor shall verify the fire extinguisher locations and mounting heights on the Contract Drawings with the Fire Marshall before installation. If locations on the Drawings are not accepted by the Fire Marshal, install fire extinguishers where directed by the Engineer.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where fire extinguishers and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed fire extinguishers and appurtenances.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of fire extinguishers and appurtenances. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.06 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, the requirements of the Code, with NFPA 10, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall block and reinforce walls as required to support the fire extinguishers and appurtenances.

C. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

D. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

E. Horizontal lines shall be level, and vertical lines shall be plumb.

F. Secure mounting brackets and fire extinguishers to structure, square and plumb.

3.07 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, fire extinguishers and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Fire extinguishers shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When fire extinguishers Work is completed, remove unused materials, containers, and equipment, and clean the Site of fire extinguishers debris.

H. Fire extinguishers shall be inspected and certified within 30 days of Substantial Completion.

END OF SECTION

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SECTION 22 10 00 – PLUMBING PIPING

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide plumbing piping and specialties, complete and operable, as indicated in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
09 96 00	High-Performance Coatings
23 07 00	HVAC Insulation
40 05 07	Hangers and Supports for Process Piping
40 05 63	Ball Valves
43 30 52	Miscellaneous Valves

B. Reference Standards

American National Standards Institute (ANSI)
American Society of Mechanical Engineers (ASME)
International Organization for Standardization (ISO)
American Society of Sanitary Engineering (ASSE)
American Society for Testing and Materials (ASTM)
American Water Works Association (AWWA)
National Sanitation Foundation (NSF)
Safe Drinking Water Act (SDWA)
United States Environmental Protection Agency (US EPA)

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. General arrangement drawings of system components

2. Catalog cuts and other manufacturer information for products

C. Samples: electrically fused test joint for drainage and vent piping

1.04 WORKMANSHIP AND MATERIALS

A. Work shall be in strict accordance with the International Plumbing Code and codes of the State of Utah, City of Magna, and any other authorities having jurisdiction.

B. The Contractor shall have required certifications and shall be thoroughly familiar with the local codes.

C. The Contractor shall obtain and pay for necessary permits.

D. Protection

1. Care shall be taken at all times to protect floors, stairways, and walls during the make-up and installation of piping and equipment.

2. The Contractor shall remove stains and repair damage before final acceptance of the Work.

E. Identifying Marks

1. If the Engineer finds materials that have identifying marks removed or lack such marks completely, such items will be rejected until the Contractor has furnished proof that said items conform to the Specifications.

2. Adequacy and extent of such proof will be determined by the Engineer.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.

B. Floor drains or floor sinks shall be provided for equipment drains.

C. No equipment drains shall discharge to floor slabs.

D. Any pipe, plumbing fitting or fixture, solder, or flux used in the installation or repair of any public water system or any plumbing in a facility providing water for human consumption, shall be “lead free” except when necessary for the repair of leaded joints of cast iron pipes.

1. Lead free products shall meet or exceed the requirements of the Safe Drinking Water Act (SDWA) - USEPA.

2. Lead free is defined as not more than 0.2 percent lead when used with respect to solder and flux; not more than 0.25% in the wetted surface material of pipes, pipe fittings, plumbing fittings and fixtures.

2.02 CAST IRON PIPING AND FITTINGS FOR SANITARY DRAIN, ROOF DRAIN AND VENTS

A. Cast iron sanitary, storm, vent pipe, and fittings shall be manufactured in accordance with and shall meet the requirements of ASTM A 74 - Cast Iron Soil Pipe and Fittings.

B. Dimensions of cast iron soil pipe and fittings shall be as given in Table 2 of ASTM A 74.

C. Hub-less cast iron soil pipe and fittings with **Clamp-All** type pipe couplings, or equal, shall be used for above ground sanitary, storm, and vent piping where approved for use by local authorities.

D. Hub-less cast iron soil pipe and fittings shall meet CISPI Standard 301.

E. Pipe couplings shall have high-torque capacity and shall meet FM standard 1680.

F. Flashing

1. Vent piping passing through the roof shall be flashed.

2. Flashing shall extend a minimum 12 inches from the outer surface of the pipe in each direction.

3. Flashing shall be fabricated from one piece of spun, heavy, 0.064 prime aluminum or 4-pound lead sheet.

2.03 PVC PIPING AND FITTINGS FOR POTABLE AND NON-POTABLE WATER

A. PVC Schedule 80 pipe, IPS sizes 1/8” through 24”, shall be rated for temperatures up to and including 200 °F, and Pressure rating (120 psi to 810 psi) depending on pipe schedule, pipe size. Pipe material shall be generally resistant to most acids, bases, salts, aliphatic solutions, oxidants, and halogens. Chemical resistance data is available and should be referenced for proper material selection. Pipe exhibit excellent physical properties and flammability characteristics (independently tested flame and smoke characteristics-ULC). Typical applications include: chemical processing, plating, high purity applications, potable water systems, water and wastewater treatment, drainage, irrigation, agricultural, and other applications involving corrosive fluid transfer.

B. All sizes of PVC Schedule 80 pipe shall be manufactured in strict accordance to the requirements of ASTM D1785 for physical dimensions and tolerances. PVC Sch 80 pipe sizes 1-1/2" through 24" diameters shall also meet the requirements of ASTM D2665 Standard Specification for PVC plastic drain, potable water (PW), waste and vent (DWV) pipe and shall be dual marked as such. Each production run of pipe manufactured in compliance to the standard, shall also meet or exceed the test requirements for materials, workmanship, burst pressure, flattening, and extrusion quality defined in ASTM D1785 and ASTM D2665 as applicable. All belled-end pipe shall have tapered sockets to create an interference-type fit, which meet or exceed the dimensional requirements and the minimum socket length for pressure-type sockets as defined in ASTM D2672. All PVC Schedule 80 pipe must also meet the requirements of NSF Standard 14 and CSA Standard B137.3 rigid PVC pipe for pressure applications, and shall bear the mark of these Listing agencies. This pipe shall have a flame spread rating of 0-25 when tested for surface burning characteristics in accordance with CAN/ULC-S102-2-M88 or equivalent.

C. Product marking shall meet the requirements of ASTM D1785 and ASTM D2665 as applicable and shall include: the manufacturer's name (or the manufacturer's trademark when privately labeled); the nominal pipe size; the material designation code; the pipe schedule and pressure rating in psi for water @ 73°F; the ASTM designation D1785; the ASTM designation D2665 (when dual marked); the independent laboratory's seal of approval for potable water usage; and the date and time of manufacture.

D. All PVC Schedule 80 pipe shall be manufactured from a Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell Classification of 12454 per ASTM D1784. The pipe shall be manufactured in strict compliance to ASTM D1785 and D2665 (where applicable), consistently meeting and/or exceeding the Quality Assurance test requirements of these standards with regard to material, workmanship, burst pressure, flattening, and extrusion quality. The pipe shall be manufactured in the USA, using domestic materials, by an ISO 9001 certified manufacturer. Standard lengths of pipe sizes 6" and larger shall be beveled each end by the pipe manufacturer. All pipe shall be stored indoors after production at the manufacturing site until shipped from factory. This pipe shall carry the National Sanitation Foundation (NSF) seal of approval for potable water applications.

2.04 INSULATION

A. Hot and cold water piping, valves, fittings, and exposed horizontal sanitary, storm, and vent piping shall be provided with one-inch-thick insulation in accordance with the requirements of Section 23 07 00 – HVAC Insulation.

B. Coverings

1. Cover valves, flanges, fittings, and ends-of-insulation with a pre-molded high- and low-temperature PVC fitting cover, end cap, or similar pre-formed unit.

2. The pre-formed covers shall be sized to receive the same thickness of insulation as used in the adjacent piping and shall be in accordance with Section 23 07 00 – HVAC Insulation.

C. Exposed Piping

1. Exposed supply and drain piping shall be insulated and jacketed with ADA compliant safety cover under all lavatories in order to prevent burns and abrasions to handicapped persons.

2. Removable insulated covers shall be Plumberex Specialty Products Handy-Shield type, or equal.

2.05 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK

A. General

1. For utility piping such as cold water, hot water, compressed and vacuum air, and sanitary drain pipes located inside the building, the Contractor shall provide hangers and supports for vertical, axial, and seismic loads in accordance with the International Plumbing Code section 308, and per Section 01 33 17 – Structural Design, Support and Anchorage.

2. No perforated strap hangers nor wire supports will be permitted.

3. The Contractor shall obtain the services of a registered mechanical or structural professional engineer for design of the supports, and the Shop Drawings showing installation shall be stamped by the registered engineer.

4. Pipe supports shall be as indicated in Section 40 05 07 – Hangers and Supports for Process Piping.

B. Hangers supporting insulated piping shall be sized to fit the pipe plus the insulation.

C. Insulation at support points shall be provided with metal shields in order to prevent damage to the insulation.

D. Spacing

1. Pipe support spacing for steel and cast-iron pipe shall be as indicated in Section 40 05 07 – Hangers and Supports for Process Piping.

2. Copper tube support spacing shall be not more than 6 feet between supports.

3. PVC support spacing shall not exceed more than 4 feet for horizontal and 10 feet for vertical piping.

4. Cast Iron piping support spacing shall not exceed more than 5 feet for horizontal piping and 10 feet for vertical piping.

E. Rod sizes for pipe hangers shall be as recommended by the hanger manufacturer.

F. Pipe hangers used to support uninsulated copper tube shall be constructed of copper or copper plated.

G. Vertical piping shall be supported at the base with fittings made for this purpose or shall be supported from the nearest horizontal member or floor with a riser extension pipe clamp.

H. Inserts

1. Anchors that are installed into existing concrete shall be Grinnell Figure 117, Modern Figure 740, or equal, expansion case inserts.

2. Drill clean holes for the insertion of case and patch concrete around the hole, as required.

3. Continuous-slotted concrete inserts, if used, shall be Crawford Figure 148, Fee & Mason Figure 9000, or equal.

4. The Contractor shall provide secondary angle supports between main inserts in order to handle the loads which can be properly supported by such arrangement.

5. Concrete inserts shall be as indicated in Section 40 05 07 – Hangers and Supports for Process Piping.

6. Inserts shall be galvanized.

2.06 PIPE SLEEVES

A. Sleeves shall be constructed from Schedule 40 galvanized steel pipe, one size larger than the pipe passing through, or where pipe is insulated, one size larger than the pipe plus insulation.

B. At exposed wall or ceiling surfaces, install a suitable chromium plated brass wall plate approved by the Engineer.

C. At exterior wall pipe penetrations, the space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.

D. To prevent accidental liquid spills from passing to a lower level, provide the following:

1. For sleeves: Extend sleeve 1 inch above finished floor and provide sealant for watertight joint.

2. For blocked out floor openings: Provide 1 1/2 inch angle set in silicone adhesive around opening.

3. For drilled penetrations: Provide 1 1/2 inch angle ring or square set in silicone adhesive around penetration.

E. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration. Caulk opening at fire-rated walls minimum one-half inch depth with an approved fire barrier caulk.

2.07 VALVES

A. Water shutoff valves shall be of the ball valve type, including on fixture supply piping.

B. Hose Valves

1. Interior hose valves shall be provided as indicated.

2. The hose nipple shall be a female iron pipe thread inlet with hose thread outlet.

3. Hose bibbs shall be 3/4-inch size.

C. Ball valves shall be in accordance with the requirements of Section 40 05 63 - Ball Valves.

D. Ball Shut-Off Valves

1. Provide ball shut-off valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shut-off control on the water system.

2. Ball shut-off valves shall be placed on hot and cold water connections to equipment and fixtures.

3. Show the locations of shut-off valves on the Shop Drawings.

E. Relief Valves

1. Provide a temperature and pressure relief valve of bronze for each water heater.

2. Provide pressure relief valves at other locations where indicated.

3. Relief valves shall be equipped with manual test levers.

4. Provide piping to convey the relief valve discharge to the nearest floor drain, the building exterior, or elsewhere if approved by the Engineer.

2.08 ACCESS DOORS AND COVERS

A. Access doors, where required in ceilings for access to valves, controls, and other equipment, shall be Karp Assoc., Style DSC-210, Inryco-Milcor, Style AT, or equal.

B. The doors shall be of sufficient size to allow access but shall be not less than 12-inch by 12-inch.

C. Ceilings with lay-in acoustical tile do not require access panels.

D. Valves and equipment located above ceiling tile shall have a 3/4-inch-diameter blue plastic button with a letter "V" set in the tile.

E. Floor Covers

1. Floor access covers in unfinished concrete floors not exposed to chemicals shall be constructed of galvanized cast iron with a clear opening of not less than 8-inch by 8-inch, and shall be Alhambra Foundry Company, Model A-2015, Neenah Foundry Co., No.R-6687, or equal.

2. In traffic or chemical areas, access covers shall be Alhambra Foundry Company, Model A-1240, Neenah Foundry Co., Model R-1977, or equal, with a clear opening of not less than 10 inches in diameter.

2.09 ROOF DRAINS

A. Roof drains shall be provided with galvanized cast iron drain bodies, a threaded outlet, removable locking mushroom aluminum or brass stone strainers, clamping collars with integral gravel guards, a receiver, a deck clamp, and extension sleeves where required.

B. Manufacturers, or Equal

1. Josam Mfg. Co., Series 21500

2. Jay R. Smith Mfg. Co., Fig. 1010

3. Zurn Industries, Inc., Series Z-100

2.10 FLOOR DRAINS IN CONCRETE FLOORS

A. Floor drains in concrete floors shall be constructed of cast iron, in the sizes indicated, and provided with sediment buckets.

B. Each floor drain located on an upper floor shall have a clamping collar, with 4-lb sheet lead flashing 12 inches minimum all around.

C. Where lead flashing does not comply with the Code, use epoxy waterproofing material, and submit a Shop Drawing for review.

D. Manufacturers, or Equal

1. Josam Mfg. Co., Series 32100-AE-81

2. Jay R. Smith Mfg. Co., Fig. 2350

3. Zurn Industries, Inc., Series Z-520-Y

2.11 ELECTRIC ACTUATED TYPE TRAP PRIMER

A. Where required by the Code, floor drains and floor sinks connected to the sanitary sewer shall be furnished with trap primers connected to the water supply.

B. Run 1/2-inch copper tubes from the primers to the traps.

C. Trap primers shall be surface mounted in accessible locations.

D. Factory programmed, 4 to 30 port manifold, Electronic Trap Primer providing automatic trap priming.

E. Unit will supply a minimum of 2 oz. of potable water at 20 PSIG at a preset factory setting of 6 seconds every 24 hours. The entire unit is pre-assembled in a NEMA 1 galvanized steel surface mounted housing and cover.

F. 3/4 FNPT inlet connection, brass ball-type stop valve, 120 VAC solenoid valve, brass atmospheric vacuum breaker, 5/8 or 1/2 outlet compression fittings.

G. Anti-Siphon atmospheric vacuum breaker meets Los Angeles code, IAPMO, New York Board of Standards, ASSE 1001 and CSA.

H. Electrical 2 amp Circuit Breaker, Manual Over Ride Switch/Test Button, Timer, 120 VAC Solenoid Valve marked as UL listed. 2 wire plus ground, hold current 0.13 Amps, in rush 0.28 amps.

I. Manufacturers, or Equal

1. Precision Plumbing Products, Model PTS

2. Zurn Industries, Inc.

2.12 CLEANOUTS

A. Cleanouts shall be heavy plugs with tapered shoulders against caulked lead or heavy brass plugs.

B. Where underground or concealed, cleanouts shall be brought to floor level and to accessible locations with access covers and frames.

C. Manufacturers, or Equal

Service	**Josam Series**	**J.R. Smith No.**	**Zurn No.**
Exposed Locations	58500-20	4405	Z-1440-A
Underground (finished floors)	56010/30	4143	ZN-1400-2
Walls, Concealed	58790-20	4535	ZN-1445-1-A
Traffic Areas	56070	4240	Z-1420-27

D. Cleanouts shall have a minimum diameter of 3 inches.

E. Stack cleanouts shall be installed at the base of each stack.

F. Cleanouts shall be fabricated from galvanized cast iron with ABS plastic cleanout plugs.

2.13 HOSE BIBBS AND HYDRANTS

A. Hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type.

B. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless steel warning signs reading "DO NOT DRINK" in clearly legible letters, permanently attached at the hose bibb.

C. Hose bibbs shall be provided with vacuum breakers as furnished by Crane Co., American Standard, or equal.

D. Manufacturers or Equal

Drawing Callout	Fixture Type	Description
HB-1	Indoor Hose Bibb	Exposed, anti-siphon, wall faucet for indoor installation, complete with Z1399-BFP external backflow preventer, all bronze interior components, vandal-resistant operating stem, rough bronze exterior and ¾ male hose connection (Conform to ASME B1.20.7). Zurn Industries, Inc., Model Z1341-BFP
HB-2	Non-Freeze Hydrant, Wall-Type	Heavy duty bronze hydrant with nickel-bronze face, hinged cover, recessed box, and key. Length to suit wall. Jay R. Smith Mfg. Co., Fig. 5509 Josam Mfg. Co., Zurn Industries, Inc.,

2.14 SHOCK ABSORBERS

A. Building cold and hot water piping that is connecting self-closing faucets, quick-action valves, water closets, emergency showers, washers, and dishwashers, shall be protected by shock absorbers located at each fixture or battery of fixtures.

B. Shock absorbers shall be corrosion-resistant, permanently sealed, and shall be sized and installed to the manufacturer's printed recommendations.

C. Manufacturers, or Equal

1. Josam "SHOKTROLS"

2. Jay R. Smith "HYDROTROL"

3. Zurn, Model Z-1022

2.15 WALL-MOUNTED HOSE RACKS

A. The Contractor shall provide wall-mounted hose racks at the indicated locations.

B. Racks shall be of welded steel construction, minimum 8-gauge sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 feet of the indicated hose.

C. Racks located in the open shall be supported from two 2-by-2-by-1/4-inch galvanized steel angle posts set in a concrete base or as indicated.

2.16 HOSES AND NOZZLES

A. The Contractor shall furnish the following lengths of hose:

1. Three lengths of 75-ft long, 3/4-inch hose.

a. Each length of hose shall be provided with male and female connectors and a nozzle.

b. Hoses shall be fabricated from seamless extruded rubber designed for a working pressure of at least 300 psig and shall be suitable for industrial applications.

c. Hoses shall be oil resistant reinforced to provide kink resistance.

d. Hoses shall be provided with brass threaded fittings, for hose bib and nozzle connection.

e. Temperature range is -20 °F to 180 °F.

2. Hoses Manufacturers, or Equal

a. Flexicraft, Model RM1

B. Nozzles:

1. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90-degree conical fog.

2. Nozzle material shall be polished brass.

3. Nozzles shall be provided with rubber bumpers.

2.17 BACKFLOW PREVENTER

A. Provide reduced pressure backflow prevention units where indicated.

B. The valve shall be designed to be installed either vertically or horizontally.

C. The units shall be of bronze body construction, with celcon check seats and stainless steel relief valve seats, shafts, and bolts.

D. The units shall be provided with tight-seating check valve and relief assemblies, and bronze bodies with non-rising stem ball valve test cocks.

E. The units shall be Watts Regulator Co., No. LF909 Series, or Engineer approved equal.

F. Installation shall meet local code requirements.

G. Nozzle Manufacturers, or Equal

1. W.D. Allen Mfg. Co.

2. Fire-End and Croker Corp.

3. Halprin Supply Co.

4. Western Fire Equipment Co.

2.18 NATURAL GAS SERVICE AND INSTALLATION

A. General

1. The Contractor shall provide the natural gas system and valving as indicated.

2. The Contractor shall pay any fees or charges levied by the Gas Company for installation or inspection.

B. Gas Piping

1. Gas piping shall be installed in strict conformance with applicable local or state regulations and the indicated requirements.

2. Black Steel Piping

a. Gas piping shall consist of black steel, Schedule 40, ASTME A53. Fittings 2 ½" and smaller shall be Malleable iron, ASME B16.3, Banded, Black, 150 PSI. Fittings 3" and larger shall be steel ASME B16.9, butt welded.

b. Joints for exposed piping shall be of the screwed type, with an adequate number of unions to facilitate removing of equipment and dismantling of piping for cleaning and inspection.

c. Joint compounds on steel pipe shall be rated for natural gas service, shall be resistant to the action of gas, shall be non-hardening, and shall be used sparingly on the male threads only.

C. Valves

1. Valves shall be used in accordance with the rating and service recommendations of the manufacturer.

2. Valves shall conform to the requirements of ANSI B 31.8.

3. Full-opening non-lubricated plug valves shall be used in sizes larger than 2-inch or for pressures greater than 0.5 psig.

4. No unions or valves shall be installed on pipe lines that will be concealed in partitions, ceilings, or the like.

5. Every union or valve shall be readily accessible for inspection and repair.

6. A plug valve shall be provided at each piece of equipment the gas system serves.

D. Gas Pressure Regulator

1. Provide a gas pressure regulator in accordance with IPC, IMC, IFC, ASHRAE and local codes.

2. Pressure regulator shall be provided with high and low trip points

3. Pressure regulator shall be of ventless type.

3. Design Features:

a. Maximum inlet pressure: 100 bar (1450 psi) (Refer to drawings for exact inlet pressure)

b. Outlet pressure range: 0.02 bar (0.3 psi) to 90 bar (1305 psi) (Refer to drawings for exact outlet pressure)

c. Maximum pressure drop: 1 bar

d. Class of lock-up pressure zone: SZ 2.5

e. Temperature range: -20 Deg C to +60 Deg C

4. Pipe Connections:

a. Pipe connections shall be in accordance with ISO 8434-1 for pipe diameters between ¾" to 1 ½"

b. Pipe flanges shall be Class 600 according to ANSI 16.5

5. Materials:

a. Main valve body shall be aluminum alloy or steel

b. Actuator shall be aluminum alloy

Internal parts shall be aluminum alloy, brass, steel, polyamide

d. Diaphrams, O-rings shall be perbunan

6. All mechanical components shall be without potential ignition sources and/or hot faces.

7. Manufacturers, or Approved Equal

a. Honeywell, Model HON

b. Grainger

2.19 PAINTING

A. Ferrous metal, except finished, galvanized, and machined surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09 96 00 – High-Performance Coatings.

B. Prime colors shall be compatible with finish coats that are applied in the field.

C. Self-contained units such as wall-mounted hose racks shall be supplied with factory-applied finish coats of baked enamel.

D. Field painting shall comply with the requirements of Section 09 96 00 – High-Performance Coatings.

PART 3 -- EXECUTION

3.01 PREPARATION

A. The Contractor shall coordinate the roughing-in process with provisions for wall and floor sleeves, pipe inserts, and cutting of roof and floor penetrations, such that drain lines will have the required invert elevations and slopes.

3.02 OPENINGS

A. New Construction

1. The Contractor shall provide necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the building.

2. Openings shall be as indicated or as required to provide passage for the plumbing Work.

3.03 INSTALLATION AND APPLICATION

A. The Contractor shall provide plumbing specialties in accordance with manufacturer's printed instructions.

B. Pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.

C. Pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.

D. Piping in buildings shall be as close to the ceilings or walls as possible unless indicated otherwise.

E. Joints

1. Screwed joints shall be made with joint compound and be tight and leak-proof.

2. A sufficient number of brass-to-ferrous metal seat unions shall be placed in lines such that any pipe, valve, or piece of equipment may be easily disconnected.

F. Drainage and Sanitary Lines

1. Drainage and sanitary lines shall be properly run, trapped, and vented in order to conform to Code requirements.

2. Changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe.

3. Changes in pipe size shall be made with reducing fittings.

4. The minimum depth of cover shall be 3 feet.

G. Horizontal soil, drain, and waste pipes shall be provided with a slope of at least 1/4 inch per foot, unless indicated otherwise.

H. Floor drains and cleanouts shall be installed such that the tops of the drains are flush with the finished floor.

I. Plug each natural gas outlet, including valves, with a threaded plug or cap immediately after installation, and retain the plugs until continuing piping or equipment connections are completed.

J. Joints in PE pipe shall be installed such that the longitudinal pull out resistance of each joint is at least equal to the tensile strength of the pipe.

3.04 EQUIPMENT DAMAGE AND REMOVAL

A. The Contractor's operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment that are to remain in the finished Work.

B. Any damage caused by the Contractor or Subcontractor through their operations shall be repaired to the satisfaction of the Engineer.

3.05 TESTING

A. The Contractor shall perform such tests as are required by local ordinances and Codes in the presence of a local governing authority inspector to show that piping is tight, leak-free, and otherwise satisfactory, and shall also perform such tests as the Engineer may direct to ensure that fixtures and equipment operate properly.

B. The Contractor shall pay the costs to perform such tests and the costs of making changes or repairs until the Work is acceptable to the governing authorities.

C. Gas Piping Testing and Purging

1. Before the gas piping system is accepted, a test for tightness shall be performed and witnessed by the Engineer.

2. The system shall be subjected to a test pressure of at least 1.5 times the maximum operating pressure, but never less than 3 psig.

3. Air or an inert gas such as carbon dioxide, or nitrogen, shall be used as the pressurizing medium.

4. Under no circumstances shall oxygen or natural gas be used to test for tightness or to locate leaks.

5. The system shall hold pressure after disconnecting the pressure source for a period of at least 30 minutes without showing any drop in pressure after the test gas in the pipe has been given time to come to equilibrium at the ambient temperature.

6. Leaks shall be located by approved leak detectors, or by a soap and water solution, while the system is under pressure.

7. Purging

    a. After pressure testing, piping shall be fully purged with an inert gas inserted from the location most distant from the point of entry of the natural gas.

    b. Each major branch line shall be similarly purged from its far end.

    c. Purging shall be performed only by personnel experienced in this particular operation.

8. Repair or replace defective piping, and retest.

D. Potable, Non-Potable Water and Drainage Piping Pressure Testing

1. Demonstrate to an Owner witness that the piping passes the following pressure tests before it is insulated or covered by walls or ceilings. Test piping after all fittings and valves for that portion of the piping have been installed.

2. All pressure testing shall be witnessed and documented with results approved and signed off by an Owner representative.

3. Repair leaks discovered during pressure testing. Retest failed sections of piping to demonstrate satisfactory results.

4. Potable/Non-Potable Water Testing: Upon completion of a section or of the entire hot and cold water supply system, it shall be tested and proved tight under a water pressure not less than one and half time of the working pressure under which it is to be used, but not less than 125 psi. The water used for tests shall be obtained from a potable source of sup- ply. The piping shall withstand the test without leaking for a period of not less than 15 minutes.

5. Drainage Water Testing: The drainage, and venting systems shall be tested with water. The water test shall be applied to the drainage and vent systems either in its entirety or in sections. Where the test is applied to the entire system, openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. Where the system is tested in sections, each opening shall be tightly plugged, except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10-foot head of water. In testing successive sections, not less than the upper 10 feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 feet of the system) shall have been submitted to a test of less than a 10-foot head of water. The water shall be kept in the system, or in the portion under test, for not less than 15 minutes before inspection starts. The system shall then be tight at all points.

3.06 DISINFECTION

A. The line shall then be filled with water and maintained under not less than 10 psig pressure, for not less than 48 hours, during which period each valve on the line shall be opened and closed several times, after which it shall be flushed clean and then tested by the Owner.

B. After potable/non-potable water supply lines are successfully pressure tested, they shall be disinfected by introducing an HTH solution, liquid chlorine, or chlorine solution of sufficient strength.

C. Potable/Non-Potable water systems shall be purged of deleterious matter and disinfected prior to utilization. The method to be followed shall be that prescribed by the health authority or water purveyor having jurisdiction or, in the absence of a prescribed method, the procedure described in either AWWA C651 or AWWA C652, or as described in this section.

   1. The pipe system shall be flushed with clean, potable water until dirty water does not appear at the points of outlet.

   2. The system or part thereof shall be filled with a water/chlorine solution containing not less than 50 parts per million (50 mg/L) of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing not less than 200 parts per million (200 mg/L) of chlorine and allowed to stand for 3 hours.

   3. Following the required standing time, the system shall be flushed with clean potable water until the chlorine is purged from the system.

   4. The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.

D. This procedure shall be repeated as often as necessary until the line is pronounced safe for use by the Owner.

E. No cross-connection between the water main and any pipe not yet disinfected will be permitted.

END OF SECTION

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SECTION 23 05 00 – COMMON WORKS RESULTS FOR HVAC

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide heating, ventilating, and air conditioning systems and associated equipment complete with supports, mounting frames, ventilators, ductwork, piping, louvers, panels, filters, grilles, electric drive units and controls, mechanical equipment, electrical work, appurtenances, testing, and balancing, as indicated in accordance with the Contract Documents.

B. The equipment shall be installed ready for operation.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
01 42 19	Reference Standards
09 96 00	High-Performance Coatings
23 07 00	HVAC Insulation
23 23 00	Refrigerant Piping
26 00 00	Electrical Work, General
26 05 10	Electric Motors
26 05 33	Electrical Raceway Systems
26 05 43	Underground Raceway Systems
26 29 00	Low-Voltage Motor Control Centers
40 05 07	Hangers and Supports for Process Piping

B. Reference Standards

Air Movement and Control Association International, Inc. (AMCA)	
American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)	
ASHRAE Standard 52-76/ASHRAE 52.1-1992 Standard	Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
American Society of Civil Engineers (ASCE)	
ASCE 7-10	(2010; Errata 2011; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures
American Society of Mechanical Engineers (ASME)	

Institute of Electrical and Electronics Engineers (IEEE)	
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 72	(2022) National Fire Alarm and Signaling Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
Underwriters Laboratories (UL)	
UL 900	(2015) Standard for Air Filter Units

1.03 CONTRACTOR SUBMITTALS

A. Shop Drawings

1. Submit complete shop drawings and certificates, test reports, affidavits of compliance, for all equipment, ductwork and piping systems, in accordance with the requirements in Section 01 33 00 – Submittal Procedures, and as indicated in the individual equipment, piping or ductwork Sections.

2. Construction Drawings

a. The HVAC Drawings define the general layout, configuration, routing, size and the general intent of the design. and are not fabrication drawings.

b. The ductwork dimensions provided on the design drawings represent a free area and they are clear inside dimensions. The contractor shall be responsible to account for the loss of free area due acoustical lining, or any internal obstructions, and oversize the ductwork to provide the same free area as the one shown on the design drawings.

c. It shall be the Contactor's responsibility to develop the Shop Drawings required for the construction of the HVAC system.

3. The Shop Drawings shall include all necessary dimensions and details regarding equipment, pipe and ductwork joints, fittings, valves, appurtenances, design calculations, and material lists.

4. The submittals shall include detailed layout, spool, or fabrication drawings which shall show all fittings, and supports as necessary to accommodate the equipment as a complete and functional system.

B. Equipment Numbers

1. Equipment is identified by assigned numbers for reference and location purposes in the Contract Documents.

2. Indicate the appropriate equipment numbers on the Shop Drawings and other submittals.

C. Furnish certified fan curves for each fan.

1.04 WARRANTY

A. Air conditioners, heaters, fans, ventilators, grilles, and the like, that are provided by the Contractor shall carry the manufacturer’s standard warranty.

B. Warranties shall be furnished to the Engineer upon final acceptance of the completed systems by the Owner.

C. Refrigerant compressors shall carry a manufacturer's 5-year warranty.

D. Control System

1. The temperature and equipment control system shall be warranted free from defects in workmanship and material under normal use and service for a period of one year after acceptance by the Engineer.

2. Equipment that proves to be defective in workmanship or material during the warranty period shall be adjusted, repaired, or replaced by the automatic control manufacturer as part of the Contract.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Quality

1. Mechanisms and other parts shall be amply proportioned for the stresses which may occur during operation and for any other stresses which may occur during fabrication and erection.

2. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials, and shall be of the manufacturer's top-line, industrial-commercial grade.

B. Supports

1. Equipment and appurtenances shall be firmly anchored or connected to supporting members.

2. Equipment shall be supported on restrained spring-type vibration isolators.

3. Support as required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided unless otherwise indicated.

C. Noise and Vibration Control

1. The system shall be free of objectionable vibrations and noise.

2. Provide flexible connections in ducts and piping connections to fans, compressors, and other vibrating equipment.

D. Seismic Restraints

1. Design the equipment, duct and piping supports and restraints for static, dynamic, and seismic loads in Zone 4 in accordance with the International Building Code.

2. Seismic restraints shall not induce stresses in the equipment, ductwork and piping caused by thermal expansion and contraction.

3. Comply with Section 01 33 17 – Structural Design Support and Anchorage.

2.02 MOTORS

A. Motors provided with the equipment shall conform to the latest IEEE and NEMA requirements for mechanical and electrical characteristics, including service factors.

B. Motors shall be in conformance with the requirements of Section 26 05 10 – Electric Motors.

C. Each motor shall bear the manufacturer's nameplate with complete motor data.

D. Each motor shall be of ample size and construction to continuously carry the loads which might be imposed by the equipment throughout the full range of operation of the equipment.

E. The maximum motor loading shall be less than or equal to the nameplate horsepower rating, exclusive of the service factor.

2.03 ELECTRICAL WORK

A. The Work of this section (Division 23) shall include:

1. Provide controls, sensors and control panels relating to the HVAC systems, including starters, thermostats, motorized dampers, louver operators and other equipment as indicated.

2. Provide wiring and conduits to all thermostats, sensors, dampers, and all other HVAC controls equipment requiring 120 volt and less.

3. Provide control wiring of 120-volt and less as indicated in this Section and in conformance the requirements of Division 26 – Electrical and Division 40 – Instrumentation and Control.

B. The Work of Division 26 shall include:

1. Provide local power disconnects, where required.

2. Provide circuit breakers, starters in motor control centers, and 120-, 208-, 240- and 480-volt power feeders from the starters and circuit breakers to the HVAC equipment, as indicated.

C. Stand-alone starters shall be in accordance with the requirements of Section 26 05 15 – Industrial Control Panels.

D. Starters in motor control centers shall be in accordance with the requirements of Section 26 29 00 – Low-Voltage Motor Control Centers.

E. Enclosures shall be of the same NEMA class as the electrical equipment in the same area.

F. Starters shall be of the same manufacturer as the starters indicated under Section 26 05 15 – Industrial Control Panels.

G. Low-voltage control wiring shall be in accordance with the National Electric Code.

H. Control wiring for line voltage 120-volt and higher shall be in conformance with the requirements of Section 26 05 19 – Wiring and Cabling.

I. Control panels shall be in conformance with the requirements of Section 26 05 15 – Industrial Control Panels.

J. Conduit shall be in conformance with the requirements of Section 26 05 33 – Electrical Raceway Systems and Section 26 05 43 – Underground Raceway Systems.

2.04 FLASHING

A. Equipment that passes through roofs of buildings or structures shall be provided with flashing as indicated.

2.05 PIPE AND FITTINGS

A. Heating piping shall be Schedule 40 black steel pipe with screwed fittings.

B. Refrigerant piping shall be Type L hard temper copper with cast brass fittings.

C. Provide a drain at each low point in the piping system.

D. Copper and steel pipe and fittings shall be in conformance with the requirements of Section 23 23 00 – Refrigerant Piping.

E. Joints in refrigeration piping shall be made with silver solder.

2.06 VALVES

A. Gate Valves

1. Gate valves shall be rated for 125 psig working pressure and shall be in every respect suitable for the purpose intended.

2. Gate valves shall be of brass construction with screwed ends and shall be wheel operated.

3. Gate valves shall be Powell Co. No. 500, Jenkins 47U, or equal.

B. Check Valves

1. Check valves shall be of all-brass or bronze construction and shall be provided with regrinding discs.

2. Check valves shall be Crane No. 36, Jenkins 762A, or equal.

2.07 PIPING AND DUCTWORK INSULATION

A. HVAC Pipe Insulation shall be in conformance with the requirements of Section 23 07 00 – HVAC Insulation.

B. HVAC Ductwork insulation shall be in conformance with the requirements of Section 23 07 00 – HVAC Insulation.

C. HVAC Refrigerant Pipe insulation shall be in conformance with the requirements of Section 23 23 00 – Refrigerant Piping.

2.08 WELDING

A. The welding of black steel or alloy pipe shall be carried out in strict accordance with AWS procedures and the codes and ordinance of the City of Greater Salt Lake and the State of Utah pertaining to welded steel pipelines.

B. Welding shall be accomplished by means of the shielded electric arc process and performed by workers who are certified for this Work.

2.09 EXPANSION JOINTS AND LOOPS

A. Provide expansion loops or expansion joints at the indicated locations and as necessary to provide for the expansion of piping.

B. The maximum straight run of pipe without an expansion joint or loop installed shall not exceed 75 feet.

C. Provide an expansion joint or loop at every building construction joint.

D. Construction

1. The pipe expansion joints on metal piping 3-inch and smaller shall be of the 2-ply stainless steel bellows type, with a 1-1/2-inch compression stroke, a 1/2-inch extension and a total stroke of 2 inches.

2. The joints shall be suitable for a maximum operating temperature of 750 degrees °F and a maximum working pressure of 175 psig.

3. The compensator shall have male pipe thread ends for steel pipe and female sweat ends for copper pipe.

E. Pipe Expansion Joints Manufacturers, or Equal

1. Flexonics, Model H for steel piping and Model HB for copper piping

2. Keflex Series 7Q

3. Adsco Compensators

2.10 HANGERS AND SUPPORTS

A. Anchorage and bracing for all suspended ductwork and other distribution systems needs to be provided per 2021 IBC Section 1613/ASCE 7-10 Chapter 13

B. Provide all necessary hangers, supports, concrete inserts, anchors and guides for material and equipment to be installed.

C. No perforated strap hangers and no wire supports will be accepted.

D. Insulation Allowance

1. Hangers supporting insulated pipe shall be sized to fit the pipe plus the insulation.

2. The insulation at support points shall be provided with a metal shield in order to prevent damage to the insulation.

E. Anchors and guides shall be constructed of steel, in accordance with approved Shop Drawings, and as indicated.

F. Pipe hangers used to support uninsulated copper piping shall be copper plated.

G. Anchors

1. Anchorages shall be obtained by welding lugs onto the pipe and providing abutting surfaces against the lugs to restrict longitudinal movement.

2. Anchors shall be designed such that the pipe may be removed by removing bolts; no welding of pipe to the anchor will be accepted.

3. bolting materials shall be cadmium plated.

H. Guides shall be located not more than 20 feet from each expansion loop or joint.

I. Horizontal runs of pipe shall be provided with supports spaced such that the sag of the unsupported length will not create any pockets in the piping (weight of fluid included).

J. Pipe support lengths shall be in conformance with the requirements of Section 40 05 07– Hangers and Supports for Process Piping.

K. Vertical Piping

1. Vertical piping shall be:

a. Supported at the base with fittings made for this purpose; or

b. Supported from the nearest horizontal member or floor with a riser extension pipe clamp.

2. Provide a riser extension clamp on each floor.

L. Hangers for ductwork and equipment shall be as indicated and in accordance with the guidelines of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

M. Inserts shall be galvanized.

2.11 PIPE SLEEVES

A. The Contractor shall examine the Drawings carefully for sleeves that are to be built into the construction and plan the Work accordingly, such that the sleeves are placed well in advance and care is taken with their location and support until encased.

B. Sleeves shall be fabricated from standard weight galvanized steel pipe for dry interior installations.

C. Sleeves for exterior or wet installations shall be fabricated from standard-weight ductile black steel, stainless steel, or standard-weight PVC for pipe temperatures below 120 degrees °F.

D. Sleeves shall be sized one pipe size larger than uninsulated piping and one pipe size larger than piping plus insulation for insulated pipe.

E. Locations

1. Where pipes pass through floors, sleeves shall extend 3 inches above the finished floor.

2. Where pipes pass through walls, sleeves shall be flush with the wall.

2.12 FLUES

A. Provide flues, supports, and other accessories as required for gas-fired heaters and appliances as indicated.

B. Construction

1. Flues shall be fabricated from 12-gauge steel.

2. Flues shall be painted with one coat of a high-temperature rust-inhibitive primer.

3. Flues shall not be supported by the unit.

4. Comply with SMACNA recommendations for fabrication, construction, details and installation procedures, except as otherwise indicated.

C. Manufactured, Prefabricated Flues

1. Manufactured, Prefabricated flues shall be:

a. UL-listed

b. Used at temperatures not to exceed 1000 degrees °F under continuous operating conditions

c. Designed to be gas-tight to prevent leakage of combustion products into the building

d. Designed to compensate for flue gas-induced thermal expansions

2. The double-wall flue shall be provided with:

a. An inner gas-carrying pipe fabricated of Type 304 stainless steel

b. A nominal one-inch air space between the walls

c. An outer jacket constructed of aluminum-coated steel or Type 304 or Type 316 stainless steel, for additional corrosion protection in hostile environments

3. The flue duct shall be Selkirk Metalbestos Model PS, or equal.

2.13 MOTORIZED DAMPERS

A. General

1. Provide motorized opposed blade dampers as indicated.

2. Damper sizes and capacities shall be as indicated on the Drawings.

B. Design and Construction

1. The damper and frames shall be fabricated from aluminum with a minimum thickness of B&S 12-gauge.

2. The aluminum blades shall be provided with interlocking edges, with one center and two edge crimps, and brass bearings.

3. The frame shall be of welded channel construction and shall be provided with lugs and mounting brackets for damper operators.

4. The dampers shall be provided with felt or rubber seals at their edges to minimize air infiltration when closed.

C. Motors

1. Damper motors shall be electric with necessary linkages for positioning the damper blades.

2. The motors shall be powered open and spring-closed, unless otherwise indicated.

2.14 BACKDRAFT OR GRAVITY DAMPERS

A. General

1. Provide backdraft dampers on the exhaust fans and ventilators where indicated.

2. Damper sizes and capacities shall be as indicated on the Drawings.

B. Design and Construction

1. The dampers shall be of the multi-blade type, with soft-seating gaskets for minimizing noise and air leakage when closed.

2. Blades shall be constructed of 16-gauge aluminum and shall be of an air foil design.

3. Frames shall be fabricated from 16-gauge extruded aluminum alloy.

4. The frames shall be totally out of the air stream and arranged for flange mounting.

5. The dampers shall be designed to operate at 0.05-inch w.g. S.P., or less.

6. Blades shall be individually counterbalanced and shall be provided with non-ferrous pins turning in nylon bearings.

C. Damper Manufacturers, or Equal

1. Air Balance, Inc.

2. Air Dynamic

3. Ruskin, Model BD2A1

2.15 VOLUME, CONTROL DAMPERS (MANUAL AND MOTORIZED)

A. General

1. Provide volume control dampers in accessible locations in branch supply ducts and at each exhaust air opening, in order to properly regulate the volume of air delivered or withdrawn from each inlet and outlet, and as indicated.

2. Damper sizes and capacities shall be as indicated on the Drawings.

B. Construction

1. The volume dampers shall be of the opposed blade type.

2. The dampers shall be constructed of aluminum, of B & S 14-gauge thickness.

3. The dampers shall be suitably reinforced with sturdy control shafts.

4. Ductwork shall be reinforced to double thickness at damper shaft openings.

C. Air Extractor Type

1. The volume control dampers indicated to be of the air extractor type shall be constructed of stainless steel, of 20-gauge for frames and of 24-gauge thickness for blades.

D. No splitter dampers will be accepted.

E. Manual control dampers shall be provided with mechanisms for adjustment and locking into position after being set.

F. Motors

1. Damper motors shall be electric with either modulating or 2-position control and necessary linkages.

G. The motors shall be powered open and spring-closed, unless otherwise indicated.

2.16 REGISTERS, GRILLES AND DIFFUSERS

A. General

1. Provide supply and return registers and grilles, and all supply diffusers as indicated.

2. The sizes, capacities, and deflection of each unit shall be as indicated on the Drawings.

B. The following schedule shall be followed:

Air Terminal Type	**Border Type**	**Manufacturer, Model and Material**	**Optional damper**	**Neck Type**	**Note to Designer (See Performance cutsheets for selection)**
Return/Exhaust Registers (RR/ER)	Surface mount	Titus Model 350FL; Tuttle and Bailey; or equal	yes	Rectangular	To be used mainly as duct mounted. Good for areas with high humidity. It is better not to include the optional damper and separately specify volume dampers on duct for air balance.

C. Registers, grilles and diffusers shall be constructed of aluminum.

D. The finish shall be a baked-on enamel.

E. Accessory equipment shall be constructed of aluminum, or steel if aluminum is not available, and provided with a baked-on enamel.

F. The proper border style shall be selected by the Contractor to suit the installation conditions.

G. Registers, grilles, and diffusers located in corrosive atmospheres, as indicated, shall be painted with a special protective coating in accordance with the requirements of Section 09 96 00 – High-Performance Coatings.

2.17 AIR FILTERS

A. The aluminum washable metal mesh filter shall be 2-inch thick and shall consist of multiple layers of 20-gauge aluminum slit and expanded into mesh of differing densities with hundreds of baffle-like surfaces. Filter shall contain 5 layers of ¼" and 5/8" thick corrugated aluminum. Mesh media shall be contained within a .017-.019 one piece constructed roll formed aluminum frame. Frame shall come with drainage ports. Initial airflow resistance shall be 0.04-inch w.g. initial resistance and 0.50-inch w.g. recommended final resistance, and rated for maximum Temperature of 240° F.

1. Aluminum Washable Air Filters Manufacturer, or Equal

a. Permatron, Model MMA-2"

B. Flat air filters shall be 2-inch thick, pleated, throw-away type, and provided as an integral part of each unit. The flat air filters shall be constructed of an adhesive-coated fiber media, rated at 300-fpm face velocity; and rated at 0.04-inch w.g. initial resistance and 0.50-inch w.g. recommended final resistance.

1. Flat Air Filters Manufacturer, or Equal

a. Airguard Industries

b. Farr Co.

c. Snyder General Corp.

C. Filter Supply

1. Furnish 3 complete spare filter changes for each flat filter in each unit.

2. Provide one new filter set in each unit at the time of turning the units over to the Owner.

3. Filters used in the units during construction are not included in the above supply, and these filters shall be provided as part of the Work.

2.18 STATIONARY WALL LOUVERS

A. General

1. Provide wall louvers where indicated.

2. Provide louvers complete with aluminum bird screen and necessary linkages for the operating section.

3. Louver sizes and capacities shall be as indicated on the Drawings.

4. Louvers shall be of the adjustable type or fixed type as indicated or required and shall be provided with a drain gutter in each blade and downspouts in jambs and mullions.

5. The louvers shall be provided with an extended sill.

B. Construction

1. Stationary blades and adjustable blades shall be contained within a single 6-inch louver frame.

2. The adjustable section shall include low-leakage blade and jamb seals.

3. Louver components, including heads, jambs, sills, blades, and mullions, shall be factory-assembled by the louver manufacturer.

4. The water stop at the sill shall be factory-caulked watertight.

C. Finish

1. Provide louvers with a Kynar 500, or equal, finish.

2. The color of the louver shall be submitted for the Engineer's approval.

D. Performance

1. Submit published louver performance data bearing the AMCA Certified Ratings Seal for Air Performance & Water Penetration, for approval prior to fabrication.

2. The performance data shall demonstrate pressure drop and water penetration equal to or less than the indicated model.

E. Fixed-type wall louvers shall be with extruded 6063T5 aluminum alloy construction as follows:

1. Frame: 0.125-inch wall thickness; box-type

2. Blades: stationary section and adjustable center pivoted section; 0.125-inch wall thickness; 37-1/2-degree angle on approximate 4-1/2-inch centers

3. Operator: electric-type; furnished with louver; 120-volt maximum

F. Manufacturer or approved equal

1. Ruskin Model ELF 6375DXH

2. Greenheck

2.19 VIBRATION ISOLATORS

A. General

1. Provide vibration control isolation all rotating equipment except electric motors.

2. Where rotating units are part of factory-assembled package units, such as a package air handling unit, provide the isolator under the unit casing.

B. Support suspended equipment by a combination of spring and fiberglass isolation hangers, incorporating minimum 2-inch-thick neoprene jacketed fiberglass inserts in series with springs, encased in steel brackets.

C. Mount floor-mounted or platform-mounted built-up or package air handling units on structural steel or concrete bases with isolator springs and brackets.

D. Springs used in the vibration isolators shall have approximately one inch of deflection under load and shall have a minimum additional travel of 50 percent between the design height and the solid height.

E. All isolation equipment shall be provided in strict compliance with the manufacturer's recommendations.

F. Pads

1. For vibration isolation between HVAC equipment and supports and where indicated, provide 3/4-inch-thick rubber pads for full contact between equipment and support

G. The pads shall be Mason Industries, Super W Pads, or equal.

2.20 ROOF CURBS AND ROOF EQUIPMENT SUPPORTS

A. Curbs

1. Roof curbs for all roof openings for roof mounted exhaust fans and air intakes and exhausts, unless otherwise indicated, shall be of the raised cant type with a minimum 12-inch height above the roof line.

2. The curbs shall be pitched at the base for roof pitches in excess of 3/8 inch per foot.

3. Provide a minimum 4-inch raised cant unless otherwise indicated.

4. The curbs shall be of a box design, constructed from 20-gauge galvanized steel with continuous welded seams, full mitered angle seam corners, and factory-installed wood Nailers.

5. Insulate the curbs with a minimum of 1-1/2-inch thick, 3 lbs./cu.ft. density rigid board fiberglass.

6. Roof curbs shall be provided with an 18-gauge stainless steel liner set in mastic and extended the full height of curb if the duct does not extend to the top of the curb.

7. The roof curbs shall be supplied by the manufacturer of the equipment being provided.

8. Roof Curb Manufacturers, or Equal

    a. Pate Model PC-5

    b. Thy curb

B. Equipment Supports

1. Provide roof equipment supports for roof-mounted equipment.

2. Construct the supports from 180gauge galvanized steel, with continuous welded seams, an integral base plate, a wood nailer with a one-inch overhang to accommodate insulation, and counter flashing with lag screws.

3. Provide the supports with a raised cant of not less than 4 inches and a minimum of 15 inches high.

4. The length and width of the units shall conform to the support requirements of the equipment being supported.

5. Roof Equipment Supports Manufacturers, or Equal

    a. Pate Model PC-5

    b. Thycurb

2.21 TEMPERATURE AND EQUIPMENT CONTROL

A. General

1. Design and provide a complete electric-electronic system of automatic temperature control as indicated.

2. The temperature control equipment and devices shall be furnished by Johnson Controls, Honeywell, or Barber Colman.

B. Wiring and Switches

1. Provide wiring incidental to the temperature control system, including electrical interlock.

2. Furnish detailed wiring diagrams along with necessary supervision.

3. Provide control wiring (line voltage or low voltage) as required to complete the temperature control system (by interconnecting starters, thermostats, PE switches, relays, and like devices) in accordance with the requirements of Section 26 00 00 – Electrical Work, General.

4. Provide HOA switches in accordance with the requirements of Division 26 specifications.

5. Switches shall be UL-listed and of a type to meet the current and voltage requirements of the particular application.

C. Thermostats

1. Room thermostats shall be of the digital type, provided with heating and cooling setpoints.

2. Adjustment shall be accomplished by pressing the thermostat UP or DOWN arrows.

3. Comfort Setpoints: adjustable from 66 to 80 degrees °F

4. Setback Setpoints: adjustable from 55 to 70 degrees °F for heating setback; adjustable from 75 to 90 degrees °F for cooling setback

5. Automatic Setback Time Period:

   a. 7-day setback programming

   b. Up to 2 automatic setback comfort time periods per day

   c. Built-in setback override, adjustable from 10 minutes to 40 hours

   d. 7-day electric time clock

   e. Heat/cool/fan annunciators to indicate equipment operation and automatic heating/cooling changeover.

6. The thermostats shall meet the Energy Conservation Standard approval where required by the State having jurisdiction over the Project.

7. Provide an insulating back where exterior wall mounting is indicated.

8. Provide guards for room thermostats installed in areas other than administrative offices or control rooms.

D. Relays

1. Provide 2-position relays, capacity relays, sequencing relays, and other controls as necessary in order to provide a properly operating automatic control system.

2. Relays shall be UL-listed and of a type to meet the current and voltage requirements of the particular application.

E. Control Panels

1. General

   a. Control panels shall be provided with relays, control switches, transformers, pilot lights, timers, time clocks, step controllers, gages, thermostats (unless otherwise indicated), and other accessories necessary for the particular system.

   b. The panels shall be of aluminum construction with a baked enamel finish and shall be provided with a hinged front door and locking handle.

c. Manual switches and direct-reading gauges shall be flush-mounted on the front face and identified by engraved and riveted Bakelite or laminated plastic nameplates with white letters on black background.

d. Manual switches shall be of heavy-duty, oil-tight construction.

2. Wiring

a. Control devices shall be prewired internally.

b. Wires leaving the panel shall be terminated at separate numbered terminal strips.

c. Provide individual connectors for every item of mechanical equipment, integral and remote pilot lights, and other devices described for each panel.

d. Power and control circuit requirements shall be as indicated on the Electrical Drawings.

e. Identify wires by color coding or numerical tags at both ends.

f. Wire each control device to the terminal strip without splices.

g. Provide integral circuit protection for panel-mounted control devices.

h. Wire each panel with a single 20-amp, 120-volt, ac feeder in accordance with the requirements of Division 26 specifications.

3. Diagrams

a. Secure the panel electrical wiring diagrams to the inside of the panel door.

2.22 PAINTING

A. Painting of the equipment and materials shall comply with the requirements of Section 09 96 00 – High-Performance Coatings.

B. Touch-Ups

1. Touch up factory-painted surfaces that are rusted or scratched.

C. Clean finishes to be touched up to bright metal, prime with a corrosion inhibitor, and finish with a coating to match the original finish.

PART 3 -- EXECUTION

3.01 GENERAL

A. Openings - New Construction

1. Provide necessary openings in walls, floors, and roofs for the passage of heating and ventilating equipment in the buildings.

2. Openings shall be as indicated or as required to provide passage for heating and ventilating Work.

3. Provide hanger and support inserts into masonry or structural steel as required for proper completion of the Work.

3.02 INSTALLATION OF PIPING

A. Drain Piping

1. Valve-Drain Piping

a. Provide valve-drain piping where valves are equipped with a drain connection.

b. Fabricate piping from Type L copper tube, and solder-joint drainage fittings.

2. Provide piping system and equipment drains fabricated from copper tube with solder-joint fittings, or from black steel piping with fittings as indicated.

3. Install drain piping at the low points of supply and return piping, at abrupt changes in vertical offsets in horizontal runs, and in piping at mechanical equipment including pumps.

4. Extend drain piping to the nearest drain.

B. Bypass Piping

1. Except as otherwise indicated, fabricate, and install bypass piping using the same materials and in the same plane as connected piping, but one pipe size smaller or as indicated.

2. Provide a valve in the bypass piping.

3.03 INSTALLATION OF VALVES

1. Set the valves carefully regarding their location with respect to accessibility and the equipment being controlled.

2. Consider the location of valves with respect to the proper drainage of the piping system.

3. Install valves where required for proper operation of piping and equipment, including valves in branch lines necessary to isolate sections of piping.

4. Locate valves to be accessible and such that separate support can be provided where necessary.

5. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward.

6. Where insulation is indicated, install extended-stem valves, arranged in the proper manner to receive insulation.

7. Control Valve Installation

    a. Coordinate valve submittals for type, quantity, size, and piping configuration, in order to ensure compatibility with pipe design.

    b. Slip-stem control valves shall be installed such that the stem position is not more than 60 degrees from the vertical up position.

    c. Install ball-type control valves with the stem in the horizontal position.

    d. Install valves in accordance with the manufacturer's recommendations.

    e. Install valves such that they are accessible and serviceable, and such that actuators may be serviced and removed without interference from structure or other pipes or equipment.

    f. Install isolation valves such that the control valve body may be serviced without draining the supply- or return-side piping system.

    g. Install unions at connections to screw-type control valves.

    h. Identification Tags

        1) Provide tags for control valves, indicating service and number.

        2) Tags shall be brass, 1.5 inch in diameter, and with 1/4-inch-high letters.

        3) Securely fasten tags with chain and hook.

        4) Match identification numbers as shown on approved control Shop Drawings.

3.04 BALANCING TESTING

A. Balancing Subcontractor

1. After the installation Work has been completed, the Contractor shall provide the services of an independent balancing subcontractor who shall perform necessary adjustments of volume dampers, volume controllers, exhaust blowers, exhaust fans, supply and return registers, and heating units.

B. Balancing Procedures

1. Balancing and testing shall be in conformance with the requirements of Section 23 05 93 – Testing Adjusting and Balancing for HVAC.

3.05 COMMISSIONING OF HVAC

1. Commissioning of HVAC shall be in conformance with the requirements of Section 23 08 00 – Commissioning of HVAC.

3.06 FLUES

A. Assemble and install flues in accordance with recognized industry practices which will achieve air-tight systems.

B. Install with a minimum of joints.

C. Align accurately at connections and keep internal surfaces smooth.

D. Support flues rigidly with suitable ties, braces, hangers, and anchors of the type which will hold the Work true-to-shape and prevent buckling.

E. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment.

F. Pitch flues upward from equipment to stack.

3.07 VIBRATION ISOLATORS

A. Install isolation equipment in strict compliance with the manufacturer's recommendations.

3.08 TEMPERATURE AND EQUIPMENT CONTROL

A. After completion of the installation, use trained personnel to adjust thermostats, and sensors in the motors and other provided equipment, and place them in complete operating condition subject to the approval of the Engineer.

B. Instruct the operating personnel in the operation of the control system.

END OF SECTION

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.01 SUMMARY

A. The Work included in this Section shall consist of the furnishing of all labor, and materials, for the installation of hangers and supports for the heating, ventilating, and air conditioning (HVAC) systems as indicated in the Contract Documents and herein.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support, and Anchorage
09 96 00	High-Performance Coatings
23 31 13	Metal Ducts

B. Reference Standards

American Society of Civil Engineers (ASCE)	
ASCE/SEI 7-05	Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASCE 7-10	Minimum Design Loads for Buildings and Other Structures
American Society of Mechanical Engineers (ASME)	
ASME BPVC	Boiler and Pressure Vessel Code
ASME B31.9	Building Services Piping
American Welding Society (AWS)	
AWS D1.1/D1.1M	Structural Welding Code—Steel
ASTM International (ASTM)	
ASTM C552	Standard Specification for Cellular Glass Thermal Insulation
ASTM C591	Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C533	Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM A36/A36M	Standard Specification for Carbon Structural Steel
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)	
MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-89	Pipe Hangers and Supports - Fabrication and Installation Practices
Society of Protective Coatings (SSPC)	
SSPC-PA 1	Shop, Field, and Maintenance Coating of Metals

C. Reference Standards

1. Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

2. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

3. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

4. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

5. Design trapeze pipe hangers and equipment supports, including comprehensive engineering Analysis by a qualified professional engineer, using performance requirements and design criteria as indicated.

6. Comply with structural drawing S-001 and spec section 01 33 17 – Structural Design, Support, and Anchorage

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Product Data: For each type of product indicated.

C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.

2. Metal framing systems.

3. Fiberglass strut systems.

4. Pipe stands.

5. Equipment supports.

D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.

2. Design Calculations: Calculate requirements for designing trapeze hangers.

3. Welding Certificates

1.04 QUALITY ASSURANCE

A. Comply with Special Inspection Requirements of IBC 2009.

B. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding Qualifications: Qualify procedures and operators according to ASME boiler and Pressure Vessel Code.

PART 2 -- PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon Steel Pipe Hangers and Supports

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts

2.03 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.

c. Flex-Strut Inc.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut Corporation; Tyco International, Ltd.

g. Wesanco, Inc.

2. Description: Shop or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.

4. Channels: Continuous slotted steel channel with in-turned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

7. Metallic Coating: Hot-dipped galvanized.

8. Paint Coating: Vinyl or Acrylic.

9. Plastic Coating: PVC.

2.04 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.

2. Clement Support Services.

3. ERICO International Corporation.

4. National Pipe Hanger Corporation.

5. PHS Industries, Inc.

6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

7. Piping Technology & Products, Inc.

8. Rilco Manufacturing Co., Inc.

9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100 psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C533, Type I calcium silicate with 100 psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2-in. beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.06 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

2. Base: Plastic.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

2. Bases: One or more; plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.07 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon steel shapes.

2.08 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 -- EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Anchorage and bracing for all suspended ductwork and other distribution systems needs to be provided per 2021 IBC Section 1613/ASCE 7-10 Chapter 13

B. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support- piping from the building structure.

C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4-in. thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, DN 65 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

O. Comply with spec section 01 33 17 – Structural Design Support and Anchorage

P. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight distribution plate for pipe DN 100 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight distribution plate for pipe DN 100 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. DN 8 to DN 90: 12-in. long and 0.05-in. thick.

b. DN 100: 12-in. long and 0.06-in. thick.

c. DN 125 and DN 150: 18-in. long and 0.06-in. thick.

d. DN 200 to DN 350: 24-in. long and 0.075-in. thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1.5-in.

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 0.002-in.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 96 00 – High-Performance Coatings.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.06 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Hangers and supports for all Plumbing piping shall be installed in accordance with International Plumbing Code.

C. Copper tube support spacing shall be not more than 6 feet between supports.

D. PVC support spacing shall not exceed more than 4 feet for horizontal and 10 feet for vertical piping.

E. Cast Iron piping support spacing shall not exceed more than 5 feet for horizontal piping and 10 feet for vertical piping.

F. Hangers and supports for all HVAC ductwork shall be installed in accordance with International Mechanical Code and SAMCNA.

G. Duct support spacing shall not exceed 8 feet in between two supports or from a joint or transition.

H. Perforated strap hangers will not be acceptable.

I. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

J. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

K. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

L. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.

M. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

N. Use padded hangers for piping that is subject to scratching.

O. Use thermal-hanger shield inserts for insulated piping and tubing.

P. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes DN 15 to DN 750.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 degrees F, pipes DN 100 to DN 600, requiring up to 4-in. of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes DN 20 to DN 900, requiring clamp flexibility and up to 4-in. of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes DN 15 to DN 600 if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes DN 15 to DN 100, to allow off center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes DN 20 to DN 200.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes DN 15 to DN 200.

8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes DN 15 to DN 200.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes DN 15 to DN 200.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes DN 10 to DN 200.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes DN 10 to DN 80.

12. U-Bolts (MSS Type 24): For support of heavy pipes DN 15 to DN 750.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes DN 100 to DN 900, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes DN 100 to DN 900, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes DN 65 to DN 900 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes DN 25 to DN 750, from two rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes DN 65 to DN 600, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes DN 50 to DN 1050 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes DN 50 to DN 600 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes DN 50 to DN 750 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

Q. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers DN 24 to DN 600.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers DN 20 to DN 600 if longer ends are required for riser clamps.

R. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6-in. for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 degrees F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degrees F piping installations.

S. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

    b. Medium (MSS Type 32): 1500 lb.

    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

T. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

U. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1.25-in.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

   a. Horizontal (MSS Type 54): Mounted horizontally.

   b. Vertical (MSS Type 55): Mounted vertically.

   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

V. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

W. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

X. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 48 – VIBRATION AND SEISMIC CONTROLS FOR HVAC

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, and Section 01 33 17 – Structural Design, Support, and Anchorage, apply to this Section.

1.02 THE SUMMARY

A. Section Includes:

1. Isolation pads
2. Isolation mounts
3. Restrained elastomeric isolation mounts
4. Freestanding and restrained spring isolators
5. Housed spring mounts
6. Elastomeric hangers
7. Spring hangers
8. Spring hangers with vertical-limit stops
9. Pipe riser resilient supports
10. Resilient pipe guides
11. Seismic snubbers per Section 01 33 17 – Structural Design, Support, and Anchorage
12. Restraining braces and cables
13. Steel and inertia, vibration isolation equipment bases.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Definitions

1. IBC: International Building Code
2. ICC-ES: ICC-Evaluation Service
3. OSHPD: Office of Statewide Health Planning and Development for the State of California

B. Reference Specifications

01 33 17	Structural Design Support and Anchorage
01 79 00	Owner Staff Training

C. Reference Standards

American Association of State Highway and Transportation Officials (AASHTO)	
American Society of Civil Engineers (ASCE)	
ASCE/SEI 7-05	Minimum Design Loads for Buildings and Other Structures
ASCE 7-05	Wind Loads: Guide to the Wind Loads Provisions of ASCE 7-05
American Welding Society, Inc. (AWS)	
AWS D1.1/D1.1M	Structural Welding Code
ASTM International (ASTM)	
ASTM A36/A36M	Standard Specification for Carbon Structural Steel
ASTM A603	Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM A492	Standard Specification for Stainless Steel Rope Wire
ASTM E488	Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)	
MSS SP-127	Bracing for Piping Systems: Seismic – Wind – Dynamic Design, Selection and Application

1.04 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Comply with ASCE/SEI 7-05 and IBC 2009

2. Comply with Structural drawing S-001 and Spec Section 01 33 17 – Structural Design, Support, and Anchorage

3. Basic Design Wind Speed (3-second gust): 109 mph

4. Risk Category: III

5. Exposure: C

6. Minimum 48.8 kg/sq. m multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Comply with ASCE/SEI 7-05 and IBC 2009

2. Comply with Structural drawing S-001 and Spec Section 01 33 17 – Structural Design, Support, and Anchorage

3. Site Class as Defined in the IBC 2006: D

4. Seismic Design Category: D

5. Risk Category: III

    a. Seismic Importance Factor, Ie: 1.25

    b. Component Importance Factor, Ip: 1.5

    c. Component Response Modification Factor, Rp: varies, refer to ASCE 7-05 Table 13.6-1

    d. Component Amplification Factor, ap: varies, refer to ASCE 7-05 Table 13.6-1

6. Design Spectral Response Acceleration at Short Periods (0.2 Second), Ss: 1.28g

7. Design Spectral Response Acceleration at 1-Second Period, S1: 0.51g

1.05 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.

    b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage

5. Seismic- and Wind-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

e. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer

B. Welding certificates

C. Field quality-control test reports

1.07 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 -- PRODUCTS

2.01 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ace Mountings Co., Inc.

2. Amber/Booth Company, Inc.

3. California Dynamics Corporation

4. Isolation Technology, Inc.

5. Kinetics Noise Control

6. Mason Industries

7. Vibration Eliminator Co., Inc.

8. Vibration Isolation

9. Vibration Mountings & Controls, Inc.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant rubber or hermetically sealed compressed fiberglass.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2. Minimum Additional Travel: 50 percent of the required deflection at rated load.

3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to 6-mm thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 3447 kPa.

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 6-mm thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.

2. Base: Factory drilled for bolting to structure.

3. Snubbers: Vertically adjustable to allow a maximum of 6-mm travel up or down before contacting a resilient collar.

H. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 13-mm thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 3.45 MPa and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 13-mm thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements

2.02 VIBRATION ISOLATION EQUIPMENT BASES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation

3. Isolation Technology, Inc.

4. Kinetics Noise Control

5. Mason Industries

6. Vibration Eliminator Co., Inc.

7. Vibration Isolation

8. Vibration Mountings & Controls, Inc.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 25-mm clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 25-mm clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.03 SEISMIC-RESTRAINT DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation

3. Cooper B-Line, Inc.; a division of Cooper Industries

4. Hilti, Inc.

5. Kinetics Noise Control

6. Loos & Co.; Cableware Division

7. Mason Industries

8. TOLCO Incorporated; a brand of NIBCO INC.

9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A603 galvanized or ASTM A492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.

J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.04 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected

D. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage.

3.02 APPLICATION

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Refer to drawings for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 3.2 mm.

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 12 m o.c., and longitudinal supports a maximum of 24 m o.c.

3. Brace a change of direction longer than 3.7 m.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage.

C. Perform tests and inspections.

D. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.

3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.

6. Measure isolator restraint clearance.

7. Measure isolator deflection.

8. Verify snubber minimum clearances.

9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

3.06 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.07 DEMONSTRATIONS

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Section 01 79 00 – Owner Staff Training

END OF SECTION

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide HVAC Piping and Equipment, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Standards

ASME International (ASME)	
ASME A13.1	Scheme for the Identification of Piping Systems

1.03 CONTRACTOR SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

1.04 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 -- PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.031-in. minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2.5-in. by 0.75-in.

3. Minimum Letter Size: 0.25-in. for name of units if viewing distance is less than 24-in., 0.5-in. for viewing distances up to 72-in., and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 0.125-in. thick, and having predrilled holes for attachment hardware.

2. Letter Color: Black.

3. Background Color: White.

4. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2.5-in. by 0.75-in.

6. Minimum Letter Size: 0.25-in. for name of units if viewing distance is less than 24-in., 0.5-in. for viewing distances up to 72-in., and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on A4 bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 0.125-in. thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2.5-in. by 0.75-in.

F. Minimum Letter Size: 0.25-in. for name of units if viewing distance is less than 24-in, 0.5-in. for viewing distances up to 72-in., and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1.5-in. high.

2.04 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 0.125-in. thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2.5-in. by 0.75-in.

F. Minimum Letter Size: 0.25-in.for name of units if viewing distance is less than 24-in., 0.5-in. for viewing distances up to 72-in., and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1.5-in. high.

2.05 VALVE TAGS

A. Valve Tags: Stamped or engraved with 0.25-in. letters for piping system abbreviation and 0.5-in. numbers.

1. Tag Material: Brass, 0.032-in. minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on A4 bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4-in. by 7-in.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 -- EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50-ft. along each run. Reduce intervals to 25-ft. in areas of congested piping and equipment.

B. Pipe Label Color Schedule:

1. Heating Water Piping:

a. Background Color: Black.

b. Letter Color: White.

2. Refrigerant Piping:

a. Background Color: Black.

b. Letter Color: White

3.04 DUCT LABEL INSTALLATION

A. Install plastic-laminated, self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.

2. Yellow: For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50-ft. in each space where ducts are exposed or concealed by removable ceiling system.

3.05 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Refrigerant: 2-in., round

2. Valve-Tag Color:

a. Refrigerant: Natural.

3. Letter Color:

a. Refrigerant: Black.

3.06 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 -- GENERAL

A. The Work included in this Section shall consist of the furnishing of all labor, instruments, tools, and services as required for the total system balancing of the heating, ventilating, and air conditioning (HVAC) systems as indicated in the Contract Documents.

B. The Work under this Section shall include the following items:

1. Preparation for balancing of air systems

2. Preparation of control systems

3. Notification requirements by the General Contractor of systems readiness

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Standards

Associated Air Balance Council (AABC)	
American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)	
ASTM International (ASTM)	
American National Standards Institute (ANSI)	
ANSI S1.13	(2020) American National Standard Measurement of Sound Pressure Levels in Air

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 GENERAL

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment shall be performed by a certified, independent third-party, AABC Agency, selected and employed by the Contractor and approved by the Owner.

B. The preparation for and corrections necessary for the testing, adjusting, and balancing of these systems, as described herein, are the responsibility of the Contractor.

C. Make changes or replacements to fan sheaves and belts, dampers, valves, and the like, as may be required for correct balance as advised by the TAB firm, as part of the Work.

D. Provide and coordinate the services of qualified, responsible subcontractors, suppliers, and personnel, as required to correct, repair, or replace deficient items or conditions found during the course of the Project, including the testing, adjusting, and balancing period.

E. Operate the systems for the length of time necessary to properly verify their completion and readiness for TAB.

F. Scheduling

1. Project completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy.

2. Allow adequate time for coordinating Owner-required services associated with the testing and balancing activities during the construction period and prior to Substantial Completion.

G. Accessibility

1. Install valves, dampers, and miscellaneous adjustment devices in a manner that will leave them accessible and readily adjustable.

2. Should any such device not be readily accessible, provide access as requested by the TAB firm.

3. Malfunctions encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately such that the balancing work can proceed with minimal delays.

H. The TAB firm shall check, adjust, and balance the components of the HVAC system in order to obtain the optimal performance of the equipment.

I. The Work is intended to be accomplished after the system components are installed and operating as indicated and required.

J. It shall be the responsibility of the Contractor to place the equipment into service.

K. The following components of the HVAC systems shall be tested, adjusted, and balanced:

1. Air moving equipment

2. Air distribution systems

3. Heating systems

4. Control systems (testing and verification)

3.02 FIELD TESTING

A. During the progress of the work, tests shall be performed as indicated and as required by authorities having jurisdiction, including the local building department, the Owner, the Owner's insuring agency, and the Engineer.

B. Perform such tests as part of the Work, including qualified personnel, equipment apparatus, additional thermometer wells, gauge connections, instrument connections, and services as required to perform the tests.

C. Submit 6 copies of each complete test report to the Engineer for review and send 2 copies of the accepted report to the Owner.

3.03 DEFECTIVE WORK

A. Leaks, damage, and defects discovered or resulting from tests shall be repaired or replaced to a like-new condition.

B. Leaky pipe joints, ductwork, and the like, shall be removed and replaced with acceptable materials.

C. Reporting

1. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the TAB firm shall advise the Engineer and Owner in writing such that the conditions may be corrected by the Contractor.

2. The written document need not be formal but must be understandable and legible.

3. The TAB firm shall not instructor direct subcontractors in any of the Work.

3.04 CONTRACTOR'S RESPONSIBILITIES

A. Have the building and air conditioning systems in complete operational readiness for the TAB Work to begin.

B. Allow sufficient time for the TAB firm to perform their Work within the construction schedule.

C. Complete the W by systems or floors, whichever is the more efficient method for testing systems.

D. Scheduling

1. Within 2 weeks after the construction schedule has been developed, schedule a TAB coordination meeting to include the TAB firm, the Contractor and primary subcontractors, the Engineer, and the Owner for the purpose of developing a testing schedule for the Project.

2. Submit copies of the proposed schedule to the TAB firm at least one week prior to the coordination meeting.

E. Promptly correct deficiencies of materials and workmanship identified as delaying completion of the TAB firm's Work.

F. Assume responsibility for added costs to the Owner resulting from failure to have the building and air conditioning systems ready for TAB when scheduled, and from failure to correct deficiencies promptly.

G. Coordinate with the TAB firm to compile and submit:

1. one set of HVAC specifications

2. one copy of relevant revisions, clarifications, and modifications

3. one complete set of Drawings, less the Civil and Structural sheets

4. one set of the HVAC floor plans of the conditioned spaces

5. one copy of approved submittal data for installed equipment

6. one copy of related changes as required to accomplish the indicated test procedures

3.05 TAB FIRM RESPONSIBILITIES

A. The following observations and tests shall be performed by the TAB firm:

1. During the construction submittal stage and before the submittal documents are finalized, review the mechanical and HVAC submittals, drawings and specifications for balance-ability and furnish commentary.

2. During construction, review approved HVAC submittals such as control diagrams, air handling devices, and the like, that pertain to TAB work and balancing.

3. Perform construction observations and submit a written report including the following topics.

a. The ductwork prior to insulation and ceiling cover-up

b. The piping prior to insulation and ceiling cover-up

4. Perform a pre-balance site review and submit a written report.

3.06 OPERATIONAL READINESS

A. “Operational readiness,” as referred to in this Section, shall be defined as the time when the construction status of the building permits the closing of doors, windows, ceilings, and the like, to obtain simulated or projected operating conditions.

B. Operational readiness of the HVAC system shall require that the following items have been accomplished:

1. Air Distribution Systems

a. The installation conforms to the indicated design requirements.

b. Volume, smoke, and smoke/fire dampers have been properly located and are functional.

c. Dampers have tight closure and open fully with smooth and free operation.

d. Exhaust grilles have been installed and secured in a fully open position.

e. Final clean filters are in place, coils are clean with fins straightened, bearings are properly greased, belts are aligned and tightened, and the system is completely operational.

f. It has been verified that all systems are operating within the design pressure limits of the piping and ductwork.

g. Fans (supply, return, and exhaust) are operating and verified for freedom from vibration, proper fan rotation and belt tension.

h. Heater elements in motor starters are of proper size and rating, in accordance with the starter manufacturer's requirements.

i. Motor amperage and voltage have been recorded on each phase at start-up and verified that they do not exceed nameplate ratings.

2. Automatic Controls

a. A meeting has been held with the Engineer, the TAB firm, and the Owner, for a pre-submittal review of the proposed controls strategy.

b. Control components have been installed in accordance with project requirements and are functional, including electrical interlocks, damper sequences, high- and low-temperature thermostats, safeties, and the like.

c. Controlling instruments have been calibrated and set for design operating conditions, with the exception of components that require input from the TAB firm, but a default has been set.

1) Cooperate with the TAB firm and provide all software and interfaces to communicate with the system.

d. Controls, sensors, operators, sequences, and the like, have been checked before notifying the TAB firm that the Energy Management System is operational.

1) Furnish technical support (technicians and necessary computers) for a complete check of these systems.

e. Fire alarm detection devices, sequences, inter-locks, and the like, have been checked before notifying the TAB firm that the system is operational.

1) Checked devices shall include the Fireman's Override Panel.

2) Provide all detection devices (fire and smoke), complete with all smoke zones identified along with all alarm and event chart devices identified.

3) Certify that the systems are totally operational prior to the TAB beginning.

f. A start-up report has been submitted.

1) The start-up report shall include the submitted and actual RPM, and the actual and nameplate voltage and amperage of all motors.

2) This requirement applies to each piece of electrically driven air conditioning equipment in the system, including supply and exhaust fans, other fans of fractional horsepower, pumps, and the like.

3) Furnish the addresses and initial set points of all controlled devices.

3.07 NOTIFICATION OF SYSTEM READINESS

A. After the above operational readiness items have been accomplished, notify the Engineer in writing, certifying that the Work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing.

B. With the notification, include a copy of tabulated data as required.

C. The Engineer will notify the TAB firm of the readiness for balancing, and forward copies of the Contractor's certification and tabulated motor voltages, currents, and RPM.

D. If the TAB firm has been notified as described above and the inspection reveals that the TAB services notification is premature, costs of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriate parties by the Contractor.

3.08 TESTING AND BALANCING

A. In coordination with the TAB firm, submit an overview of system TAB procedures including:

1. An agenda

2. Field observation reports

3. System testing, including:

a. Traverses to be made

b. Instrumentation to be used

c. How correction factors for grilles and diffusers will be obtained

d. How measurements will be verified at maximum and minimum

e. How control components will be verified

4. Report forms with each systems components identified and numbered.

3.09 INSTRUMENTATION

A. Ensure that instruments being used are currently calibrated and listed in the TAB report, showing instrument description, serial number, and date of calibration.

B. The accuracy of instruments used shall be as indicated in the current AABC National Standards.

3.10 FINAL AIR BALANCE

A. When systems are complete and ready for operation, the TAB firm shall perform a final air balance for all air systems and record the results.

B. The volume of air for the supply, return, exhaust, and outside air equipment and terminals shall be tested and balanced within the tolerances of the AABC Standard.

C. Air handling unit and fan volumes shall be adjusted by changing fan speed.

D. Air distribution device volume shall be adjusted using the spin-in damper for flexible duct-connected devices, and the damper for duct-connected devices.

E. Air distribution devices shall be balanced with air patterns as indicated.

F. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are indicated.

G. The general scope of balancing by the TAB firm shall include the following items:

1. Filters: Check air filters and filter media and balance only systems with essentially clean filters and filter media.

2. Fan Speed: Measure and record RPM at each fan speed.

3. Voltage and Amperage Readings: Measure and record the final operating amperages and voltage for each motor.

4. Static Pressure Profile

a. Static pressure profiles shall be measured and recorded across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter, and exhaust fan, and at the furthest air device or terminal unit from the air handler supplying that device.

b. Furnish static pressure profiles for systems which do not perform as designed.

5. Equipment Air Flow: Adjust and record exhaust, return, outside, and supply air CFM and temperatures, as applicable, at each fan and coil.

6. Outlet Air Flow

a. Adjust each exhaust inlet and supply diffuser, register and grille to within the tolerances shown in the AABC Standard.

b. Include all terminal points of air supply and all points of exhaust.

7. Pitot Tube Traverses

a. For use in future troubleshooting by maintenance personnel, measure air velocity in all exhaust ducts, main supply ducts, outside air, and return ducts, and record by the Pitot tube traverse method shown in the AABC Standard.

b. Locations of these traverse test stations shall be described both verbally and by graphic representation on the sheet containing the data.

3.11 SOUND

A. Read and record sound levels at up to 15 locations in the building designated by the Engineer, and show that all areas are within acceptable sound levels in accordance with ASTM and ASHRAE Standard Test method for measurement of sound in commercial Spaces, or the American National Standard Institute's Methods for the Measurement of Sound Pressure Levels, ANSI S1.13.

B. Perform measurements using an octave band analyzer.

3.12 TESTING OF TEMPERATURE CONTROL SYSTEMS

A. Coordinate with the Contractor in order to ensure that the most effective total system operation is within the design limitations, and to obtain a mutual understanding of the intended control performance.

B. Verify that all control devices are properly connected and operated by the intended controller.

C. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.

D. Observe the calibration of all controllers.

E. Verify the proper application of all normally opened and normally closed valves.

F. Sensors

1. Observe the locations of all sensors in order to verify whether their position will allow them to sense the intended temperatures and pressures of the media accurately.

2. The Contractor shall relocate the sensors as deemed necessary by the TAB firm.

a. Verify that the sequence of operation for control modes is in accordance with approved Shop Drawings and as indicated.

b. Verify the proper operation of all interlock systems.

c. Perform variable volume system verification in order to assure the system and its components track, with changes from full flow to minimum flow.

3.13 TAB FINAL ACCEPTANCE AND BALANCING

A. At the time of TAB final acceptance inspection, the TAB firm shall recheck, in the presence of the Engineer, specific and random selections of data that were recorded in the certified test and balance report.

B. Points and areas for recheck shall be selected by the Engineer.

C. Measurements and test procedures shall be the same as the submitted and approved test and balance agenda.

D. Selections for verification, specific plus random, shall not exceed 10 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

E. If 10 percent of the random verification tests demonstrate a measured flow deviation of 10 percent or more from that recorded in the certified test and balance report, the report shall be automatically rejected.

F. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test and balance report submitted, and a new inspection test made, as part of the Work.

G. Final Acceptance will not occur until after the successful completion of the TAB verification process.

END OF SECTION

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SECTION 23 07 00 – HVAC INSULATION

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide pipe and equipment insulation, complete and in place, as indicated in accordance with the Contract Documents.

B. In addition to the insulation indicated, the Contractor shall insulate cold or hot piping and exhausts that could be hazardous to personnel upon contact.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

B. Federal Specifications

HH-1-558B	Insulation Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)

C. Commercial Standards

ASTM International (ASTM)	
ASTM C547	Mineral Fiber Pipe Insulation
ASTM E84	Test Method for Surface Burning Characteristics of Building Materials
ASTM C1136	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1290	Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
National Fire Protection Association (NFPA)	
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	Standard for the Installation of Warm Air Heating and Air Conditioning Systems

1.03 CONTRACTOR SUBMITTALS

A. Submit complete Shop Drawings of thermal insulation, with manufacturer's data on materials, covering, jackets, and finish, in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Furnish the following certifications:

1. Certification from the heating system manufacturer that the insulation has been installed in accordance with the manufacturer's recommendations.

2. Certification from the acoustic insulation/duct lining manufacturer that the lining has the indicated sound absorption coefficients.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Components of the insulation, including covering, mastics, and adhesives, shall have a flame-spread rating of not greater than 25 and a smoke development rating of not greater than 50.

B. Ratings shall be as established by tests in accordance with ASTM E84, and the above federal and commercial specification standards.

C. Insulation shall be applied in strict accordance with the manufacturer's instructions.

2.02 BASIC MATERIALS

A. Unless otherwise indicated, the insulation thickness shall be as follows:

Pipe		**Minimum Thickness of Insulation (inches)**
Hot and cold potable water	6-inch and smaller	1
	8-inch and larger	1-1/2
Condensate, boiler blowdown, and boiler feed	8-inch and smaller	1-1/2
	10-inch and larger	2
Compressed air piping and liquid refrigerant piping exposed to the weather	all sizes	2
Heat-traced piping	3-inch and smaller	1
	4-inch and larger	1-1/2

2.03 PIPING INSULATION

A. Except as indicated otherwise, piping shall be insulated with heavy density, unfaced, fiberglass pipe insulation.

B. Pipe insulation shall have an average density of 4 pounds per cubic foot or greater, and its conductivity (k) shall not exceed 0.23 BTU-inch per (hour) (square foot) (degree F) at a mean temperature of 75 degrees F.

C. Supporting Hangers

1. For 3-inch piping and larger, the insulation shall be protected at supporting hangers by the suitable hollow steel protection saddles, filled with loose glass fiber insulation as indicated.

2. For piping smaller than 3-inch, place 1/16-inch thick sheet metal shims between the insulation and the supporting hanger; the shim shall be at least 6 inches long.

3. The insulation shall be oversized for installation over electric heating cable.

4. The 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.

5. 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.

6. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-barrier cement before installation of the finish jacket.

7. The pipe insulation and vapor-barrier shall be continuous through hangers and supports.

8. Where insulation is indicated for the top-half segment of pipe, insulation at support locations shall be of the same density.

9. 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.

D. Jacketing

1. A final covering of the insulation for piping shall be of 0.030-inch thick PVC or equivalent strength smooth aluminum, preformed jacketing with a factory-attached moisture barrier.

2. Valves, flanges, fittings, and ends of insulation shall be covered with a pre-molded, precision-formed, high-low temperature PVC fitting cover or end cap, or equivalent preformed unit to match the piping insulation jacket.

3. The pre-molded covers shall be sized to receive the same thickness of insulation as used on the adjacent piping, and shall be sized to cover and protect the insulated fitting.

4. Joints shall be sealed with silicone mastic or solvent welding to provide a continuous air- and weather-tight joint.

5. Strapping shall be 1/2-inch wide, Type 3003 aluminum or stainless steel.

6. Pre-molded fittings shall be Zeston 2000 PVC, or equal.

E. Standard Temperature Insulation

1. Standard temperature insulation shall be used for process, cold and hot water, steam, and condensate piping and equipment with surface temperatures up to 850 degrees F.

2. Pipe insulation and jacketing shall be applied to piping where indicated, including associated fittings, flanges, and valves.

3. Pipe insulation shall consist of a molded-type pipe covering, constructed of fibrous glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature.

2.04 DUCTWORK INSULATION

A. Supply ductwork and outside air ductwork shall be insulated as indicated under this Section.

B. The finished duct system shall meet the requirements of NFPA 90A and 90B.

C. Duct wrap insulation shall meet the requirements of ASTM C1290, Type III, to a maximum service temperature of 250 degrees F.

D. Facing material shall meet the requirements of ASTM C1136, Type II, when surface burning characteristics are determined in accordance with ASTM E84 with the foil surface of the material exposed to the flame.

E. Density and Thickness

1. Density: 1.5 lbs per cu ft

2. Thickness: 1-1/2 inches or 2 inches, as indicated

F. The duct wrap insulation shall consist of a blanket of glass fibers factory-laminated to a reinforced foil/ kraft (FRK) vapor retarder facing, with a 2-inch-wide (minimum) stapling and taping flange on one edge.

G. The duct wrap insulation shall provide installed R-values as indicated in the following table:

Density, lbs/cu ft	**Nominal Thickness, inches**	**R-value[1,2], (hour) (sq ft) (degree F) per BTU**
1.50	1-1/2	6.0
1.50	2	8.0

[1] *at 75 degrees F mean temperature*
[2] *assumes 25 percent compression of insulation*

H. Exposed Ductwork

1. Ductwork with exterior insulation which is exposed to the weather shall be protected with an aluminum-magnesium alloy jacket having a minimum thickness of 0.016 inch.

2. The jacketing shall include built-in isolation felt.

3. The jacket shall be lapped at least 3 inches at joints, and secured with stainless steel bands on 6-inch centers.

I. Manufacturers, or Equal

1. Manville Products Corporation, Linacoustic-HP

2. Owens-Corning

PART 3 -- EXECUTION

3.01 GENERAL

A. Piping, fittings, and valves to be insulated shall be clean and dry prior to installation of insulation.

B. Piping indicated to be insulated shall be completely insulated inside structures, except where indicated otherwise.

3.02 INSULATION OF STRAIGHT DUCT AND FITTINGS

A. Before applying the duct wrap, air ducts shall be clean, dry and tightly sealed at joints and seams.

B. Portions of the duct designated to receive duct wrap shall be completely covered with duct wrap.

C. Remove a 2-inch piece of insulation from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.

D. Install duct wrap insulation with facing outside such that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap.

E. Adjacent sections of the duct wrap insulation shall be tightly butted and overlapped with the 2-inch stapling and taping flap.

F. If the duct is rectangular or square, install insulation such that it is not excessively compressed at corners.

G. Seams shall be stapled approximately 6 inches on center, using 1/2-inch steel outward clinching staples.

H. Seams and joints shall be sealed with pressure-sensitive tape matching the insulation facing (either plain foil or FRK backing stock) or glass fabric and mastic.

I. Cloth duct tape of color or finish using reclaimed rubber adhesives will not be accepted for use on duct wrap insulation.

J. Where rectangular ducts are 24 inches or greater in width, the duct wrap insulation shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers, spaced on 18-inch centers (maximum) to prevent the insulation from sagging.

K. Where a vapor retarder is indicated, seal tears, punctures and other penetrations of the duct wrap facing using one of the above methods to provide a vapor-tight system.

L. Damaged Insulation

1. The Contractor shall replace insulation that has been damaged or removed by modifications to the existing ductwork.

2. The replacement insulation shall be new and joints between new and existing insulation shall be made water-tight.

3.03 DUCTWORK INSPECTION

A. After completing the installation of the duct wrap and before operations are to commence, visually inspect the system and verify that it has been installed correctly.

B. Open system dampers and turn on fans to blow scraps and other loose pieces of material out of the duct system; allow for a means of removal of such material.

C. Check the duct system to ensure that there are no air leaks through joints.

3.04 FIBERGLASS INSULATION

A. Fiberglass insulation shall be securely held in place before the final covering is applied.

B. A scrim fabric, similar to a 20 x 10 thread count mesh and 100 percent fiberglass, shall be pasted in place to hold the pipe insulation securely to the pipe.

C. The scrim fabric shall be at least 4-inches wide, with at least 2 applications per length of pipe insulation, and one at each joint.

3.05 JACKETING

A. Joints shall be neatly finished with no ragged ends.

B. When finished, the covering shall show no exposed staples or other binding used during installation.

C. Staples, if used, shall be stainless steel.

3.06 LAGGING FABRIC

A. The final lagging fabric shall be neatly pasted in place with a 3-inch longitudinal overlap using a **Luben No. 9 adhesive**, or equal.

B. Each transverse joint shall have a 3-inch butt strip of the same fiberglass fabric.

C. Final joints shall be neatly finished with no ragged ends and the covering shall present a neat, uniform surface when finished.

D. The fabric shall show no exposed staples or other binding used during construction; staples, if used, shall be stainless steel.

3.07 COMPRESSION COUPLINGS AND EXPANSION JOINTS

A. The rigid insulation blocks shall be held in place with stainless steel bands, approximately 1/2 inch wide by 0.015 inch thick.

B. After banding, the blocks shall be finished with a trowel coat of insulating cement to filling voids, and troweled to a smooth, neat finish.

C. The installation shall then be covered with an acoustical insulation consisting of a fiberglass fabric weighing 24.6 oz. per sq yd, and coated with a loaded vinyl weighing 83.4 oz. per sq yd.

D. The acoustical insulation shall be **Alpha-Sonic Style No. 75**, or equal.

E. The acoustical insulation shall be covered with a 100-percent fiberglass lagging fabric as indicated.

END OF SECTION

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SECTION 23 08 00 – COMMISSIONING OF HVAC

PART 1 -- GENERAL

1.01 SUMMARY

A. Related Documents

1. Drawings and general provisions of the Subcontract apply to this Section.

2. Review these documents for coordination with additional requirements and information that apply to Work under this Section.

B. Section Includes:

1. General requirements that apply to implementation of commissioning of HVAC systems, assemblies and components.

C. Reference Specifications

Division 23	HVAC Sections

D. Reference Standards

Associated Air Balance Council (AABC)
National Environmental Balancing Bureau (NEBB)

1.02 REFERENCES

A. General

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.

2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.

1.03 DESCRIPTION

A. The purpose of commission is to ensure the Owner and Engineer that Work has been completed as specified and that systems are functioning in the manner as described in the design documents and specified system operating criteria. It will assist operating staff training and familiarization with new systems. It will serve as a tool to reduce post-occupancy critical systems operational difficulty or failure. It will, also, be used to develop test protocol and record the associated test data in an effort to advance the building systems from a state of substantial completion to a full dynamic operation.

B. Commission will commence after preliminary punch list items are completed by Subcontractors.

C. The steps associated with commissioning are outlined below:

1. Step One - Installation Verification

2. Step Two - System Start-Up.

3. Step Three - Functional Performance Testing.

D. Operational staff training is essential to the commission process and will run concurrently with steps one through three.

E. The Commissioning Team will include representatives of the Owner, Construction and Installing Subcontractors, Test and Balance Subcontractor, Temperature Controls Subcontractor and Construction Subcontractor's Commissioning Agent. Equipment manufacturer's representatives will be present for start-up as specified in the equipment Specification Sections and for equipment training.

1.04 SYSTEMS TO BE COMMISSIONED

A. Commissioning will be performed on the following systems:

1. Controls System

2. Air Conditioning Equipment.

3. Supply and Exhaust Air Systems.

1.05 SUBMITTALS

A. Commissioning Plan as prepared by the prime Subcontractor or his Commissioning Agent.

B. Prime subcontractors or his Commissioning Agent shall provide Functional Performance Tests (FPT) procedures for the above listed systems. Prime subcontractors or his Commissioning Agent shall provide system narrative descriptions as part of the FPT procedures.

PART 2 -- PRODUCTS

2.01 COMMISSIONING PLAN

A. The commissioning plan shall outline the organization, scheduling, team members, and documentation pertaining to the overall commissioning process.

2.02 NARRATIVE DESCRIPTIONS

A. A narrative description of the design intents of the systems and their intended modes of sequences of operation.

2.03 FUNCTIONAL PERFORMANCE TESTS (FPT) PROCEDURES

A. The FPT procedures at the minimum shall consist of the following Sections:

1. Narrative Description:

a. This Section provides a narrative description of the design intents of the systems and their intended modes of sequences of operation.

2. Testing Prerequisites:

   a. This Section contains verification that primary mechanical, electrical, and controls systems that support or interact with the system that the FPT is prepared against are completed, tested and operational.

3. Installation Verification:

   a. This Section contains verification that the system installation is completed and is ready for commissioning.

4. Commencement of Functional Performance Testing:

   a. This Section records the date and time of the start of system commissioning.

5. System Condition Prior to Staring Performance Testing:

   a. This Section records the current set points and parameters of the system at the start of commissioning.

6. Functional Performance Test:

   a. This Section shall provide the following:

      1) Sequential steps required to set parameters and conditions required to test component and functions throughout intended ranges of operation.

      2) Full range of checks and tests carried out to determine if electric and pneumatic connections, components, subsystems, systems and interfaces between systems function in accordance with the contract documents and design intents.

      3) All modes and sequences of control operations, interlocks and conditional control responses and specified responses to abnormal emergency conditions.

7. End of Functional Performance Test:

   a. This Section records the date and time of the end of system commissioning.

8. Field Notes:

   a. This Section records notes or remarks during system commissioning.

9. List systems modifications, not required by the Contract Documents, but provided by the Subcontractor. List other questions regarding such system modifications.

10. List problems discovered during Commissioning that were corrected.

11. List problems discovered during Commissioning that were not corrected.

12. List recommended party that should take action on these problems.

PART 3 -- EXECUTION

3.01 GENERAL

A. The Subcontractors shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Functional Performance Tests (FPT). Members of the designated Commissioning Team shall witness various portions of the commissioning process. Responsibilities for these activities are listed in the following paragraphs. Commissioning Team members shall sign-off on appropriate Sections after verifying installation, operation, or documentation. Final sign-off shall be by the Owner and Commissioning Agent.

B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by Subcontractors.

C. Subcontractors shall provide to the Commissioning Team documentation of calibration of controls. Documentation shall include dates, setpoints, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the Work.

3.02 OPERATION STAFF TRAINING

A. System narrative descriptions will be prepared by the Commission Agent and supported by flow diagrams, one line diagrams, and appropriate Specification Sections for major systems to be commissioned. The Commission Agent will coordinate “system description” meetings with members of facility management and maintenance department groups to review system description documentation. The meetings will provide an overview of major system features, components, and arrangements.

B. The Subcontractor and associated manufacturer’s representatives shall provide required training to operational staff after the system description meetings have occurred. The Subcontractor training sessions shall provide a more detailed analogy of systems operation and maintenance.

3.03 INSTRUMENTATION

A. Instrumentation will be provided by the Subcontractor. Instruments used for measurements shall be accurate. Calibration histories for each instrument shall be available for examination. Calibration and maintenance of instruments shall be in accordance with the requirements of NEBB or AABC Standards.

B. Application of instruments and accuracy of measurements shall be in accordance with NEBB or AABC Standards.

3.04 DOCUMENTATION

A. The installing Subcontractor shall be responsible for collection of pertinent data during system start-up and functional performance testing. The Subcontractor shall submit to the Commissioning Agent documentation of tests performed prior to and after system start-up. Documentation shall also include start-up procedures as approved by Commissioning Team.

B. Documentation is to be typewritten on 8-1/2 by 11 inches (200 by 280 mm) paper and inserted in a 2 inches (50 mm) to 3 inches (75 mm) thick three ring binder. Indicate the project name, number, volume number, and volume title on the end panel of each binder.

C. Provide a title sheet for each volume and list the following:

1. Volume Title and Section Name and Number requiring this submittal.

2. Project name, project number, and address.

3. Subcontractor name, address, and phone number.

4. Name, title, signature, and date of person making the submittal.

5. Name of Owner, a blank line for signature, and the date of person accepting the submittal.

6. Name, address, and phone number of Commission Agent; a blank line for signature; and date of person accepting the submittal.

D. Provide a Table of Contents for multiple submittals. List each submittal and page number. Number each page, centered on the bottom in sequential numerical order. Provide tabs for multiple submittals in a single binder.

3.05 STEP ONE – INSTALLATION VERIFICATION

A. General Commissioning responsibilities:

1. Before system start-up begins, the Commission Team shall conduct a final installation verification audit. The Subcontractor shall be responsible for completion of Work including change orders and punch list items to the Owner's satisfaction. The audit shall include, but not be limited to, checking of:

a. Piping specialties including balance, control, and isolation valves.

b. Ductwork specialty items including turning devices, balance, fire, smoke, control dampers, and access doors.

c. Control sensor types and location.

d. Identification of piping, valves, equipment, controls, etc.

e. Major equipment, pumps, valves, starters, gauges, thermometers, etc.

f. Documentation of prestart-up tests performed, including manufacturer's factory tests.

B. If Work is found to be incomplete, incorrect, or non-functional, the Subcontractor shall correct the deficiency before system start-up Work proceeds.

3.06 STEP TWO – SYSTEM START-UP

A. General Commissioning Responsibilities:

1. A start-up plan shall be developed and submitted by the installing Subcontractor. Start-up plan to include the following:

a. Flushing and cleaning of pipe.

b. Filters, strainers, and screens.

c. Valve/damper positions.

d. Electrical tests.

e. Pressure tests.

f. Safeties.

g. Chemical treatment.

h. Manufacturer's tests.

B. The start-up plan will be reviewed and a prestart-up inspection performed by designated members of the Commissioning Team. The installing Subcontractor shall commence with system start-up after approval has been given to start-up plan and the prestart-up inspection is completed. Designated members of the Commissioning Team shall witness system start-up and list system and equipment deficiencies noted during start-up. The Subcontractor shall take corrective action on system deficiencies noted and demonstrate to the Commissioning Team members suitable system operation.

3.07 STEP THREE – FUNCTIONAL PERFORMANCE TESTING

A. General Commissioning Responsibilities:

1. Functional Performance Testing begins after operational testing, adjusting, and balancing of the systems have been completed by the Subcontractors; and the System Description and Hands-on Training sessions have been completed.

2. The objective of the Functional Performance Testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements and design intent.

3. Attaining this object will be accomplished by developing individual systems testing protocols which, when implemented by the Subcontractor, will allow the Commissioning Team to observe, evaluate, identify deficiencies, recommend modifications, tune, and document the systems and systems equipment performance over a range of load and functional levels.

4. Functional Performance tests for the systems to be commissioned are defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

END OF SECTION

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SECTION 23 09 01 – INSTRUMENTATION AND CONTROL FOR HVAC (STAND ALONE SYSTEM)

PART 1 -- GENERAL

1.01 PRODUCTS FURNISHED AND INSTALLED UNDER THIS SECTION

A. Section 23 - Hydronic Piping - The HVAC Subcontractor shall:

1. Furnish and install all automatic valves, temperature sensor wells, flow meters, etc., which are specified to be supplied by this Section.

2. Furnish and install any necessary reducing fittings required to install smaller than line-size control valves.

3. Furnish and install all necessary pressure taps, water, drain and overflow connections and piping.

4. Furnish and install all necessary penetrations and spool pieces required for flow devices.

B. Section 23 - Refrigerant Piping - The HVAC Subcontractor shall:

1. Furnish and install all pressure and temperature sensor wells and sockets, which are specified to be supplied by this Section.

C. Section 23 - Ductwork Accessories - The HVAC Subcontractor shall:

1. Furnish and install all duct smoke detectors whether shown on the drawings or required by code. If the project includes an existing fire alarm panel all signals from the duct smoke detectors shall be transmitted to the existing fire alarm panel. If the project does not include an existing fire alarm panel, and a new fire alarm panel is not required for any other reason, signals from the duct smoke detectors shall be transmitted to the HVAC automatic temperature control panel.

2. Furnish and install all automatic dampers and provide necessary blank off plates or transitions required to install dampers that are smaller than duct size.

3. Assemble multiple section dampers with required interconnecting and jackshaft linkage and extend required number of shafts through duct for external mounting of damper motors.

4. Furnish and install all necessary sheet metal baffle plates to eliminate stratification and provide the air volumes specified. Locate baffles by experimentation. Fix and seal permanently in place only after stratification problems have been eliminated.

5. Furnish and install airflow stations specified under this Section.

6. Furnish and install access doors or other approved means of access through ducts for service to control equipment.

D. Section 26 Electrical - The Electrical Subcontractor shall:

1. Furnish and install and connect all power wiring. Power wiring shall be defined as:

    a. Wiring of all power feeds through all disconnect starters and variable speed controllers to electric motors.

    b. Provide local power disconnects, where required.

    c. Provide circuit breakers, starters in motor control centers, and 120-, 208-, 240- and 480-volt power feeders from the starters and circuit breakers to the HVAC equipment, as indicated.

    d. Wiring of 120 VAC normal/emergency power feeds to all temperature control panels.

    e. Power wiring to 120/277-volt single-phase motors shown on electrical plans and all VAV boxes shown (with or without fan motors).

    f. All conduit, wiring and terminations between the ATC Panel and the Facility SCADA System

E. Section 23 HVAC - The HVAC Subcontractor shall:

1. Design and install a complete HVAC controls system as described herein and contract drawings.

2. Provide controls, sensors and control panels relating to the HVAC systems, including starters, thermostats, duct smoke detectors, motorized dampers, louver operators and other equipment as indicated.

3. Provide wiring and conduits to all thermostats, sensors, dampers, and all other HVAC controls equipment requiring 120 volt and less.

4. Provide control wiring of 120-volt and less as indicated in this Section and in conformance the requirements of Division 26 – Electrical and Division 40 – Instrumentation and Control.

F. Starters, whether as an integral or separate part of the equipment, shall be in accordance with the requirements of Division 26 specifications.

G. Enclosures shall be of the same NEMA class as the electrical equipment in the same area.

H. Starters shall be of the same manufacturer as the starters indicated under Section 26 29 00 – Low-Voltage Motor Control Centers.

I. Low-voltage control wiring shall be in accordance with the National Electric Code.

J. Control wiring for line voltage 120-volt and higher shall be in conformance with the requirements of Division 26.

K. Control panels shall be in conformance with the requirements of Section 26 05 15 – Industrial Control Panels.

L. Conduit shall be in conformance with the requirements of Section 26 05 33 – Electrical Raceway Systems and Section 26 05 43 – Underground Raceway Systems.

1.02 RELATED SECTIONS

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of this Specification and shall be used in conjunction with this Section as a part of the contract documents. Consult them for further instructions pertaining to this Work. The Contractor is bound by the provisions of Division 0 and Division 1.

B. The following Sections constitute related Work:

01 33 00	Submittal Procedures
23 05 00	Common Work Results for HVAC
26 05 33	Electrical Raceway Systems
26 05 43	Underground Raceway Systems
26 29 00	Low-Voltage Motor Control Centers
40 92 00	Control Panels

C. Reference Standards

1. All Work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities having jurisdiction.

2. Such codes, when more restrictive, shall take precedence over the Contract Documents.

D. The installation shall comply with the following codes:

American National Standards Institute (ANSI)	
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	
ASHRAE Standard 135	A Data Communication Protocol for Building Automation and Control Networks
ASHRAE/ANSI	135-2001: Data Communication Protocol for Building Automation and Control Systems (BACNET)
International Building Code (IBC)	
International Mechanical Code (IMC)	
National Electric Code (NEC)	
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 72	National Fire Alarm and Signaling Code
Underwriters Laboratories (UL)	

1. All BAS DDC controllers and local user displays shall be UL-listed under Standard UL 916, category PAZX and Standard ULC C100, category UUKL7.

2. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and labeled as such.

1.03 SYSTEM DESCRIPTION

A. Performance Standards

1. The system shall conform to the minimum standards indicated in Tables 1 and 2, below.

2. Information transmission and display times shall be based upon network, rather than modem, connections.

3. Programmable controllers shall be capable of executing DDC PID control loops at a selectable frequency adjustable down to once per second.

4. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

5. The system shall report all values with end-to-end accuracy as listed or better than those listed in Table 1.

6. Control loops shall maintain measured variable at set point within the tolerances listed in Table 2.

TABLE 1 - REPORTING ACCURACY

MEASURED VARIABLE	**REPORTED ACCURACY**
Space Temperature	plus or minus 1 deg F
Ducted Air	plus or minus 1 deg F
Outside Air	plus or minus 2 deg F
Dew Point	plus or minus 3 deg F
Water Temperature	plus or minus 1 deg F
Delta-T	plus or minus 0.25 deg F
Relative Humidity	plus or minus 5 percent RH
Water Flow	plus or minus 5 percent of full scale
Airflow (terminal)	plus or minus 10 percent of full scale (see Note 1)
Airflow (measuring stations)	plus or minus 5 percent of full scale
Airflow (pressurized spaces)	plus or minus 3 percent of full scale
Air Pressure (ducts)	plus or minus 0.1-in w.g.
Air Pressure (space)	plus or minus 0.01-in w.g.
Water Pressure	plus or minus 2 percent of full scale (see Note 2)

MEASURED VARIABLE	REPORTED ACCURACY
Electrical (A, V, W, Power Factor)	5 percent of reading (see Note 3)
Carbon Monoxide (CO)	plus or minus 5 percent of reading
Carbon Dioxide (CO2)	plus or minus 50 ppm

Note 1: 10 percent to 100 percent of full scale
Note 2: for both absolute and differential pressure
Note 3: not including utility-supplied meters

TABLE 2 - CONTROL STABILITY AND ACCURACY

CONTROLLED VARIABLE	CONTROL ACCURACY	RANGE OF MEDIUM
Airflow	plus or minus 10 percent of full scale	-----
Space Temperature	plus or minus 2 deg F	-----
Duct Temperature	plus or minus 3 deg F	-----
Humidity	plus or minus 5 percent RH	-----

1.04 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. No Work may begin on any segment of the Project until submittals have been successfully reviewed for conformity with the design intent.

C. Submittals shall include:

1. Wiring diagrams and layouts for each control panel, showing all termination numbers.

2. Schematic diagrams for all field sensors and controllers, and floor plans of all sensor locations and control hardware.

3. Diagrams

a. Submit schematic diagrams for all control, communication, and power wiring.

b. Submit a schematic drawing of the central system installation. Show all interface wiring to the control system.

c. Submit riser diagrams of wiring between central control unit and all control panels.

D. Controlled Systems

1. Schematic Diagrams

a. Submit a schematic diagram of each controlled system.

b. Indicate all control points labeled, with point names shown or listed.

c. Graphically show the location of all control elements in the system.

2. Schematic Wiring Diagrams

a. Submit a schematic wiring diagram for each controlled system.

b. Label all elements.

c. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name.

d. Label all terminals.

3. Instrument List

a. Submit an instrumentation list for each controlled system.

b. Each element of the controlled system shall be listed in table format.

c. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.

4. Description

a. A complete description of the operation of the control system, including sequences of operation.

b. Include and reference a schematic diagram of the controlled system.

5. I/O

a. Submit a points list for each system controller, including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device.

6. Quantities of items submitted will be reviewed but this shall be the responsibility of the Contractor.

1.05 QUALITY ASSURANCE

A. All products used in this project installation shall be new and currently under manufacture and shall be the version currently being sold by the manufacturer for use in new installations.

B. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner in writing. Spare parts shall be available for at least five years after completion of this contract.

1.06 WARRANTY

A. Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and Owner receives beneficial use of the system.

B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.

C. The Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

D. All Work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up.

E. If the Work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Temperature Controls

1. Temperature Control Panels furnished and installed by the HVAC Subcontractor shall be in accordance with Section 26 05 15 – Industrial Control Panels. Temperature Control Panels provided by HVAC equipment manufacturers shall be in accordance with Section 40 92 00 - Control Panels.

2. The temperature control system shall be as indicated on contract documents and shall consist of PLC or controllers.

3. HVAC Subcontractor shall be responsible for the installation, calibration, and operator training as necessary for a complete and full operating temperature control system.

4. The temperature control system shall be a complete stand-alone building automation system, modular in construction and not requiring a central computer for operation or programming.

5. All programming shall be possible from a keypad/display on any field panel or from a remote computer.

6. Systems which do not have a keypad/display capability shall be provided with a portable interface with required cables and software.

2.02 CONTROLLER SOFTWARE

A. Each intelligent field panel shall be completely user programmable, and shall include the indicated programs installed in the base operating system.

B. Alarms

1. The alarm program shall provide for alarm reporting as follows:

    a. Pilot light indication at local ATC Panel

    b. Remote annunciation of identified alarm to facility SCADA System via hardwired contact closure

C. Analog Input Scaling

1. Analog inputs shall be scaled and labeled to read out in engineering units of the variable being measured (e.g., deg, CFM, etc.).

D. Analog Outputs

1. Each analog output shall be user programmable to be direct or reverse acting and vary the output between 2 and 10 VDC.

2. The panel shall allow the user to program minimum and maximum output levels as well as a manual fixed output level.

3. The analog output shall be assignable to operate based on any physical input or calculated value on the network.

E. System Calendar

1. Each panel other than Application Specific Controllers (such as Terminal Controllers) shall be provided with a 365/366 day battery-backed clock, with an automatic daylight savings time switch-over on the day entered.

F. PID Control

1. In order to provide precise control, each analog output shall be programmable with a proportional plus integral plus derivative (PID) program.

2. Individual constants shall be programmable for the P, I, and D functions.

3. The integral time interval shall be user programmable.

4. The current proportional term, the integral term, and the PID sum shall be dynamically displayed on the screen to provide assistance to start-up and service personnel in tuning the system.

G. The diagnostics program in each panel shall monitor and report system status.

2.03 BUILDING CONTROLLERS

A. General

1. Provide an adequate number of Building Controllers to achieve the indicated performance.

2. Each controller shall meet the following requirements.

a. The Building Controller shall be provided with sufficient memory to support its operating system, database, and programming requirements.

b. Controllers that perform scheduling shall be provided with a real-time clock.

B. Communication

1. The Building Controller shall be provided with a service communication port for connection to a portable operator terminal.

C. Environment

1. Building Controller hardware shall be suitable for the anticipated ambient conditions.

2. Controllers used outdoors or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at minus 40 deg F to plus 150 deg F .

3. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32 deg F to 120 deg F .

D. Keypad

1. Provide a local keypad and display or a connection for a portable operator terminal for each Building Controller.

2. The keypad shall be provided for interrogating and editing data.

3. An optional system security password shall be available to prevent unauthorized use of the keypad and display.

4. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.

E. Serviceability

1. Provide diagnostic LEDs for power, communication, and processor.

2. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

F. Memory

1. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

2. Applications shall be maintained in flash memory.

G. Immunity to Power and Noise

1. The controller shall operate at 90 percent to 110 percent of its nominal voltage rating, and shall perform an orderly shutdown below 80 percent nominal voltage.

2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft .

2.04 INPUT/OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through building controllers, advanced application controllers, or application-specific controllers.

B. Input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller.

C. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.

D. Binary Inputs

1. Provide binary inputs to allow the monitoring of ON-OFF signals from remote devices.

2. The binary inputs shall provide a wetting current of at least 12 mA in order to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise.

3. Binary inputs shall sense “dry contact” closure without external power (other than that provided by the controller) being applied.

2.05 AUXILIARY CONTROL DEVICES

A. General

1. All materials and equipment used shall be standard components, of regular manufacture for this application.

2. All systems and components shall have been thoroughly tested and proven in actual use.

3. Exceptions to the indicated requirements will not be accepted.

B. Damper Actuators

1. Electronic damper actuators shall be of the direct-couple rotary type, suitable for mounting directly on the damper end shaft.

2. Electronic damper actuators shall be properly sized to provide sufficient torque to position the damper throughout its operating range.

3. On dampers with multiple sections, provide one actuator per section.

4. Damper actuators used on economizers and outside air dampers shall be of the spring return type.

C. Control Panels

1. All direct digital controllers mounted on HVAC equipment located indoors shall be installed in NEMA 4X enclosures.

2. All direct digital controllers mounted on HVAC equipment located outdoors shall be installed in NEMA 4X enclosures.

3. Enclosures shall be of suitable size to accommodate power supplies, relays, and accessories as required for the application.

4. Each enclosure shall include a subpanel for direct mounting of the enclosed devices, including matched key locks for all enclosures.

5. Construction

    a. Control panels shall contain all relays, control switches, transformers, pilot lights, timers, time clocks, step controllers, gages, thermostats, and other accessories as necessary for the particular system.

    b. The panels shall be constructed of aluminum with a baked enamel finish, and shall include a hinged front door with locking handle.

    c. All manual switches and direct-reading gauges shall be flush-mounted on the front face, and identified by engraved and riveted Bakelite or laminated plastic nameplates with white letters on black background.

    d. Manual switches shall be of heavy-duty, oil-tight construction.

6. Wiring

    a. Control devices shall be pre-wired internally.

    b. Terminate all wires leaving the panel at separate numbered terminal strips.

    c. Provide individual connectors for every item of mechanical equipment, all integral and remote pilot lights, and other devices indicated for each panel.

    d. Power and control circuit requirements shall be as indicated on the Electrical Drawings.

    e. Identify all wires by color coding or numerical tags at both ends.

    f. Wire each control device without splices to the terminal strip.

    g. Provide integral circuit protection for all panel-mounted control devices.

    h. Wire each panel with a single 20-amp, 120-volt, and AC feeder.

7. Panel electrical wiring diagrams shall be secured to the inside of the panel door.

D. Thermostats - Line Voltage

1. Materials: cold-rolled steel; beige thermoplastic; liquid sensing element

2. Contact Rating

    a. 6 amps running; 36 amps locked rotor; 120 VAC

    b. 3.5 amps running; 21 amps locked rotor; 208 VAC

    c. 3.0 amps running; 8 amps locked rotor; 240 VAC

3. Switch Action: single-pole, double-throw; open on rising temperature

4. Sensing Element: coiled bulb and capillary

5. Range: 0 to 130 deg F

6. Manufacturer, or Equal

    a. Dry Locations (no hose valves or open water processes in room): **Johnson Controls Model A19BAC-1** in NEMA 1 enclosure

    b. Wet (hose valves or open water processes in room) or Outdoor Locations: **Johnson Controls Model A19PRC-1** in NEMA 4X enclosure.

E. Duct and Well Temperature Sensors

1. Sensors for duct and water temperature sensing shall incorporate either RTD or thermistor sensing devices.

2. The sensing element accuracy shall be 0.1 percent or better over the sensor span.

3. Where the element is being used for sensing mixed air or coil discharge temperatures or the duct cross sectional area is in excess of 10 sq ft , the element shall be of the averaging type.

4. Immersion sensors shall use matched Type 316 stainless steel bulb wells.

5. Provide duct and immersion sensors with conduit connection housings.

6. Provide sensors with adequate standoffs for insulation installation.

F. Selector Switches

1. Selector switches shall be of the 2- or 3-position, knob or key type as required by the sequence of operation.

2. Selector switches shall be of oil-tight construction and fitted with snap-fit contact blocks rated for 10A, 600 Vac/dc operation.

3. Provide labels indicating switch position.

G. Pushbutton Switches

1. Pushbutton switches shall be of either the maintained or momentary type as required by the sequence of operation.

2. Pushbutton switches shall be of oil-tight construction and fitted with snap-fit contact blocks rated for 10A, 600 Vac/dc operation.

3. Provide labels indicating switch function.

H. Pilot Lights

1. Provide pilot lights as required by the sequence of operation.

2. Pilot lights shall utilize multi-colored dome lenses and replaceable LED lamps.

3. Provide labels indicating light function.

2.06 WIRING AND RACEWAYS

A. Provide copper wiring, plenum cable, and raceways as indicated in the applicable Sections of Division 26 – Electrical.

B. All insulated wire shall be copper conductor, and UL-labeled for 194 deg F minimum service.

2.07 CONTROL SYSTEM CONTRACTORS AND MANUFACTURERS, OR EQUAL

A. Schneider Electric – Authorized Field Office, Wadsworth Solutions

B. Johnson Controls – Factory Branch Office

C. Siemens – Factory Branch Office

D. Honeywell – Factory Branch Office

E. Trane – Authorized Field Office, Gardiner Trane

F. The above list of manufacturers applies to controller software, custom application programming language, building controllers, custom application controllers; and application specific controllers; all other indicated products (e.g., sensors, valves, dampers and actuators) need not necessarily be manufactured by the above manufacturers.

PART 1 -- EXECUTION

1.01 EXAMINATION

A. The Drawings shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

B. Inspect the Project Site to verify that the equipment may be installed as indicated, and report any discrepancies, conflicts, or omissions to the Engineer for resolution before rough-in work is started.

C. Examine the Contract Documents for other parts of the Work, and if head room or space conditions appear inadequate, report these discrepancies to the Engineer and obtain written instructions for any changes that may be necessary to accommodate the Work with the work of others.

D. Changes in the Work made necessary by the failure or neglect of the Contractor to report such discrepancies shall be considered to be part of the Contract.

1.02 COORDINATION

A. Site

1. Where the Work will be installed in close proximity to, or will interfere with, the work of other trades, the Contractor shall assist in accommodating space conditions to make a satisfactory adjustment.

2. If the Contractor installs the Work before coordinating with other trades, so as to cause any interference with the work of other trades, the Contractor shall make the necessary changes in the Work in order to correct the condition as part of the Contract.

3. Coordinate and schedule the Work with all other work in the same area, or with work that is dependent upon other work, in order to facilitate mutual progress.

B. Coordination with Other Controls

1. Other controls and control devices that are to be part of or integrated into the control system specified in this Section. These controls shall be integrated into the system and coordinated by the Contractor as follows:

2. All communication media and equipment shall be provided as specified in Part 2, “Communication” of this Specification.

3. Each supplier of a control product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this Section.

4. The HVAC Subcontractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other Sections or divisions of this Specification.

5. The HVAC Subcontractor is responsible for the integration of control products provided by multiple suppliers regardless of where this integration is described within the contract documents.

C. Coordination with Facility SCADA System

1. Each Automatic Temperature Control System Panel (ATC) shall annunciate critical alarms with Pilot Light (Red) illumination.

2. All critical alarms will also be annunciated to the Facility SCADA system via hard wired contact closure of each respective alarm.

3. All other local Pilot Light indication (Green – System On) (Yellow – System Caution) (Blue – System Off) are considered non-critical and not required to be annunciated to the Facility SCADA System

4. Division 23 - shall provide necessary relays and termination strip for wiring to the Facility SCADA System. Conduit and wiring between the ATC Panel and the SCADA system shall be by Electrical Subcontractor

5. See general sheets for ATC panel and Pilot Light layout.

1.03 GENERAL WORKMANSHIP

A. Install equipment, piping, wiring, and raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration isolation of piping and equipment.

C. Install all equipment in readily accessible locations as defined by the National Electrical Code (NEC).

D. Verify the integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and shall be executed in strict adherence to local codes and standard practices.

1.04 WIRING FOR CONTROL SYSTEMS

A. Furnish and install all wire, conduit, raceways, and cable systems as required for the complete operation of the Building Management and Control System in accordance with the requirements of Division 26 specs.

1.05 SENSOR INSTALLATION

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air-sealed in their raceways or in the wall in order to stop air transmitted from other areas from affecting sensor readings.

E. Averaging Sensors

1. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.

2. Averaging sensors shall be installed in a serpentine manner vertically across the duct.

3. Support each bend with a capillary clip.

F. Temperature Sensors

1. All pipe-mounted temperature sensors shall be installed in wells.

2. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

1.06 ACTUATORS

A. Mount and link control damper actuators according to manufacturer's instructions.

B. To compress seals when spring-return actuators are used on normally closed dampers, the actuator shall be powered to an approximately 5 degree open position, the damper closed manually, and then the linkage tightened.

C. Check the operation of damper/actuator combination in order to confirm that the actuator modulates damper smoothly throughout the stroke to both OPEN and CLOSED positions.

D. Provide all mounting hardware and linkages for the actuator installation.

E. Electric and Electronic Actuators

1. Dampers

a. Actuators shall be direct-mounted on the damper shaft or jackshaft unless indicated as a linkage installation.

b. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degrees available for tightening the damper seals.

c. Actuators shall be mounted in accordance with the manufacturer's recommendations.

1.07 CONTROLLERS

A. General

1. Provide a separate controller for each AHU or other HVAC system.

2. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller.

3. Control of an AHU or other mechanical equipment item shall not be split between multiple controllers; points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

B. Building Controllers and Custom Application Controllers

1. Building controllers and custom application controllers shall be selected to provide a minimum of 15 percent spare I/O point capacity for each point type found at each location.

2. If input points are not universal, 15 percent of each type shall be required, and if outputs are not universal, 15 percent of each type is required.

3. A minimum of one spare is required for each type of point used.

4. The future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software.

5. No additional controller boards or point modules shall be required to implement use of such spare points.

1.08 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging.

B. Provide a minimum of 25 percent of available memory free for future use.

C. BACnet Points

1. Provide a detailed BACnet points list.

2. In addition to standard I/O information, the BACnet points list shall contain the proposed I/O names and BACnet object description.

3. The proposed I/O names and object descriptions are subject to change as directed by the Engineer.

4. Deliver an as-built list of the BACnet points with actual names and BACnet object addresses to the Owner at Project completion.

D. Software Programming

1. Provide programming for the system and adhere to the indicated sequences of operation.

2. Provide all other system programming necessary for the operation of the system but not indicated in this Section.

3. Embed into the control program sufficient comment statements to clearly describe each section of the program, reflecting the language used in the sequences of operation.

1.09 CONTROL SYSTEM CHECKOUT AND TESTING

A. Start-up Testing

1. All testing listed in this article shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system.

2. This testing shall be completed before the Engineer is notified of the system demonstration.

B. Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this Section.

C. Verify that all control wiring is properly connected, free of shorts and ground faults, and that terminations are tight.

D. Enable the control systems and verify calibration of all input devices individually.

E. Perform calibration procedures according to manufacturers' recommendations.

F. Verify that all binary output devices (e.g., relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

G. Verify that all analog output devices (e.g., I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct.

H. Verify that the system operation adheres to the sequences of operation.

I. Simulate and observe all modes of operation by overriding and varying inputs and schedules.

J. Tune all PID loops and optimize START/STOP routines.

K. Alarms and Interlocks

1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

1.10 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this Section.

2. These tests shall occur after the Contractor has completed the installation, started up the system, and performed tests.

1.11 TRAINING

A. Provide a minimum of 2 on-site or classroom training sessions of 8 hours each, throughout the Contract period for personnel designated by the Owner.

B. Additional Training

1. Provide 2 additional training sessions at 6 and 12 months following the facility's turnover.

2. Each session to be 8 hours in length and shall be coordinated with the Owner.

C. Train the designated Owner's staff to perform the following items:

1. Day-to-day Operations:

a. Operate the system proficiently

b. Understand the control system architecture and configuration

c. Understand the DDC system components

d. Understand system operation, including DDC system control and optimizing routines (algorithms)

e. Operate the workstation and peripherals

f. Log on and off the system

g. Access graphics, point reports, and logs

h. Adjust and change system set points, time schedules, and holiday schedules

i. Recognize malfunctions of the system by observation of the system graphics, trend logs, and other system tools

j. Understand system drawings and the operation and maintenance manual

k. Understand the job layout and location of control components

l. Access data from the DDC controllers and ASCs

m. Operate portable operator terminals

2. Advanced Operations:

a. Create, delete, and modify alarms, including annunciation and routing of these items

b. Create, delete, and modify trend and graph or print these both on ad-hoc basis and at user-definable time intervals

c. Create, delete, and modify reports

d. Add, remove, and modify the system's physical points

e. Create, modify, and delete programming

f. Add panels when required

g. Add operator interface stations

h. Create, delete, and modify system displays, both graphical and others

i. Perform DDC system field checkout procedures

j. Perform DDC controller unit operation and maintenance procedures

k. Configure hardware including controllers and I/O points

l. Maintain, calibrate, and replace system components

3. System Management and Administration:

a. Maintain software and prepare backups

b. Interface with job-specific, third-party operator software

c. Add new users and understand password security procedures

D. Groupings

1. Split the above objectives into 3 logical groupings, as follows and based on the above descriptions.

2. Participants may attend one or more of these, depending on their level of knowledge required.

a. Day-to-day operators

b. Advanced operators

c. System managers and administrators

E. Provide a course outline and materials in accordance with the “Submittals” article in Part 1 of this Section.

F. The instructor shall provide one copy of training material per student

G. The instructor shall be factory-trained and experienced in presenting this material.

H. Classroom training shall be performed using a network of working controllers representative of the installed hardware.

END OF SECTION

SECTION 23 23 00– REFRIGERATION PIPING

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide copper tube for refrigeration service, complete and in place, as indicated in accordance with the Contract Documents

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 17	Structural Design, Support, and Anchorage
07 92 13	Elastomeric Joint Sealants

B. Reference Standards

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)	
AHRI 710 (2009)	Performance Rating of Liquid-Line Driers
AHRI 711 (2009)	Performance Rating of Liquid-Line Driers
AHRI 720 (2002)	Refrigerant Access Valves and Hose Connectors
ANSI/AHRI 750 (2007)	Thermostatic Refrigerant Expansion Valves
ANSI/AHRI 760 (2007)	Performance Rating of Solenoid Valves for Use With Volatile Refrigerants
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)	
ANSI/ASHRAE 15 & 34	
ASHRAE 17 (2008)	Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves
AMERICAN WELDING SOCIETY AWS A5.8/A5.8M (2011)	Specification for Filler Metals for Brazing and Braze Welding, AWS BRH (2007; 5th Ed) Brazing Handbook, AWS D1.1/D1.1M (2010) Structural Welding Code – Steel, AWS Z49.1 (2005) Safety in Welding and Cutting and Allied Processes
ASME INTERNATIONAL (ASME)	
ASME B1.20.1 (1983; R 2006)	Pipe Threads, General Purpose
ASME B16.11 (2009)	Forged Fittings, Socket-Welding and Threaded
ASME B16.21 (2011)	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22 (2001; R 2010)	Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26 (2011)	Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3 (2011)	Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5 (2009)	Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Inch Standard
ASME B16.9 (2007)	Standard for Factory-Made Wrought Steel Buttwelding Fittings

ASME B31.1 (2010)	Power Piping
ASME B31.5 (2010)	Refrigeration Piping and Heat Transfer Components
ASME B31.9 (2011)	Building Services Piping
ASME B40.100 (2005; R 2010)	Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX (2010)	BPVC Section IX-Welding and Brazing Qualifications
ASTM INTERNATIONAL (ASTM)	
ASTM A193/A193M (2011)	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A334/A334M (2004a; R 2010)	Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A53/A53M (2010)	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M (2011)	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117 (2011)	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B280 (2008)	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B32 (2008)	Standard Specification for Solder Metal
ASTM B62 (2009)	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75 (2002; R 2010)	Standard Specification for Seamless Copper Tube
ASTM B813 (2010)	Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D3308 (2006)	PTFE Resin Skived Tape
ASTM D520 (2000; R 2011)	Zinc Dust Pigment
ASTM E84 (2011b)	Standard Test Method for Surface Burning Characteristics of Building Materials

1.03 QUALITY ASSURANCE

A. Submit 4 copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations. Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests to be performed at the work site, if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made, as a permanent record.

B. Contract Drawings: Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that

would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

PART 2 -- PRODUCTS

2.01 REFRIGERANT PIPING SYSTEM

A. Refrigerant piping, valves, fittings, and accessories shall be in accordance with ANSI/ASHRAE 15 & 34 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant. Submit drawings, at least 2 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

1. Piping layouts which identify all valves and fittings.

2. Plans and elevations which identify clearances required for maintenance and operation.

2.02 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

A. Copper Tubing

1. Copper tubing shall conform to ASTM B280 annealed or hard drawn as required.

2. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required.

3. Soft annealed copper tubing shall not be used in sizes larger than 1 3/8-in. Joints shall be brazed except that joints on lines 7/8-in and smaller may be flared. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62.

4. Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B75M ASTM B75. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings.

5. Cast sweat-type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

B. Solder

1. Solder shall conform to ASTM B32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

C. Brazing Filler Metal

1. Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.03 VALVES

A. Valves, General

1. Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 1-in and smaller shall have brazed or socket welded connections. Valves larger than 1-in shall have butt welded end connections.

2. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections.

3. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body.

4. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

B. Refrigerant Stop Valves

1. Valve shall be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing shall be replaceable under line pressure. Valve shall be provided with a handwheel operator and a seal cap. Valve shall be the straight or angle pattern design as indicated.

C. Check Valves

1. Valve shall be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve shall be provided with resilient seal.

D. Liquid Solenoid Valves

1. Valves shall comply with ANSI/AHRI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions.

2. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required.

3. Valves shall have safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

E. Expansion Valves

1. Valve shall conform to ANSI/AHRI 750 and ASHRAE 17. Valve shall be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing.

2. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 2 deg F of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body.

3. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve.

4. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

F. Safety Relief Valves

1. Valve shall be the two-way type, unless indicated otherwise.

2. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

G. Evaporator Pressure Regulators, Direct-Acting

1. Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 2 deg F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

H. Refrigerant Access Valves

1. Refrigerant access valves and hose connections shall be in accordance with AHRI 720.

2.04 PIPING ACCESSORIES

A. Filter Driers

1. Driers shall conform to AHRI 711AHRI 710. Sizes 5/8-in and larger shall be the full flow, replaceable core type. Sizes ½-in and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant.

2. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

B. Sight Glass and Liquid Level Indicator

1. Assembly and Components: Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type.

2. Ferrous components subject to condensation shall be electro-galvanized.

C. Gauge Glass

1. Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

D. Bull's-Eye and Inline Sight Glass Reflex Lens

1. Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

E. Moisture Indicator

1. Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

F. Vibration Dampeners

1. Dampeners shall be of the all-metallic bellows and woven-wire type.

G. Flexible Pipe Connectors

1. Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 300 deg F. Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

H. Strainers

1. Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

I. Pressure and Vacuum Gauges

1. Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3 ½-in in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range

J. Temperature Gauges

1. Temperature gauges shall be the industrial duty type and be provided for the required temperature range. Gauges shall have Fahrenheit scale in 2 degrees graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 ft of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 ft to 7 ft above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 7 ft above the finished floor.

K. Stem Cased-Glass

1. Stem cased-glass case shall be polished stainless steel or cast aluminum, 9-in long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

L. Bimetallic Dial

1. Bimetallic dial type case shall be not less than 3 ½-in, stainless steel, and shall be hermetically sealed with clear acrylic lens.

2. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment. Accuracy shall be one percent of dial range.

M. Liquid-, Solid-, and Vapor-Filled Dial

1. Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3 ½-in, stainless steel or cast aluminum with clear acrylic lens.

2. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

N. Thermal Well

1. Thermal well shall be identical size, ½-in or ¾-in NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type ½-in NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1-in.

O. Pipe Hangers, Inserts, and Supports

1. Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

P. Escutcheons

1. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.05 FABRICATION

A. Factory Coating

1. Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand [125] [500] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8-in on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

B. Refrigerant Pipe Insulation

1. Insulation shall be a flexible, closed-cell elastomeric pipe insulation, AP Armaflex, AC Accoflex.

2. Adhesive shall be Armaflex 520, 520 Black or 520 BLV Adhesive. The insulation must conform to ASTM C534 Grade 1, Type I.

3. Insulation materials shall have a closed cell structure to prevent moisture from wicking which makes it an efficient insulation.

4. Insulation materials shall be manufactured without the use of CFC’s, HFC’s or HCFC’s. It is also formaldehyde free, low VOCs, fiber free, dust free and resists mold and mildew.

5. Insulation materials shall have a flame-spread index of less than 25 and a smoke-developed index of less than 50 as tested in accordance with ASTM E 84. In addition, the products, when tested, shall not melt or drip flaming particles, and the flame shall not be progressive.

6. Insulation materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft^2-deg F at a 75 deg F mean temperature as tested in accordance with ASTM C 177 or ASTM C 518.

7. Insulation materials shall have a maximum water vapor transmission of 0.08 per m-in when tested in accordance with ASTM E 96, Procedure A.

8. As a minimum, insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150.

9. Insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50.

10. Flame spread and smoke developed indexes shall be determined by ASTM E84.

11. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material.

12. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

13. All liquid and suction lines shall be insulated continuously from a point 6-in inside the display case to the suction service valve at the compressor.

14. All low temperature lines (plus 10 deg F and below) shall be insulated with a minimum of 1-in wall thickness.

15. All medium and high temperature lines (above plus 10 deg F) shall be insulated with a minimum of ¾-in wall thickness.

16. Heat reclaim lines shall be insulated from the condensing unit to the heat reclaim units with ¾-in thickness.

17. All refrigerant copper lines must be free of extraneous chemicals such as corrosive cleaners or building materials' dust prior to the installation of the insulation. The insulation must be clean and dry prior to installation.

18. Refrigerant pipe shall be sealed while slipping on insulation to prevent foreign matter from entering the tube.

19. Insulation is to be slid onto pipe; longitudinal slitting of the insulation is not allowed except on mitered sections. Insulation shall be pushed onto pipe, not pulled.

20. Insulation shall be mitered, preadhered and longitudinally slit inside throat to fit over all Ptraps, tees and elbows or bends over 90 degrees.

21. All butt joints and mitered seams shall be adhered with full coverage of adhesive on both surfaces. Insulation shall not be stretched when adhering.

22. Insulation must be installed in an adequately ventilated area. It may be necessary to increase insulation thickness if adequate ventilation is not present, do not crowd the insulation, allow for adequate air movement.

23. At the beginning, at every 12 ft to 18 ft, and at the ends of piping runs, the insulation shall be adhered directly to the copper using a 2-in strip of adhesive. Insulation should not be adhered to the pipe at the extreme low points in any piping run.

24. Saddles shall be installed under all insulated lines at unistrut clamps, clevis hangers, or locations where insulation may be compressed.

25. Armafix IPH or NPH insulation pipe hangers can be installed at the compression locations and the seams shall be sealed with Armaflex 520, 520 Black or 520 BLV contact adhesive.

26. To minimize the movement of Armafix, a pair of non-skid pads be adhered to the clamps. In addition, to prevent loosening of the clamps, use of an anti-vibratory fastener, such as a nylon-locking nut.

27. Wood dowels or blocks, of a thickness equal to the insulation, shall be inserted and must be completely sealed into the insulation at the saddle locations. All seams shall be sealed with Armaflex 520, 520 Black or 520 BLV contact adhesive.

28. Hangers clamped directly to the pipe shall be insulated over the hanger; insulation shall be fully adhered to the hanger. In addition, hangers with double rods shall be insulated between the rods. All seams of the insulation shall be sealed with adhesive.

29. All insulation exposed to sunlight or installed outdoors shall be protected with two coats of WB Armaflex Finish or weather resistant coating.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. After becoming familiar with all details of the work, perform a verification of dimensions in the field. Submit a letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found before performing any work.

3.02 INSTALLATION

A. Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

1. Directional Changes: Changes in direction shall be made with fittings, except that bending of pipe 4-in and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

2. Functional Requirements: Piping shall be installed ½-in/10 ft of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or

equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

B. Fittings and End Connections

1. Threaded Connections: Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

C. Brazed Connections

1. Brazing shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

D. Welded Connections

1. Welded joints in steel refrigerant piping shall be fusion-welded. Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

E. Flared Connections

1. When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

F. Flanged Connections

1. When steel refrigerant piping is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, chillers, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for use with the refrigerants to be handled.

G. Valves General

1. Refrigerant stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Stop valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches shall be external to thermal insulation. Safety switches shall not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated non-condensable gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

H. Expansion Valves

1. Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2 1/8-in in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 2 1/8-in. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall be installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

I. Valve Identification

1. Each system valve, including those which are part of a factory assembly, shall be tagged. Tags shall be in alphanumeric sequence, progressing in direction of fluid flow. Tags shall be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 1 3/8-in diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Tags shall be attached with nonferrous, heavy duty, bead or link chain, 14-gauge annealed wire, nylon cable bands or as approved. Tag numbers shall be referenced in Operation and Maintenance Manuals and system diagrams.

J. Vibration Dampers

1. Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and shall be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

K. Strainers

1. Strainers shall be provided immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

L. Filter Dryer

1. A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer.

2. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed.

3. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

M. Sight Glass

1. A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.

N. Discharge Line Oil Separator

1. Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

O. Accumulator

1. Accumulators shall be provided in the suction line to each compressor.

P. Flexible Pipe Connectors

1. Connectors shall be installed perpendicular to line of motion being isolated. Piping for equipment with bidirectional motion shall be fitted with two flexible connectors, in perpendicular planes. Reinforced elastomer flexible connectors shall be installed in accordance with manufacturer's instructions. Piping guides and restraints related to flexible connectors shall be provided as required.

Q. Temperature Gauges

1. Temperature gauges shall be located specifically on, but not limited to the following: the liquid line leaving a receiver and the suction line at each evaporator or liquid cooler. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1-in.

R. Pipe Hangers, Inserts, and Supports

1. Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2-in and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

S. Hangers

1. Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

T. Inserts

1. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

U. C-Clamps

1. Type 19 and 23 C-clamps shall be torqued in accordance with MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer.

2. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

V. Angle Attachments

1. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

W. Saddles and Shields

1. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4-in and larger when the temperature of the medium is 60 deg F or higher. Type 40 shields shall be used on all piping less than 4-in and all piping 4-in and larger carrying medium less than 60 deg F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2-in and larger.

X. Horizontal Pipe Supports

1. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 ft from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 ft apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

Y. Vertical Pipe Supports

1. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 ft not more than 28 ft from end of risers, and at vent terminations.

Z. Pipe Guides

1. Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

AA. Steel Slides

1. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4-in and larger, a Type 39 saddle shall be used. On piping under 4-in, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

BB. High Temperature Guides with Cradles

1. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4-in, or by an amount adequate for the insulation, whichever is greater.

CC. Multiple Pipe Runs

1. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member.

2. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

DD. Structural Attachments

1. Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking.

2. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

3. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section.

EE. Seismic Requirements

1. Piping and attached valves shall be supported and braced to resist seismic loads as specified under 01 33 17- Structural Design, Support, and Anchorage.

2. Comply with spec Section 01 33 17– Structural Design, Support, and Anchorage

FF. Pipe Alignment Guides

1. Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 ft on each side of each expansion joint, and in lines 4-in or smaller not more than 2 ft on each side of the joint.

GG. Pipe Anchors

1. Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

HH. Building Surface Penetrations

1. Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Schedule 30. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than ½-in depth. Sleeves shall not be installed in structural members.

II. Refrigerated Space

1. Refrigerated space building surface penetrations shall be fitted with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Sleeves shall be constructed with integral collar or cold side shall be fitted with a bonded slip-on flange or extended collar. In the case of masonry penetrations where sleeve is not cast-in, voids shall be filled with latex mixed mortar cast to shape of sleeve and flange/external collar type sleeve shall be assembled with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors. Integral cast-in collar type sleeve shall be flashed with not less than 4-in of cold side vapor barrier overlap of sleeve surface. Normally noninsulated penetrating round surfaces shall be sealed to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth shall be insulated with not less than 4-in of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer. Vapor barrier sealant shall be applied to finish warm side insulation surface. Warm side of penetrating surface shall be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Wires in refrigerated space surface penetrating conduit shall be sealed with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

JJ. General Service Areas

1. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of ¼-in all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves.

2. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 13- Elastomeric Joint Sealants.

KK. Waterproof Penetrations

1. Pipes passing through roof or floor waterproofing membrane shall be installed through a 17 oz copper sleeve, or a 0.032-in thick aluminum sleeve, each within an integral skirt or flange.

2. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8-in from the pipe and be set over the roof of floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2-in above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

3. Waterproofing Clamping Flange: Pipes up to and including 10-in in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

4. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

LL. Escutcheons

1. Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided

with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

MM. Access Panels

1. Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced.

NN. Identification Tags

1. Provide identification tags made of brass, engraved laminated plastic or engraved anodized aluminum indicating service and item number on all valves and dampers. Tags shall be 1 3/8-in minimum diameter and marking shall be stamped or engraved. Indentations shall be black for reading clarity. Tags shall be attached to valves with No. 12 AWG copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.03 CLEANING AND ADJUSTING

A. Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Government as determined by the Contracting Officer. Water shall not be used in any procedure or test.

3.04 REFRIGERANT PIPING TESTS

A. General

1. After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to pneumatic, evacuation, and startup tests as described herein. Submit a schedule, at least 2 weeks prior to the start of related testing, for each test. Identify the proposed date, time, and location for each test. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Provide the services of a qualified technician, as required, to perform all tests and procedures indicated herein.

2. SYSTEMS. Submit 6 copies of the tests report in bound 8 1/2 by 11-in booklets documenting all phases of the tests performed. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

B. Preliminary Procedures

1. Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated

from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

C. Pneumatic Test

1. Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus minus 70 deg F dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ANSI/ASHRAE 15 & 34 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

D. Evacuation Test

1. Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 35 deg F. No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

E. System Charging and Startup Test

1. Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire

system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

F. Refrigerant Leakage

1. If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

G. Contractor's Responsibility

1. At all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

END OF SECTION

SECTION 23 31 13 – METAL DUCTS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Provide ductwork, complete and operable, as indicated in accordance with the Contract Documents.

B. Furnish design calculations used to determine duct wall thickness and reinforcements.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage

B. Reference Standards

Associated Air Balance Council (AABC)	
Air Movement and Control Association International, Inc. (AMCA)	
AMCA 500	Test Methods for Louvers, Dampers, and Shutters
American Society of Civil Engineers (ASCE)	
ASCE 7-10	Minimum Design Loads for Buildings and Other Structures
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	
ASTM International (ASTM)	
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2310	Standard Classification for Machine-Made “Fiberglass” (Reinforced Thermosetting Resin) Pipe
ASTM D2563	Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D2992	Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
ASTM D2996	Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe

ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
National Fire Protection Association (NFPA)	
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 91	Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
SMACNA	Thermoset FRP Duct Construction Manual

C. Codes and Standards, General

1. Anchorage and bracing for all suspended ductwork and other distribution systems needs to be provided per 2016 CBC Section 1613/ASCE 7-10 Chapter 13

2. Perform and provide the Work in full accordance with the latest rules and regulations or publications of the State Energy Resources Conservation and Development Commission, the State Fire Marshall, the Industrial Safety Orders, the Health and Safety Rules (Air Conditioning systems), the local Plumbing Code, the local Building Code, and other local codes.

3. In the absence of applicable codes, follow the installation and workmanship standards set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

4. Provide the ductwork systems in accordance with the latest edition of the ASHRAE Handbook, SMACNA Manual, and the International Mechanical Code.

5. Where conflict between these standards arises, the most stringent criterion shall control. Ducts shall be listed for use without the necessity for internal fire protection sprinklers or any devices relied on to cut off air flow in the event of fire by Factory Mutual Research Standard 4922.

6. ASHRAE Standards: Comply with AS~E handbook, Equipment Volume, Chapter "Duct Construction," for fabrication and installation of metal duct.

7. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilation Systems," NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems," and NFPA 91 "Standard for the Installation of Blower and Exhaust Systems."

8. Field Reference Manual: Have available for reference at Project field office a copy of SMACNA "Round Industrial Duct Construction Standards."

9. Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal duct, and SMACNA's "Round Industrial Duct Construction Standards" intended for use by designers of industrial ventilation systems.

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings:

1. The HVAC design drawings define the general layout, configuration, routing, size, and the general intent of the design and are not fabrication drawings. Contractors shall be responsibility to develop the shop drawings required for the construction of the HVAC system(s).

2. Submit detailed fabrication drawings with layouts and all necessary dimensions and details on equipment, and ductwork. Show all fittings, and supports necessary to accommodate the equipment provided in a complete and functional system. Show main and branch runs, fittings, offsets, takeoffs, accessories, supports, anchorage, point loads and seismic restraints, and dimensions of sub-assemblies to be shipped.

3. The ductwork dimensions provided on the design drawings represent a free area and they are clear inside dimensions. The Contractor shall be responsible to account for the loss of free area due acoustical lining, or any internal obstructions, and oversize the ductwork to provide the same free area as the one shown on the design drawings.

1.04 QUALITY ASSURANCE

A. Qualifications, General

1. Ductwork shall be fabricated and installed by experienced workers who have experience with fabrication, and installation of ductwork.

2. Work and materials shall be in full accordance with the latest rules and regulations or publications of the State Energy Resources Conservation and Development Commission, the State Fire Marshall, the Industrial Safety Orders, the Health and Safety Rules (Air Conditioning systems), the local Plumbing Code, the local Building Code, and other local codes.

3. Nothing in the Contract Documents shall be construed to permit work in violation of the above codes, rules and regulations.

4. In the absence of applicable codes, the installation and workmanship shall follow the standards set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).Use firms regularly engaged in the manufacture of ETFE coated stainless steel duct products of types, materials, and sizes required.

5. The manufacturer shall perform their own sheet metal fabrication and coating processes.

6. Use manufacturers whose ETFE-coated stainless steel duct shall have been in satisfactory use for not less than 5 years.

7. The Owner shall have the right to tour the manufacturer's plant any time that fabrication is being performed on duct intended for the Project.

8. Installer Qualifications: The installation contractor shall have at least 3 years of successful experience on duct projects, specifically industrial exhaust systems.

B. Inspection and Testing

1. All ductwork shall be inspected and approved by a qualified QC person in order to ensure proper welding and dimensional tolerances. The Inspector shall provide a written approval to the resident Engineer or Owner, stating that the ductwork has been inspect and is free of any defects.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General

1. Duct, fittings, and dampers shall be protected from damage and shall be supported by minimum 4-inch wide strapping to avoid damage due to flex strains and point loading during shipping and installation.

2. Debris and other extraneous material shall not be allowed to enter the duct.

3. Duct, fittings, and dampers shall not be thrown or dropped.

B. Material Protection

1. Protect coated duct from damage due to normal handling during shipment and storage.

2. Protection shall be applied to ends of the duct in order to prevent dirt and moisture from entering ducts and fittings.

3. Protection must be of suitable strength and material to withstand tearing and puncture.

4. Multiple pieces may be bolted together at the factory to provide protection and limit the number of open ends requiring protection.

C. Consignee must inspect shipment upon delivery and note any and all damages and discrepancies on bill of lading and notify manufacturer within 24 hours.

1.06 WARRANTY

A. Provide the ductwork manufacturer’s standard warranty.

B. Furnish the warranty to the Engineer upon final acceptance of the completed systems by the Owner.

PART 2 -- PRODUCTS

2.01 HANGERS AND SUPPORTS

A. Anchorage and bracing for all suspended ductwork and other distribution systems needs to be provided per 2021 IBC Section 1613/ASCE 7-10 Chapter 13

B. Ductwork shall be firmly anchored or connected to supporting members.

C. Provide necessary hangers, supports, concrete inserts, and anchors for material and equipment to be installed.

D. No perforated strap hangers nor wire supports will be accepted.

E. Construct the anchors and inserts of 304 stainless steel.

F. Locate hangers and supports not greater than 8 feet from each expansion loop or joint.Provide hangers and supports for ductwork and equipment in accordance with SMACNA standards.

2.02 GALVANIZED AND ALUMINUM DUCTWORK (ALL DUCTWORK SHALL BE ALUMINUM UNLESS OTHERWISE NOTED)

A. General

1. Provide air-tight and well-braced ductwork.

2. Carefully support the ductwork in horizontal runs, with rod and angle supports at no greater than 8-foot intervals.

3. Run ductwork as close as possible to the indicated layouts.

B. Construction

1. Construct sheet metal ducts and plenums with air-tight joints and seams in accordance with ASHRAE standards and the SMACNA Duct Construction Manual.

2. Tape the joints on concealed ducts with pressure-less tape and adhesive, except for welded and soldered joints.

3. Ductwork materials shall be aluminum, unless otherwise indicated.

4. Provide the following duct gauges, as a minimum:

Maximum Dimension of Duct (inches)	Galvanized Steel U.S. Standard Gauge	Aluminum B and S Gauge
12 and less	26	24
13 through 30	24	22
31 through 54	20	20
55 through 84	20	18

5. All low pressure ductwork shall be designed for 3 inches vacuum and pressure and be constructed of sheet metal of not less than the gauge designated in table above, and gauge designations provided by Brown and Sharpe Standards.

6. Radius of bends shall be not less than 1.5 duct diameters, unless otherwise indicated.

7. Provide turning vanes on all mitered elbows and extractors, as required and indicated.

8. Except where accepted by the Engineer, provide fan discharge connections and ductwork reductions with duct side slopes not exceeding 30 degrees.

9. Properly insulate aluminum duct and supports from concrete or dissimilar metals by an applied bituminous coating or by rubber gaskets at contact points.

10. Construct interior partitions from aluminum, in accordance with the latest ASHRAE guide recommendations for construction for high-pressure rectangular duct work.

11. Construct the units in accordance with the ASHRAE guide recommendations for high-pressure ductwork.

12. Seams shall be lock-formed and mastic-filled.

13. Provide rectangular casing seams in the corners of the silencer shell in order to provide maximum unit strength and rigidity.

14. Provide interior partitions with die-formed entrance and exit shapes in order to provide the maximum aerodynamic efficiency and minimum self-noise characteristics in the sound attenuator.

15. Blunt noses or squared off partitions will not be accepted.

16. Use solid galvanized steel to attach the interior partitions to the casing, welded to the outer casing.

17. Attachment of the interior partitions to the tracks shall be such that a minimum of 4 thicknesses of metal exist at this location.

18. The track assembly shall stiffen the exterior casing, provide a reinforced attachment detail for the interior partitions, and shall maintain a uniform airspace width along the length of the silencer for consistent aerodynamic and acoustic performance.

19. In addition to the above attachments, secure the interior partitions to the outer casing with welded nose clips at both ends of the sound attenuator.

20. Achieve airtight construction by the use of a duct-sealing compound applied at the Site.

21. Sound traps shall not fail structurally when subjected to a differential air pressure of 8 inches w.g. inside-to-outside of casing.

C. Seams

1. Provide double-locked seams.

2. Provide rectangular ducts with longer than a 12-inch dimension with full-perimeter standing seams not less than one inch high.

3. Provide reinforcements at intervals not greater than 30 inches along the duct.

4. No "S" seams will be accepted.

D. Low-Pressure Ductwork

1. Design all low-pressure ductwork for 3 inches vacuum and pressure.

2. Gauge designations refer to Brown and Sharpe Standards.

E. Access Doors

1. Provide access doors in the ductwork at all fire dampers, motorized and back draft dampers, filters, and as indicated.

2. Provide doors with the following features:

a. continuously hinged;

b. double-skinned;

c. constructed of either 22-gauge galvanized steel or 20-gauge aluminum to match the ductwork material;

d. one cam lock for sizes up to 16 inches square or 2 cam locks for sizes over 16 inches square;

e. match insulation thickness in door with ductwork insulation; and,

f. foam sealing gaskets on all four sides.

3. Access Doors Manufacturer, or Equal

a. Ruskin, SMACNA Standard Duct Access Doors

F. Flexible Connections

1. Attach the equipment to the ducts through using flexible connections in order to facilitate removal of the units and for sound isolation.

2. Provide flexible connectors consisting of heavy duct canvas or woven glass fabric, silicon-coated.

3. Canvas connectors shall be composed of a heavy cotton that is impregnated for waterproofing and fire retardance.

4. Use glass fabric where temperatures exceed 200 degrees F.

5. The weight of the canvas shall be 20 ounces per sq yd.

6. The weight of the glass fabric shall be approximately 12 ounces per sq yd.

7. Flexible duct shall be insulated.

8. The maximum length of flexible duct shall not exceed 10 feet.

9. Flexible duct connections shall be composed of banded or flanged 8-oz canvas, reinforced plastic, or equal, at each point where a blower unit is connected to a duct.

10. Maintain a minimum clearance of 3 inches between the duct and the source of vibration.

11. Provide materials that join and support the flexible duct in accordance with the latest edition of SMACNA.

G. Supports

1. Provide aluminum angles with 304 stainless steel threaded hanger rods as supports for horizontal ducts and plenums.

2. Supports for vertical ducts shall be aluminum of the angle bracket type.

3. Sufficiently brace inlet ducts to withstand the maximum negative pressure.

H. Seismic Restraints

1. Design the duct supports and restraints for static, dynamic, and seismic loads in accordance with the International Building Code and structural drawings and specs.

2. Seismic restraints shall not induce stresses in the ductwork caused by thermal expansion and contraction.

3. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage

I. Duct Dimensions

1. Increase sheet metal duct dimensions by 2 inches for internally lined ducts.

J. Corrosion-Resistant Ducts

1. Provide exhaust hoods as indicated, constructed of Type 316 stainless steel.

2. Fabricate the stainless steel ducts of the same gauge as the galvanized steel ducts.

K. Balancing Dampers

1. Provide butterfly or multi-blade dampers as indicated and required in order to balance the air quantities to their indicated values.

2. Provide a locking quadrant on each manual damper, with easy access for operation.

L. Inspection Doors

1. Provide duct inspection doors consisting of a 12-inch by 16-inch steel frame with gasketing around its periphery, and either a hinged glass or a removable visual panel.

2. Doors shall be constructed of **Plexiglas**, **Lucite**, or equal.

3. On smaller ducts, provide separate 6-inch by 8-inch doors with 6-inch by 6-inch visual panels.

4. Provide duct inspection doors at each duct-mounted fire damper and electric duct heater.

M. Bird Screens

1. Provide removable bird screens on outside air intakes and exhaust air discharges to outside air.

2. Secure the screens in frames constructed of the same metal as the screens.

3. The bird screens shall be 1/2-inch mesh by 14-gauge, and shall be of same material and finish as duct, hood, louver, or equipment to which the screens are attached.

N. Turning Vanes

1. Square-turn elbows shall be fitted with shop-fabricated double-blade turning vanes mounted inside the rails.

2. Construction shall be of the same material as the ductwork and shall be rigid enough to prevent vibration at high air flow.

O. Air Extractors

1. Provide an air extractor on each take-off from the main supply duct adjacent to a diffuser, register, or grille, where a splitter is not used.

2. Provide extractors with synchronized steel curved blades, heavy side rails, and a screw operator.

3. Air Extractors Manufacturer, or Equal

a. Carnes

b. Tuttle and Bailey

PART 3 -- EXECUTION

3.01 GENERAL

A. Floor, Wall and Roof Openings for New Construction

1. Provide necessary openings in walls, floors and roofs for the passage of heating and ventilating equipment in buildings.

2. The openings shall be as indicated, or as required to provide passage for the heating and ventilating Work.

3. Provide hanger and support inserts into masonry or structural steel as required for proper completion of the Work.

3.02 INSTALLATION

A. General

1. Field Measurements

a. Duct lengths shall be determined from measurements taken at the Site.

b. The indicated dimensions are approximate and shall not be used for fabrication.

2. Install ducts as indicated.

3. Necessary provisions shall be taken into consideration during fabrication and installation of ductwork to provide for expansion and contraction.

4. Ductwork shall be free from vibration when in operation.

5. Provide necessary vibration isolation devices.

6. Apply antiseize compound to bolt threads.

7. Provide smooth bends or internal turning vanes at elbows, tees, and other points where the air flow changes direction.

8. The inside of duct, specials, and fittings shall be smooth, clean, and free from blisters, sand and dirt.

9. Ductwork shall be airtight.

10. Joints shall be carefully and neatly constructed, as indicated and as recommended by the manufacturer.

11. Flanges

a. Tighten flange bolts sufficiently to slightly compress the gasket and make a seal, but not so tightly as to distort the flanges.

b. Provide a flat washer under each nut and bolt head.

12. Dampers

a. Position the dampers to fit into the connecting ductwork at the indicated locations.

b. Install axles in the horizontal position unless otherwise necessary for proper operation of the damper.

13. Supports and Hangers

a. Support the ductwork in accordance with the manufacturer's recommendations and as indicated.

b. Duct supports shall comply with SMACNA Standards and applicable code requirements.

c. Supports and hangers shall transmit loads into the building structural frame through a system of intermediate beams and struts as necessary to comply with the indicated requirements.

d. Supports or hangers employing clip angles or similar devices for attachment to the duct will not be accepted.

e. Design the supports to resist IBC seismic forces.

14. Alignment and Elevation

a. Provide ductwork to the indicated lines and elevations, and slope as indicated to facilitate water drainage.

b. Use laser beam equipment or surveying instruments to maintain alignment and elevation.

c. If laser beam equipment is used, perform periodic elevation measurements with surveying instruments in order to verify accuracy.

B. Control Dampers

1. General

a. Coordinate damper submittals for type, quantity, and size in order to ensure compatibility with sheet metal design.

b. Follow the manufacturer's instructions for field installation of control dampers.

c. Unless specifically designed for vertical blade application, mount the dampers with the blade axis horizontal.

2. Duct Openings

a. Duct openings shall be free of obstructions and irregularities that might interfere with blade or linkage rotation or actuator mounting.

b. Duct openings shall measure 3/4 inch larger than damper dimensions, and shall be square, straight, and level.

3. Damper Sections

a. Individual damper sections, as well as entire multiple section assemblies, shall be completely square and free of racking, twisting, and bending.

b. Measuring the damper sections diagonally from upper corners to opposite lower corners of each damper section, both dimensions shall be within 1/8 inch of each other.

4. Shafts

a. Install an extended shaft or jackshaft in accordance with the manufacturer's instructions.

b. If a sticker on the damper face shows recommended extended shaft location, attach the shaft on the labeled side of damper to that blade.

5. Operation

a. Damper blades, axels, and linkage shall operate without binding.

b. After installation but before system operation, cycle the damper in order to ensure proper operation.

c. On multiple section assemblies, sections shall open and close simultaneously.

6. Provide a visible and accessible indication of damper position on the drive shaft end.

7. Support ductwork or damper actuator in areas of damper when required in order to prevent sagging due to damper or damper actuator weight.

8. After installing low-leakage dampers with seals, caulk between the frame and the duct or opening in order to prevent leakage around the perimeter of damper.

C. Smoke Dampers

1. Coordinate smoke damper and smoke/fire damper installations, wiring, and checkout in order to ensure that the dampers function properly and that they respond to the proper fire alarm system general, zone, and detector trips.

2. Immediately report discrepancies to the Engineer not less than 14 Days prior to inspection by the code authority having jurisdiction.

3.03 DUCT CLEANING

A. The ducts shall be blown clean of dust and debris using compressed air.

B. Do not use system fans for duct cleaning.

3.04 FIELD TESTING

A. Leak-test the ductwork after installation, in accordance with the National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, a publication of the Associated Air Balance Council (AABC).

B. The maximum allowable leakage criteria shall be in conformance with ASHRAE standards.

END OF SECTION

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SECTION 23 34 00 – HVAC FANS

PART 1 -- GENERAL

1.01 SUMMARY

A. Provide fans, blowers, ventilators, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. Where 2 or more fans, blowers, ventilators or appurtenances of the same type or size are required, they shall be furnished by the same manufacturer.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit certified fan curves for each fan.

C. O&M Data

1. Submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

1. Drive Belts: Provide one for each fan

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
03 31 00	Cast-in-Place Concrete
09 96 00	High-Performance Coatings
26 05 10	Electric Motors

B. Reference Standards

Air Moving and Conditioning Association (AMCA)	
AMCA 300-14	Reverberant Room Method for Sound Testing of Fans
Standard 99	Standards Handbook, Reverberant Room Method for Sound Testing of Fans.
Standard 210	Laboratory Methods of Testing Fans for Rating
American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)	

	HVAC Applications chapter in “Seismic Restraint Design”
	Spec 01 33 17 – Seismic and Wind Design Criteria
Institute of Electrical and Electronics Engineers, Inc. (IEEE)	
112	Standard Test Procedure for Polyphase Induction Motors and Generators
National Electrical Manufacturers Association (NEMA)	
MG 112.53a	Motors and Generators
National Fire Protection Association (NFPA)	
70	National Electric Code (NEC)
90A	Standard for the Installation of Air Conditioning and Ventilating Systems
Occupational Safety and Health Act (OSHA)	
Underwriters Laboratories Inc. (UL)	
	Product Directories

1.05 MOTORS

A. All motors shall conform to the latest IEEE and NEMA requirements for mechanical and electrical characteristics, including service factors.

B. Motors shall be in accordance with the requirements of Section 26 05 10 – Electric Motors.

C. Each motor shall bear the manufacturer’s nameplate with complete motor data.

D. Each motor shall be of ample size and construction to carry continuously all loads which might be imposed by the piece of equipment it drives throughout the full range of operation of the equipment, and the maximum motor loading shall in all cases be less than or equal to the nameplate horsepower rating, exclusive of the service factor.

E. All 2-speed motors shall be 2-winding motors.

PART 2 -- PRODUCTS

2.01 UPBLAST ROOF EXHAUST FANS (EF-01 AND EF-02)

A. Provide upblast centrifugal direct-driven roof-mounted exhausters as indicated.

B. Upblast roof exhaust fans shall be of all-aluminum construction.

C. Centrifugal ventilators shall be constructed of heliarc-welded extruded aluminum, and shall be provided with a cast aluminum power assembly.

D. Units shall be provided with V-belt drives, vibration eliminators, and motor as indicated.

E. Fans

1. Provide fan motors with externally mounted disconnect switches and shall be of the open drip-proof type.

2. Fans shall be completely coated outside and on all surfaces in contact with the exhausted air stream with Greenkote High performance Epoxy, or equal, except where otherwise indicated.

3. The fans shall be complete with gravity backdraft dampers, roof curb, and bird screen.

4. Fans shall meet the following requirements:

Fan Identification	EF-01 and EF-02
Capacity, scfm	1140
External static Pressure, inches H2O	0.75
Motor HP	½
Motor Voltage / Phase / Hertz	208/1/60
Motor RPM	1725
Special Features	Vari-green EC motor

F. Manufacturer, or Equal

1. Greenheck, Model CUE-120-VG

a. Cook

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Fans, blowers, ventilators, and hoods shall be installed in strict accordance with the manufacturer's recommendations.

B. Pipe the housing drains to the nearest utility drain

END OF SECTION

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SECTION 23 55 00 – FUEL-FIRED HEATERS

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide the gas fired equipment and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. Where 2 or more gas fired equipment or appurtenances of the same type or size are required, they shall be furnished by the same manufacturer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
22 10 00	Plumbing Piping
26 05 10	Electric Motors

B. Reference Standards

1. The Work shall be in strict accordance with the State Mechanical Code, the State of Utah, City of Greater Salt Lake, and other authorities having jurisdiction.

2. The Contractor shall obtain the required certifications and shall be thoroughly familiar with the local codes.

3. The Contractor shall obtain and pay for all necessary permits.

Air-Conditioning, Heating and Refrigeration Institute (AHRI)	
AHRI 410	Forced-Circulation Air Cooling and Air Heating Coils
AHRI 430	Standard for Application of Central-Station Air Handling Units
AHRI 260	Sound Rating of Ducted Air Moving and Conditioning Equipment
Air Movement and Control Association International, Inc. (AMCA)	
AMCA 99	Standard Handbook
AMCA 210	Laboratory Methods of Testing Fans for Rating Purposes
AMCA 300	Test Code for Sound Rating Air Moving Devices
AMCA 301	Method of Publishing Sound Ratings for Air Moving Devices
AMCA 500	Test Methods for Louvers, Dampers, and Shutters
AMCA 611-95	Methods of Testing Airflow Measurement Stations for Rating
American Bearing Manufacturers Association (ABMA)	
ABMA STD 9	Load Ratings and Fatigue Life for Ball Bearings

American National Standards Institute (ANSI)	
ANSI Z83.6-1074 / Z83-6a-1975	Vented Infrared Radiant Heater
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	
ASHRAE 52.1/52.2	Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62	Ventilation for Acceptable Indoor Air Quality
ASHRAE 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings
Underwriters Laboratories (UL)	
ANSI/UL 900	Test Performance of Air Filter Units
National Fire Protection Association (NFPA)	
NFPA 90A	Installation of Air Conditioning and Ventilation Systems
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
SMACNA	Low Pressure Duct Construction Standards

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. The submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

C. Furnish a certified fan curve for each fan.

1.04 CODE REQUIREMENTS

1.05 REFERENCES

PART 2 -- PRODUCTS

2.01 GENERAL

A. Motors shall be in conformance with the requirements of Section 26 05 10 – Electric Motors.

2.02 UNIT HEATERS (GUH-01)

A. Unit heaters shall be of the horizontal type as indicated, and shall be provided complete with motor, fan, wire guard, burners, heat exchangers, casing, vibration isolators and support brackets.

B. Fan Casings

1. Fan casings shall be steel reinforced in order to provide a suitable support for the burners and for attachment of the support brackets.

2. The casings shall be finished with a factory finish.

C. Fans and Motors

1. The fans shall be of the multi-blade propeller-type.

2. Fans shall be directly connected to the motor shaft.

3. The fan and motors shall be statically and dynamically balanced.

4. The fan shall be keyed and locked to the fan shaft.

5. Fan shafts shall be equipped with self-aligning ball or roller bearings and shall extend a sufficient length to receive the fan hub.

6. The fan and motor unit shall be mounted on vibration isolators to prevent noise.

7. Motors shall be specially designed for unit operation.

D. The unit heaters shall be provided with A.G.A. certification.

E. The burners shall be constructed of aluminized steel, and the burner shall be constructed of aluminized steel.

F. A factory-installed power vent shall be provided.

G. Provide low-voltage control transformers.

H. The heaters shall be provided with power disconnect switches, single stage direct spark ignition, single stage thermostats (field-installed kits), thermostat guard.

I. Provide control relays and Fisher type S-100 gas pressure regulator of ¾" size and ½ to 50 psi inlet pressure capacity, 30 MBH to 400 MBH capacity.

J. Unit Heaters Manufacturers, or Equal

1. Reznor,

2. Modine, Model HD

2.03 GAS SERVICE AND INSTALLATION

A. The gas piping and installation for the gas fired air heating system shall be in conformance with the requirements of Section 22 10 00 – Plumbing Piping.

PART 3 -- EXECUTION

A. The gas-fired air heating equipment shall be installed by qualified personnel in strict accordance with the manufacturer's recommendations.

B. The gas train (manifold) for each gas burner shall meet all codes as well as FM or IRI requirements.

END OF SECTION

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SECTION 23 70 10 – AIR CONDITIONING EQUIPMENT

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Provide air conditioning units and appurtenances, complete and operable, in accordance with the Contract Documents.

B. Where two or more air conditioning units or appurtenances of the same type or size are required, they shall be furnished by the same Manufacturer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

B. Reference Standards

Air-Conditioning, Heating and Refrigeration Institute (AHRI)	
AHRI 410	Forced-Circulation Air Cooling and Air Heating Coils
AHRI 430	Standard for Application of Central-Station Air Handling Units
AHRI 260	Sound Rating of Ducted Air Moving and Conditioning Equipment
Air Movement and Control Association International, Inc. (AMCA)	
AMCA 99	Standard Handbook
AMCA 210	Laboratory Methods of Testing Fans for Rating Purposes
AMCA 300	Test Code for Sound Rating Air Moving Devices
AMCA 301	Method of Publishing Sound Ratings for Air Moving Devices
AMCA 500	Test Methods for Louvers, Dampers, and Shutters
AMCA 611-95	Methods of Testing Airflow Measurement Stations for Rating
American Bearing Manufacturers Association (ABMA)	
ABMA STD 9	Load Ratings and Fatigue Life for Ball Bearings
American National Standards Institute (ANSI)	
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	
ASHRAE 52.1/52.2	Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62	Ventilation for Acceptable Indoor Air Quality
ASHRAE 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings
Building Automation Solutions (BAS)	

Canadian Standards Association (CSA)	
Department of Energy (DOE)	
National Fire Protection Association (NFPA)	
NFPA 90A	Installation of Air Conditioning and Ventilation Systems
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
SMACNA	Low Pressure Duct Construction Standards
Underwriters Laboratories (UL)	
ANSI/UL 900	Test Performance of Air Filter Units

C. The Work shall be in strict accordance with the State Mechanical Code, the State of Utah, City of Greater Salt Lake, and other authorities having jurisdiction.

D. Obtain the required certifications and become thoroughly familiar with the local codes.

E. Obtain and pay for all necessary permits.

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. The submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

C. Furnish a certified fan curve for each fan.

PART 2 -- PRODUCTS

2.01 WALL MOUNTED DUCTLESS SPLIT HEAT PUMP INVERTER TYPE (AC/CU-01 AND AC/CU-02)

A. QUALITY ASSURANCE

1. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.

2. All wiring shall be in accordance with the National Electric Code (NEC).

3. The system shall be rated in accordance with Air Conditioning Refrigeration Institute's (ARI) Standard 210/240 and bear the ARI label.

4. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

5. The outdoor unit will be factory charged with R-410A.

6. A holding charge of dry nitrogen shall be provided in the evaporator.

7. System efficiency shall meet or exceed 17.0 SEER, 10.2 EER and 8.2 HSPF.

8. Mechanical equipment for wind-born debris regions shall be designed in accordance with ASCE 7-2010 and installed to resist wind pressures on the equipment and the supports.

B. WARRANTY

1. The unit shall have manufacturer's warranty for a period of one (1) year from the date of installation. The units shall have labor warranty for a period of one (1) year from the date of installation. Compressors shall have warranty of seven (7) years from the date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced by the manufacturer. All warranty service work shall be performed by a manufacturer factory trained service professional.

C. INSTALLATION REQUIREMENTS

1. The system must be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. Installation must comply with installation manual. The mechanical contractor bids with the complete knowledge of HVAC systems requirements. Untrained contractors who wish to bid on this project may contact the equipment manufacturer to arrange training prior to bid day.

D. OUTDOOR UNIT – HEAT PUMP

1. General: The outdoor condensing unit is designed specifically for use with matched capacity indoor evaporator units.

   a. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a swing compressor, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut off valves, service ports and suction accumulator.

   b. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.

   c. The outdoor unit can be wired and piped in the front, lateral or downward directions, accessed from the right side of the unit.

   d. The sound pressure level standard shall be that value as listed in the engineering manual for the specified models at 3 feet from the front of the unit.

   e. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.

   f. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

   g. The following safety devices shall be included on the condensing unit; high pressure switch, outdoor fan driver overload protector, inverter overload protector, fusible plugs, fuses.

h. Each condensing unit shall utilize an algorithm to automatically adjust the refrigerant suction and condensing temperatures in response to the heating and cooling loads, and in response to the current weather conditions. The VRT control shall be capable of being customized in the following modes and sub modes:

1) Automatic (factory preset) – The Automatic VRT control shall allow the target evaporator temperature (Te) and target condensing temperature (Tc) to float based on outdoor ambient temperature conditions, and shall incorporate the following sub-modes:

a) Powerful

b) Quick

c) Mild (factory preset)

2) High Sensible – The High Sensible mode shall allow the system Te and Tc values to be programmed to series of fixed Te and Tc values. The High Sensible mode shall also be capable of incorporating the following sub-modes:

a) Eco

3) Basic – The Basic mode shall disable the VRT control of the outdoor unit and allow the system to operate with constant Te and Tc values.

2. Unit Cabinet:

a. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

b. The outdoor unit will come furnished with four (4) mounting feet, mounted across the base pan, to allow bolting to a cement pad or optionally supplied mounting bracket.

3. Fan:

a. The condensing unit shall consist of one propeller type, direct-drive 70 W fan motor that has multiple speed operation via a DC (digitally commutating) inverter.

b. The fan shall be a horizontal discharge configuration with a nominal airflow maximum of 2,682 cfm.

c. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.

d. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

e. The fan motor shall be (1) one quantity with 200 W output.

4. Condenser Coil:

a. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.

b. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure highly efficient performance.

c. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube.

d. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1 rated for up to 1000 hours salt spray.

e. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

5. Compressor:

a. The swing compressor shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.

b. The inverter driven compressor shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed swing type.

c. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

d. The capacity control range shall be 14-100%

e. The compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

f. The compressor shall be mounted to avoid the transmission of vibration.

6. System performance shall be in accordance with ARI 210/240 test conditions as shown in the performance table below:

Cooling Capacity	**Heating Capacity**	**SEER**	**EER**	**HSPF**
18,000	20,000	17.0	11.9	8.2

7. The cooling performance is based on 80°F DB / 67°F WB for the indoor unit and 95°F DB / 75°F WB for the outdoor unit with 25ft of interconnecting pipe-work & 0ft level difference.

8. The heating performance is based on 70°F DB / 60°F WB for the indoor unit and 47°F DB / 43°F WB for the outdoor unit with 25ft of interconnecting pipe-work & 0ft level difference.

9. The operating range in cooling will be 23°F DB ~ 122°F DB and 0°F DB ~ 115°F DB when used with an optional wind baffle.

10. The operating range in heating will -4°F WB – 60°F WB.

11. The system shall be capable of refrigerant piping up to 164 total feet with a 98 feet maximum vertical difference, without any oil traps or additional components.

12. Electrical:

    a. The power supply to the outdoor unit shall be 208-230 volts, 1 phase, 60 hertz +/- 10%, MCA 16.5 and MOP 25

Power Supply Voltage	Voltage Range
208-230V/1/60	187V-253V

    b. The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded, stranded 2 conductor cable.

    c. The control wiring shall be a two-wire multiplex transmission system.

    d. The control wiring lengths shall be as shown below:

	Outdoor to Indoor Unit	Indoor Unit to Remote Control
Control Wiring Length	3,280	1,640
Wire Type	18 AWG, 2 wire, non-polarity, non-shielded, stranded	

13. Acceptable Manufacturers, or approved equal:

    a. Daikin SkyAir Heat Pump Model RZQ18TAVJUA

    b. Mitsubishi Technology

    c. LG Technology

E. INDOOR UNIT – WALL MOUNTED FAN COIL UNIT

1. General:

a. Indoor unit shall be a wall mounted fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. It shall be available in capacities from 18,000 Btu/h to 24,000 Btu/h. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 37 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.

b. The unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The front grille shall be easily removed for washing. The drain pipe can be fitted to from either left or right sides.

c. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.

d. Both refrigerant lines shall be insulated from the outdoor unit.

e. Return air shall be through the a resin net mold resistant filter.

f. The indoor units shall be equipped with a condensate pan.

g. The indoor units shall be equipped with a return air thermistor.

h. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.

i. The voltage range will be 253 volts maximum and 187 volts minimum.

2. Unit Cabinet:

a. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.

b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

3. Fan:

a. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.

b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output of 43 W.

c. The airflow rate shall be available in high and low settings.

d. The fan motor shall be thermally protected.

4. Coil:

   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

   b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.

   c. The coil shall be a 2-row cross fin copper evaporator coil with 14 FPI design completely factory tested.

   d. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC.

   e. A thermistor will be located on the liquid and gas line.

   f. A condensate pan shall be located in the unit.

5. Electrical:

   a. A separate power supply will be required of 208-230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.

   b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet.

   c. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

6. Control:

   a. The unit shall have controls provided by the manufacturer to perform input functions necessary to operate the system.

   b. A full array of fault diagnostics shall be accessible via the remote controller.

   c. The unit shall be compatible with interfacing with connection to BACnet and LonWorks networks or interfacing with connection to BMS system

7. Accessories Available:

   a. Remote “in-room” sensor kit

   b. Navigation Remote Controller

8. Acceptable Manufacturers, or approved equal:

   a. Daikin SkyAir Heat Pump Model FAQ18TAVJU

   b. Mitsubishi Technology

   c. LG Technology

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All air conditioning equipment shall be installed in strict accordance with the manufacturer's recommendations.

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SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide the electrical Work, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.

C. The Work of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.

D. The Contractor's attention is directed to the requirement for proper coordination of the Work of this Section with the Work of equipment Specifications, the Work of instrumentation Sections, and the Work of Section 26 05 10 – Electric Motors.

E. Concrete, excavation, backfill, and steel reinforcement required for encasement, installation, or construction of the Work of the various Sections of Division 26 is included as a part of the Work under the respective Sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.

F. Equipment supports and foundations shall be in conformance with the requirements of Section 46 10 00 – Equipment General Provisions.

1.2 REFERENCE STANDARDS

NEC (NFPA 70)	National Electrical Code: 2020 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)

A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

B. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 CFR 1926, as applicable), state building standards, and applicable local codes and regulations.

C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

1.3 SIGNAGE AND MARKINGS

A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

C. Warning Signs

1. 600 Volts Nominal, or Less

a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.

D. Isolating Switches

1. Provide isolating switches not interlocked with an approved circuit-interrupting device with a sign warning against opening them under load.

1.4 PERMITS AND INSPECTION

A. Obtain permits and pay inspection fees according to the General Conditions.

1.5 CONTRACTOR SUBMITTALS

A. General

1. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

2. Custom-prepare Shop Drawings.

3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.

4. Cross out options not proposed or delete from the Shop Drawings.

B. Shop Drawings: Include the following:

1. complete material lists stating manufacturer and brand name of each item or class of material.

2. Shop Drawings for grounding Work not specifically indicated

3. front, side, rear elevations, and top views with dimensional data

4. location of conduit entrances and access plates

5. component data

6. connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers

7. method of anchoring, seismic requirements, weight

8. types of materials and finish

9. nameplates

10. temperature limitations, as applicable

11. voltage requirement, phase, and current, as applicable

12. front and rear access requirements

13. test reports

14. grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.

2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the Engineer a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.

2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

2. As-Built Drawings

a. Prepare as-built drawings, showing invert and top elevations and routing of duct banks and concealed below-grade electrical installations.

b. Furnish the drawings to the Engineer in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

1.6 AREA DESIGNATIONS

A. General

1. Designations for raceway system enclosures shall comply with the requirements of Section 26 05 33 – Electrical Raceway Systems.

2. Designations for electrical Work specifically indicated in other Sections shall comply with the requirements of those Sections unless indicated otherwise.

3. Designations for other electrical Work not included in the above Paragraphs shall be as follows:

AREA	NEMA ENCLOSURE CLASSIFICATION

	1	3R	4X	7	12	Notes
Influent Pump Station		X				
Grit Washing Facility – Electrical Room	X					
Grit Washing Facility – Grit Room			X			
Headworks – Screens and Grit Room				X		
Headworks – Pump Room			X			
Headworks – Electrical Room	X					

4. Designations for electrical Work not included in the above Paragraphs shall be NEMA 4X.

5. Installations in hazardous locations shall conform strictly to the requirements of the indicated Class, Group, and Division.

B. Material Requirements

1. Construct NEMA 4X enclosures of Type 316 stainless steel, except in chlorine and HFS areas where non-metallic enclosures shall be provided.

2. Do not coat NEMA 4X enclosures.

3. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

1.7 TESTS

A. The Contractor shall be responsible for factory and field tests indicated in Division 26, as required by the Engineer, and as required by other authorities having jurisdiction.

B. Furnish necessary testing equipment.

C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.

D. Reporting

1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.

2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.

E. Remove and replace equipment or material that fails a test, or, if the Engineer approves, repair and retested for compliance.

F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.

1.8 CONSTRUCTION SEQUENCING

A. General

1. Because the continuance of plant operation during the expansion process is critical, the Contractor shall carefully examine the Work to be provided in, on, or adjacent to existing equipment.

2. In no case shall the Contractor begin any Work in, on, or adjacent to existing equipment without written authorization from the Engineer.

B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.

2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.

3. Repair coatings to match existing.

4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the Work.

C. Existing Utilities

1. Exercise extreme caution when digging trenches to not damage existing underground utilities.

2. The cost of repairs of damages caused during construction shall be included as a part of the Work.

D. Field Verifications

1. Visit the Site before submitting a Bid to become better acquainted with the Work of this Contract.

2. The lack of knowledge will not be accepted as justification for extra compensation to perform the Work.

3. The cost for the above verifications shall be included as part of the Work.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.

B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.

C. Provide similar items in the Work as products of the same manufacturer.

D. Provide equipment and materials of industrial grade standard of construction.

E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.

F. On devices indicated to display dates, display the year as 4 digits.

G. Temperature Ratings of Equipment Terminations

1. Provide terminations and lugs rated for use with 75-degree C conductors.

2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

2.2 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. Provide nuts, bolts, and washers constructed of stainless steel.

2. Provide threaded rods for trapeze supports constructed from continuous threaded galvanized steel, 3/8-inch diameter minimum.

3. Struts

a. Construct struts for mounting of conduits and equipment of aluminum.

b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.

c. Do not use aluminum strut for free-standing support frames.

d. Strut Manufacturer, or Equal: **Unistrut**; **B-Line**

4. End Caps

a. Provide plastic protective end caps for all exposed strut ends below 8’ AFF.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Star**.

2.3 ELECTRICAL IDENTIFICATION

A. Nameplates

1. Fabricate nameplates from white-letter, black-face laminated plastic engraving stock, such as **Formica Type ES-1** or equal.

2. Securely fasten each nameplate, using fasteners constructed of brass, cadmium-plated steel, or stainless steel, and screwed into inserts or tapped holes as required.

3. Provide engraved characters of the block style, with no characters smaller than 1/8 inch top to bottom.

B. Conductor and Equipment Identification

1. Provide imprinted plastic-coated cloth marking devices, such as manufactured by Brady, Thomas & Betts, or equal.

2. Alternatively, provide heat-shrunk plastic tubing, imprinted split-sleeve markers cemented in place.

2.4 PROTECTIVE MATTING

A. Provide full-width, high-voltage switchboard matting in front of indoor switchgear, service equipment, panelboards and motor control centers.

B. For 600-volt equipment, provide matting that is 1/4 inch thick and 36 inches wide.

C. Matting Manufacturer, or Equal

1. W.H.Salisbury and Company; Mats, Inc.; Rhino

PART 3 -- EXECUTION

3.1 GENERAL

A. Incidentals

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.

2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

B. Field Control of Location and Arrangement

1. The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items.

2. Exact locations shall be determined by the Contractor in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.

3. Follow the locations on the Drawings, however, as closely as possible.

4. Conduits

    a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.

    b. Provide exposed or encased routings as indicated, except conceal conduit in finished areas unless indicated otherwise.

    c. Size conduits encased in a slab for conduit OD not to exceed 1/3 of the slab thickness, and lay out and space as to not impede concrete flow.

5. Placement

    a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.

    b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.

    c. Where exact locations are not indicated, such locations will be determined by the Engineer.

    d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the Work.

    e. Slightly adjust luminaire locations in order to avoid obstructions and to minimize shadows.

6. Circuits

    a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the Contractor's responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.

    b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).

    c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

    a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer, and using workers skilled in the Work.

    b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

    a. Fully protect materials and equipment against damage from any cause.

b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.

c. Keep moving parts clean and dry.

d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the Work.

C. Provide incoming utility power equipment in conformance with the utility's requirements.

D. Provide starters in accordance with the requirements of Section 26 05 15 – Industrial Control Panels for starters not in MCC'S.

3.2 CORE DRILLING

A. Perform core drilling as required for the installation of raceways through concrete walls and floors.

B. Base the locations of floor penetrations, as may be required, on field conditions.

C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.

D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the Owner prior to any core drilling activities.

E. Repair damage to encased conduits, wiring, and piping as part of the Work.

3.3 CONCRETE HOUSEKEEPING PADS

A. Provide concrete housekeeping pads for indoor floor-standing electrical equipment.

B. Extend housekeeping pads for equipment, including future units, 3-1/2 inches above the surrounding finished floor or grade, and 2 inches larger in both dimensions than the equipment, unless otherwise indicated.

C. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.

D. Extend housekeeping curbs to 3 inches above the finished floor or grade.

3.4 EQUIPMENT ANCHORING

A. Floor-supported, wall, or ceiling-hung equipment and raceways shall be anchored in place by methods that will meet seismic requirements in the area where the Project is located. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for support and anchorage requirements.

B. Provide wall-mounted panels that weigh more than 500 pounds or that are within 18 inches of the floor with fabricated steel support pedestals.

C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.

D. Provide transformers hung from 4-inch stud walls and weighing more than 300 pounds with auxiliary floor supports.

E. Provide leveling channels anchored to the concrete pad for MCC's, switchgear and other electrical equipment mounted on housekeeping pads.

F. Manufacturer's Recommendations

1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the Work of this Contract.

2. Submit such recommendations as Shop Drawings as indicated.

3.5 EQUIPMENT IDENTIFICATION

A. Provide nameplates for panelboards, control and instrumentation panels, starters, switches, and pushbutton stations.

B. In addition to nameplates, equip control devices with standard collar-type legend plates.

C. Identify control devices within enclosures as indicated and similar to the subparagraph above.

D. Provide suitable inscribed finish plates for toggle switches that control loads out of sight of switches and for multi-switch locations of more than 2 switches.

E. Use equipment names and tag numbers, where indicated, on nameplates.

F. Provide typewritten circuit directories for panelboards, that accurately reflect the outlets connected to each circuit.

G. Terminal Blocks

1. Label termination points on terminal blocks by identifiers on the blocks.

2. Provide identifiers that have been preprinted by the terminal manufacturer or custom-printed.

3. Hand-lettered markers will not be accepted.

H. Provide arc-flash labels for all distribution equipment, stand-alone disconnects, starters, and VFDs. Fill in all values as required by NFPA 70E, and as calculated as part of the Protective Device Study. Verify that all settings as prescribed by the approved Protective Device Study have been implemented in the field.

3.6 CLEANING

A. Before final acceptance, thoroughly clean the electrical Work of cement, plaster, and other materials.

B. Remove temporary tags, markings, stickers, and the like.

C. Remove oil and grease spots with a non-flammable cleaning solvent by carefully wiping and scraping cracks and corners.

D. Apply touch-up paint to scratches on panels and cabinets.

E. Vacuum clean electrical cabinets and enclosures. Do not use compressed air to clean cabinets.

F. Clean luminaires inside and out. Replace failed lamps.

G. Properly dispose cleaning debris and refuse off-site.

END OF SECTION

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SECTION 26 01 26 – ELECTRICAL TESTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. This Section specifies the Work necessary to test, commission, and demonstrate that the electrical work satisfies the criteria of these Specifications and functions as required by the Contract Documents.

B. The Work of this Section includes furnishing the labor, equipment, and power required to support the testing indicated in other Divisions of these Specifications. Electrical testing indicated herein and functional testing of power and controls not tested under Division 40 - Instrumentation, shall be completed before commencement of the 7 Day test of Section 01 75 00 - Equipment Testing and Plant Startup. This scope may require the Contractor to activate circuits, shutdown circuits, run equipment, make electrical measurements, replace blown fuses, and install temporary jumpers, etc.

C. The requirements of Section 26 00 00 - Electrical Work, General, apply to the Work of this Section.

D. Carry out tests indicated herein for individual items of materials and equipment in other Sections. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards.

1.2 REFERENCES

A. General

1. The publications listed below form a part of this specification to the extent referenced.

2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of the Notice Inviting Bids shall be used.

B. American National Standards Institute (ANSI)

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

D. IEEE 400-2001, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems

E. IEEE 576-2000, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications

F. InterNational Electrical Testing Association (NETA)

G. NFPA 70, National Electrical Code (NEC)

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit complete system test procedures for review. Test procedures shall include but not be limited to:

1. Detailed procedures in sufficient detail to verify conformance with these Specifications.

2. Incorporation of the Test Record Sheets included at the end of this Section.

3. Detailed comprehensive testing schedule including:

a. Each major piece of electrical distribution equipment.

b. Each major electrical subsystem.

c. Duration of each test.

d. Milestone test completion date.

e. Ambient Conditions at time of test

f. Date of test results submittals following completion of the tests.

g. Names and qualifications of the individual(s) responsible for performing the testing.

C. Following completion of the test submit the completed test results to the Engineer for review. The results shall include a dedicated section with the “as-left” settings of all devices, relays, circuit breakers, etc.

D. Test result shall be submitted in one submittal

E. Test reports shall be based on NETA’s latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA’s Acceptance Testing Specifications latest edition.

1.4 COMMISSIONING

A. Commissioning during the 7 Day test in Section 01 75 00 shall not be attempted until all subsystems have been found to operate satisfactorily. Commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable. Simulation of process parameters shall be considered only upon receipt of a written request by the Contractor.

B. Motor Current Tabulation

1. The motor current tabulation required by Section 26 05 73 – Protective Device Studies shall reflect the values occurring during commissioning.

2. Switchboard ammeters and kilowattmeters shall be recorded every half-hour during the commissioning.

3. Power monitored amperes, voltage, and kilowatts for each phase shall be recorded every 5 minutes during commissioning.

PART 2 -- TESTING & REPORTS

2.1 PRE-ENERGIZATION AND OPERATING TESTS

A. The complete electrical system shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the recommendations of the protective device study and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the authority having jurisdiction.

1. Instrument Transformers. All instrument transformers shall be tested to verify correct polarity and burden.

2. Protective Relays. Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.

3. Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.

4. Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

5. Metering Circuits. All metering circuits shall be verified to operate correctly from voltage and current sources, similarly to protective relay circuits.

6. Acceptance Tests. Complete acceptance tests shall be performed, after the station installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

7. Relays and Metering Utilizing Phase Differences. All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

B. Test Report. A test report covering the results of the tests required in the Pre-Energization and Operating Tests shall be delivered to the authority having jurisdiction prior to energization. Acceptance Testing shall be in accordance with NETA ATS-2017, *For Electrical Power Equipment and Systems*, published by the InterNational Electrical Testing Association.

2.2 TEST REQUIREMENTS

A. The following test requirements supplement test and acceptance criteria that may be stated elsewhere.

1. Lighting: Switching, include remote control, if present in system. Circuitry is in accordance with panel schedules. All interior and exterior lighting shall be checked for proper operation.

2. Power Instrumentation: Demonstrate that voltmeter and ammeter switches are functional. Demonstrate that kilowatt meters are within catalog accuracy as installed.

a. Visual and Mechanical Inspection

1) Compare equipment nameplate data with drawings and specifications.

2) Inspect physical and mechanical condition.

3) Verify tightness of electrical connections.

4) Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case-shorting contacts, as applicable.

5) Verify freedom of movement, end play, and alignment of rotating disk(s).

b. Electrical Tests

1) Verify accuracy of meters at all cardinal points.

2) Calibrate watthour meters according to manufacturer's published data.

3) Verify all instrument multipliers.

4) Verify that current transformer and voltage transformer secondary circuits are intact.

3. Demonstrate mechanical and/or electrical interlocking by attempting to subvert the intended sequence.

4. Activate ground fault tripping by operating test features provided with ground current protective systems and by injecting a known and reasonable current in the ground current sensor circuit. In general, ground fault tripping should occur at a ground current equivalent to 20 percent of phase current. Current injection is not required of circuit 400 amperes or less.

5. Low Voltage Cables-600 volts Maximum

a. Visual and Mechanical Inspection

1) Compare cable data with drawings and specifications.

2) Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.

3) Inspect bolted electrical connections for high resistance using one of the following methods:

a) Use of low-resistance ohmmeter

b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS- 2017, Table 100.12.

c) Perform thermographic survey in accordance with below Section Thermographic Survey.

4) Inspect compression-applied connectors for correct cable match and indentation.

5) Inspect for correct identification and arrangements.

6) Inspect cable jacket insulation and condition.

b. Electrical Tests

1) Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.

a) Motor feeders tested with motors disconnected and controller open.

b) Motor control circuits tested and verified for proper operation with control stations and overcurrent devices connected.

c) Panelboard feeders tested with feeder breaker open and panel-board connected. If a lighting transformer is associated with the panelboard, it shall be connected and the test made for both primary and secondary sides.

d) Conductors of main lighting feeders, including lighting panel with branch circuits open.

e) Prior to performing insulation resistance tests on cables, verify that they are not connected to a solid state device.

f) Equipment which may be damaged during this test shall be disconnected.

g) The Engineer shall be consulted if minimum insulation values cannot be obtained.

2) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

3) Perform continuity test to insure correct cable connection.

c. Test Values – Visual and Mechanical

1) Compare bolted connection resistance to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Bolt-torque levels should be in accordance with NETA ATS-2017, Table 100.12 unless otherwise specified by the manufacturer.

3) Results of the thermographic survey shall be in accordance with the below Section Thermographic Survey.

d. Test Values – Electrical

1) Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS-2017 Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.

3) Cable shall exhibit continuity.

4) Deviations in resistance between parallel conductors shall be investigated.

6. Test ground interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.

7. A functional test and check of electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:

a. Visual and physical check of cables, circuit breakers, transformers, and connections associated with each item of new and modified equipment.

b. Verification that electrical equipment has been labeled with Arc Flash protection boundary and PPE levels, as required by Section 26 05 73 – Protective Device Studies.

c. Setting of protective relays in conformance with results of the Short Circuit Study required by Section 26 05 73 - Protective Device Studies and testing of relays to assure that relays will trip at the current value and time required by the Study.

d. Circuit Breakers

1) Circuit breakers that have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field-adjusted by a representative of the circuit breaker manufacturer.

2) Time and pickup setting shall correspond to the recommendations of the Short Circuit Study.

3) Setting shall be tabulated and proven for each circuit breaker in its installed position.

4) Test results shall be certified by the person performing the tests and shall be submitted to the Engineer.

8. Complete ground testing of grounding electrodes per requirements below prior to operating the equipment.

B. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the Engineer and after process control

devices have been adjusted as accurately as possible. Alarm conditions shall be simulated for each alarm point, and alarm indicators shall be checked for proper operation. It is intended that the Contractor will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.

C. Metering and indication lights for motors and other devices shall be tested for proper operation.

D. All control circuits such as motor, interlock and remote shall be tested for proper operation.

E. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.

F. Motor operated valves shall be tested after having been phased and tested for correct motor rotation and after travel and torque limit switches have been adjusted by a representative of the valve manufacturer. Tests shall verify status indication, proper valve travel, and correct command control from local and remote devices.

G. All lighting panels, circuits and fixtures; and power panels, circuits and receptacles shall be tested for proper operation.

H. Provide ground resistance tests on the main grounding electrode or system in the presence of the Engineer and submit results

1. Visual and Mechanical Inspection

    a. Verify ground system is in compliance with drawings and specifications.

2. Electrical Tests

    a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.

    b. The earth resistance of each ground electrode shall be measured and recorded before electrodes are connected to the grounding loop.

    c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3. Test Values

    a. The resistance between the main grounding electrode and ground shall be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the Owner.

    b. Investigate point-to-point resistance values which exceed 0.5 ohm.

I. Subsystems shall be defined as individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.

J. THERMOGRAPHIC SURVEY

1. Visual and Mechanical Inspection

   a. Inspect physical, electrical, and mechanical condition.

   b. Remove all necessary covers prior to thermographic inspection. Utilize appropriate caution, safety devices, and personal protective equipment.

2. Equipment to be inspected shall include all 120 volt and higher current-carrying devices including all switchgear, switchboards, distribution panels, cable and bus connections, motor control centers and starters, disconnect switches, and other critical equipment. Testing of lighting luminaires, field instrumentation, SCADA & PLC's are not required.

3. Provide report including the following:

   a. Description of equipment to be tested.

   b. Discrepancies.

   c. Temperature difference between the area of concern and the reference area.

   d. Probable cause of temperature difference.

   e. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.

   f. Identify load conditions at time of inspection.

   g. Provide photographs and/or thermograms of the deficient area.

   h. Recommended action.

4. Test Parameters

   a. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.

   b. Equipment shall detect emitted radiation and convert detected radiation to visual signal.

   c. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B-2010, Section 11-17 (Infrared Inspection).

5. Test Values

   a. Suggested actions based on temperature rise can be found in Table 100.18.

6. RE-INSPECTION

a. All items that are reported deficient in the thermography reports section of the inspection report shall be re-inspected after repairs have been made.

b. Original specification will apply to re-inspections.

c. Submit re-inspection reports and indicate that repairs have fixed the anomaly or indicate any remaining anomalies.

d. Perform a follow-up thermographic survey within 12 months of final acceptance by the Owner.

2.3 TEST REPORTS

A. The test report shall include the following:

1. Summary of project.

2. Description of equipment tested.

3. Description of test.

4. Test data.

5. Analysis and recommendations.

B. Test data records shall include the following minimum requirements:

1. Identification of the testing organization.

2. Equipment identification.

3. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.

4. Date of inspections, tests, maintenance, and/or calibrations.

5. Identification of the testing technician.

6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.

7. Indication of expected results when calibrations are to be performed.

8. Indication of “as-found” and “as-left” results.

9. Sufficient spaces to allow all results and comments to be indicated.

C. The testing firm shall furnish a copy or copies of the complete report to the Owner as required in the acceptance contract.

TABLE 100.18

THERMOGRAPHIC SURVEY
SUGGESTED ACTIONS BASED ON TEMPERATURE RISE

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.	Recommended Action
1ºC - 3ºC	1ºC - 10ºC	Possible deficiency; warrants investigation
4ºC - 15ºC	11ºC - 20ºC	Indicates probable deficiency; repair as time permits
- - - - - -	21ºC - 40ºC	Monitor until corrective measures can be accomplished
>15ºC	>40ºC	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT. In the absence of consensus standards for ΔT, the values in this table will provide reasonable guidelines.

An alternative method of evaluation is the standards-based temperature rating system as discussed in Chapter 8.9.2, Conducting an IR Thermographic Inspection, *Electrical Power Systems Maintenance and Testing*, by Paul Gill, PE, 1998.

It is a necessary and valid requirement that the person performing the electrical inspection be thoroughly trained and experienced concerning the apparatus and systems being evaluated as well as knowledgeable of thermographic methodology

PART 3 -- TESTS

3.1 ELECTRICAL TESTS

A. The tests listed below shall be performed and the results recorded. The testing agency shall use their own test result sheets.

1. Instrument Transformers. All instrument transformers shall be tested to verify correct polarity and burden.

2. Insulation Resistance (Power, Control Wire, and Cable) Test Record

3. Insulation Resistance (Instrument Wire and Cable) Test Record

4. Ground Electrode Testing Test Record

5. Bonding Resistance Readings (Nonelectrical Equipment/Structures) Test Record

6. Bonding Resistance Readings (Electrical Equipment) Test Record

7. Insulation Resistance (Transformer) Test Record

8. Insulation Resistance (Equipment) Test Record

9. Insulation Resistance (Rotating Equipment) Test Record

10. Equipment Absorption Ratio and Polarization Index Test Record

11. Record Feeder Breaker (480 V MCC) Test Record

12. Breaker/Contactor (480 V MCC) Test Record

13. 460 V Motor Circuit (480 V MCC) Test Record

14. Electric Motor Run-In Test Record

15. Thermographic Test Record

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SECTION 26 05 10 - ELECTRIC MOTORS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The Contractor shall provide electric motors, accessories, and appurtenances complete and operable, in conformance to the Contract Documents.

B. The provisions of this Section apply to low voltage 3 phase, AC squirrel cage induction motors throughout the Contract Documents, except as indicated otherwise.

C. The Contractor shall assign to the equipment supplier the responsibility to select suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review by the Engineer. Such review will consider future availability of replacement parts and compatibility with driven equipment.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Complete motor data shall be submitted with the driven machinery Shop Drawings. Motor data shall include:

1. Machine name and specification number of driven machine
2. Motor manufacturer
3. Motor type or model and dimension drawing. Include motor weight.
4. Nominal horsepower
5. NEMA design
6. Enclosure
7. Frame size
8. Winding insulation class and temperature rise class
9. Voltage, phase, and frequency ratings
10. Service factor
11. Full load current at rated horsepower for application voltage
12. Full load speed
13. Guaranteed minimum full load efficiency. Also nominal efficiencies at 1/2 and 3/4 load.
14. Type of thermal protection or overtemperature protection, where included
15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable

16. Bearing data. Include recommendation for lubricants of relubricatable type bearings.

17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery. Provide shaft grounding details and information. Provide insulated bearing details and information.

18. Power factor at 1/2, 3/4 and full load.

19. Recommended size for power factor correction capacitors to improve power factor to 0.95 percent lagging when operated at full load.

C. If water cooling is required for motor thrust bearings, the Shop Drawing submittals shall indicate this requirement.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall be equal to nameplate horsepower rating or less, exclusive of service factor and be verifiable from the submittal data of the driven machinery.

C. Motor Capacity

1. The Contractor shall size motors for the larger of the following criteria:

a. Size motors to continuously carry the maximum load that develops across the full range of driven equipment operation.

b. Size motors for minimum size indicated

2. In every case, motor size shall be derated from nameplate values as follows:

a. Ambient Temperature

1) For ambient temperatures up to but not exceeding 40 degrees C, no derating is required.

2) For ambient temperatures exceeding 40 degrees but less than 50 degrees C, derate nameplate HP ratings to 85 percent.

b. Site Altitude: No derating is required for altitudes less than 3300 feet (1000 meters). Higher altitudes require the following derating factors:

Altitude	Derating Factor
3,300 to 5,000 ft	97 percent
5,001 to 6,600 ft	94 percent

6,601 to 8,300 ft	91 percent
8,301 to 9,900 ft	88 percent
9,901 to 11,500 ft	85 percent

3. Increased circuit breaker, magnetic starter, and conductor and conduit capacities required for motors larger than the indicated sizes shall be provided as part of the Work.

D. Exempt Motors: Motors for valve operators, submersible pumps, or motors which are an integral part of standard manufactured equipment, i.e., non-NEMA mounting, common shaft with driven element, or part of domestic or commercial use apparatus may be excepted from these requirements to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.2 DESIGN REQUIREMENTS

A. General: Electric motors shall comply with NEMA MG-1 - Motor and Generator. Motors used with adjustable frequency drives shall comply with NEMA MG-1, Part 31, and shall be clearly identified as “Inverter Duty.”

B. NEMA Design: Electric motors shall be NEMA Design B unless otherwise indicated. In no case shall starting torque or breakdown torque be less than the value in NEMA MG 1. Motors shall be suitable for the indicated starting method.

C. Motor Voltage Ratings: Low voltage motors shall have voltage ratings in accordance with the following, unless otherwise indicated:

1. Motors below 1/2 HP shall be rated 115 volts, single phase, 60 Hz. Dual voltage motors rated 115/230 volts, 115/208 volts, or 120-240 volts are acceptable, provided leads are brought out to the conduit box.

2. Motors 1/2 HP and larger shall be rated 460 volts, 3 phase, 60 Hz. Dual voltage motors rated 230/460 volts or 208/230/460 volts are acceptable, provided every lead is brought out to the conduit box.

D. Insulation: Three phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated, without exceeding Class B temperature rise limits stated in NEMA MG 1-12.44. Single phase motors shall have Class F insulation with temperature rise not to exceed the insulation class. Motors to be operated from adjustable frequency drives shall be provided with insulation systems to withstand 1600 volt spikes, with dV/dT as defined in NEMA MG 1-31. The adjustable frequency drive manufacturer shall coordinate with the motor manufacturer to determine when additional dV/dT protection is required. Where required, it shall be furnished and installed as per the manufacturer’s written instructions.

E. Motors 50 HP or smaller located in non-hazardous areas shall be totally enclosed, fan cooled (TEFC) with a Service Factor of 1.15 for non-VFD applications and service factor of 1.15 (sine)/1.0 (inverter) for VFD applications.

F. Motors 50 HP and greater located in non-hazardous areas shall be TEFC, with a service factor of 1.15 for non-VFD applications and service factor of 1.15 (sine)/1.0 (inverter) for VFD applications.

G. Motors for use in hazardous locations shall have enclosures suitable for the classification indicated. Such motors shall be U.L. listed and be stamped as such.

H. Motors larger than 50 HP or where indicated shall be provided with 120 volt AC space heaters, wired to a terminal strip in a low voltage motor junction box. If provided by the manufacturer when not specified, the manufacturer shall not require that they be connected or the Contractor shall connect them at no extra cost to the Owner, in order to keep the warranty in force.

I. NEMA Premium Efficiency Motors

1. Motors with a nameplate rating of 1 HP and larger shall be NEMA premium efficient units. Motors shall be stamped with the efficiency on the nameplate with the caption "NEMA Nominal Efficiency" or "NEMA Nom. Eff." Such motors shall have efficiencies determined by the test as set forth in ANSI/IEEE 112 - Standard Test Procedure for Polyphase Induction Motors and Generators, Method B.

2. Efficiency: Nominal efficiency and minimum efficiency shall be defined in accordance with the following tables. Both efficiencies shall be included in the Shop Drawing submittal.

OPEN DRIP-PROOF (ODP)						
FULL-LOAD EFFICIENCIES OF NEMA PREMIUM EFFICIENCY MOTORS RATED 600 VOLTS OR LESS						
	2 POLE		**4 POLE**		**6 POLE**	
HP	**Nom. Effic.**	**Min. Effic.**	**Nom. Effic.**	**Min. Effic.**	**Nom. Effic.**	**Min. Effic.**
1	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	86.5	84.0
2	85.5	82.5	86.5	84.0	87.5	85.5
3	85.5	82.5	89.5	87.5	88.5	86.5
5	86.5	84.0	89.5	87.5	89.5	87.5
7.5	88.5	86.5	91.0	89.5	90.2	88.5
10	89.5	87.5	91.7	90.2	91.7	90.2
15	90.2	88.5	93.0	91.7	91.7	90.2
20	91.0	89.5	93.0	91.7	92.4	91.0
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	94.1	93.0	93.6	92.4
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.0	94.1	94.5	93.6
100	93.6	92.4	95.4	94.5	95.0	94.1
125	94.1	93.0	95.4	94.5	95.0	94.1
150	94.1	93.0	95.8	95.0	95.4	94.5
200	95.0	94.1	95.8	95.0	95.4	94.5
250	95.0	94.1	95.8	95.0	95.8	95.0
300	95.4	94.5	95.8	95.0	95.8	95.0
350	95.4	94.5	95.8	95.0	95.8	95.0
400	95.8	95.0	95.8	95.0	--	--
450	96.2	95.4	96.2	95.4	--	--
500	96.2	95.4	96.2	95.4	--	--

Source: NEMA MG1 - 2011, Table 12-12

TOTALLY ENCLOSED - FAN COOLED (TEFC)						
FULL-LOAD EFFICIENCIES OF NEMA PREMIUM EFFICIENCY MOTORS RATED 600 VOLTS OR LESS						
	2 POLE		**4 POLE**		**6 POLE**	
HP	**Nom. Effic.**	**Min. Effic.**	**Nom. Effic.**	**Min. Effic.**	**Nom. Effic.**	**Min. Effic.**
1	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5
2	85.5	82.5	86.5	84.0	88.5	86.5
3	86.5	84.0	89.5	87.5	89.5	87.5
5	88.5	86.5	89.5	87.5	89.5	87.5
7.5	89.5	87.5	91.7	90.2	91.0	89.5
10	90.2	88.5	91.7	90.2	91.0	89.5
15	91.0	89.5	92.4	91.0	91.7	90.2
20	91.0	89.5	93.0	91.7	91.7	90.2
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	93.6	92.4	93.0	91.7
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.4	94.5	94.5	93.6
100	94.1	93.0	95.4	94.5	95.0	94.1
125	95.0	94.1	95.4	94.5	95.0	94.1
150	95.0	94.1	95.8	95.0	95.8	95.0
200	95.4	94.5	96.2	95.4	95.8	95.0
250	95.8	95.0	96.2	95.4	95.8	95.0
300	95.8	95.0	96.2	95.4	95.8	95.0
350	95.8	95.0	96.2	95.4	95.8	95.0
400	95.8	95.0	96.2	95.4	--	--
450	95.8	95.0	96.2	95.4	--	--
500	95.8	95.0	96.2	95.4	--	--

Source: NEMA MG1 - 2011, Table 12-12

J. Two speed motors shall be of the 2 winding type.

2.3 ACCESSORY REQUIREMENTS

A. General: Horizontal motors 3 HP and larger and every vertical motor shall have split-type cast metal conduit boxes. Motors shall be provided with oversized conduit boxes. Where conduit sizes indicated do not match the motor terminal box, the Contractor shall provide means to accommodate the motor requirements. Motor boxes other than open drip-proof shall be gasketed.

B. Lifting Devices: Motors weighing 265 lb (120 Kg) or more shall have suitable lifting eyes for installation and removal.

C. Special Requirements: The Contractor shall refer to individual equipment specifications for special requirements such as motor winding thermal protection or multi-speed windings.

D. Grounding Lugs: Provide motor grounding lug suitable to terminate ground wire, sized as indicated.

E. Nameplate: Motors shall be fitted with permanent stainless steel nameplates indelibly stamped or engraved with NEMA Standard motor data, in conformance with NEMA MG-1-10.40. Inverter duty motors shall be clearly identified as such.

F. Where motors are indicated by elementary schematics or specifications to have zero speed switches, the switches shall be factory mounted integral to the motors. Switches shall close the contacts when the motor is at zero speed.

G. Inverter duty motors shall be provided with shaft grounding rings. Rings shall be factory installed, and shall be manufactured by **Aegis**, or equal. The motor warranty shall include coverage against VFD-induced bearing damage or failure.

2.4 MOTOR THERMAL PROTECTION

A. Single Phase Motors: Single phase 120, 208, or 230 volt motors shall have integral thermal overload protection or shall be inherently current limited.

B. Thermostats: Where indicated or specified, winding thermostats shall be snap action, bi-metallic, temperature-actuated switch. Thermostats shall be provided with one normally closed contact. The thermostat switch point shall be precalibrated by the manufacturer. All inverter duty motors shall be provided with winding thermostats, unless RTDs are specified. All explosion-proof motors shall be provided with winding thermostats.

2.5 MOTOR BEARINGS

A. General: Bearings shall conform to Section 46 10 00 - Equipment General Provisions, except as indicated herein.

B. Motors greater than 2 HP shall have bearings designed for 17,500 hours (belted) or 100,000 hours (coupled) L-10 life.

C. Fractional Horsepower: Motors with fractional horsepower through 2 HP shall be provided with lubricated-for-life ball bearings.

D. Horizontal Motors Over 2 HP: Motors larger than 2 HP shall be provided with relubricatable ball bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

E. Vertical Motors Over 2 HP: Vertical motors larger than 2 HP shall be provided with relubricatable ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

F. Water Cooled Motors: If water cooling is required for the thrust bearings, cooling water lines shall be provided complete with shut-off valve, strainer, solenoid valve, flow indicator, thermometer, throttling valve, and, (where subject to freezing), insulation with heat tracing.

G. Inverter Duty Motors: Provide an insulated bearing to prevent circulating bearing currents.

2.6 MANUFACTURERS, OR EQUAL

A. **U.S. Motors/Nidec**

B. **Baldor**

C. **WEG**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Motor installation shall be performed in accordance with the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment. Shaft grounding devices shall be connected to the grounding system in accordance with the manufacturer’s recommendations.

B. Related electrical Work involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 26.

3.2 FACTORY TESTING

A. Motors rated 100 HP and larger shall be factory tested in conformance with IEEE 112, IEEE 43 - Recommended Practice for Testing Resistance of Rotating Machinery, and NEMA MG-2. Except where specific testing or witnessed shop tests are required by the specifications for driven equipment, factory test reports may be copies of routine test reports of electrically duplicate motors. Test report shall indicate test procedure and instrumentation used to measure and record data. Test report shall be certified by the motor manufacturer's test personnel and be submitted to the Engineer.

3.3 FIELD TESTING

A. The Contractor shall perform the following field tests (see also Section 26 01 26 – Electrical Tests):

1. Inspect each motor installation for any deviation from rated voltage, phase, frequency, and improper installation.

2. Visually check for proper phase and ground connections. Verify that multi-voltage motors are connected for proper voltage. Verify shaft grounding devices are properly grounded.

3. Check winding and bearing temperature detectors and space heaters for functional operation.

4. Test for proper rotation prior to connection to the driven equipment.

5. Visually check that motor overload heaters are properly sized and that MCP breaker settings are correct for the motor installed.

6. Test insulation (megger test) of new and re-used motors in accordance with NEMA MG-1. Test voltage shall be 1000 VAC plus twice the rated voltage of the motor.

END OF SECTION

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SECTION 26 05 15 – INDUSTRIAL CONTROL PANELS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide complete industrial control panels and/or local control stations as indicated herein or in other Sections of the Specifications. The stations shall be designed to provide the sequence of operation in Section 40 91 00 – Process Control and Instrumentation Systems and the P&ID Drawings.

B. This section also specifies miscellaneous electrical devices used throughout this project. These devices are not limited to use within industrial control panels or local control stations.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Industrial control panels and/or local control stations shall comply with the requirements of NEC (including Article 409), NEMA, and UL.

1.3 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings in accordance with Sections 01 33 00 – Submittal Procedures and 26 00 00 – Electrical Work, General.

1. Ladder diagrams and written descriptions explaining ladder diagram operation and system operation.

2. Include catalog cuts of control equipment including enclosures, overcurrent devices, relays, pilot devices, terminations, and wire troughs.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The Contractor shall provide the equipment, panels and stations to satisfy the functional requirements in the relevant mechanical equipment and Instrumentation and Control specifications and the Electrical Elementary Schematics. Each panel and station shall be fabricated with UL labeled components. Equipment not specifically indicated as being Work of other Sections shall be provided under this Section. All equipment, panels and stations shall be wired under this Section.

B. The controls shall be 120 V maximum. Where the electrical power supply is 240 V, single phase or 480 V, 3 phase, the station shall be provided with a fused control power transformer. Control conductors shall be provided in accordance with Section 26 05 19 – Wire and Cabling.

C. Each panel and/or station shall be provided with identified terminal strips for the connection of external conductors. The Contractor shall provide sufficient terminal blocks to connect 25 percent additional conductors for future use. Termination points shall be identified in accordance with Shop Drawings. The panels and/or stations shall be the source of power for all 120 VAC solenoid valves interconnected with the panels and/or stations. Equipment associated with the panels and/or stations shall be ready for service after connection of conductors to equipment, controls, panels and/or stations.

D. Wiring to door-mounted devices shall be extra flexible and anchored to doors using wire anchors cemented in place. Exposed terminals of door-mounted devices shall be guarded to prevent accidental personnel contact with energized terminals.

E. Enclosures

1. In finished rooms, enclosures shall be NEMA 12 steel enclosures painted with ANSI 61 exterior and white interior.

2. In all other non-hazardous areas, enclosures shall be NEMA 4X stainless steel with brushed finish. Where possible, penetrations shall be made in such a manner to maintain the NEMA 4X rating. If this is not possible, the penetrations shall be made in such a manner to minimize entry of foreign materials into the enclosure, subject to approval by the Engineer.

3. In hazardous areas, enclosures shall be cast aluminum NEMA 7 and shall be UL listed for use in hazardous or classified locations.

4. In chemical areas for alum, sodium hypochlorite, etc., NEMA 4X fiberglass enclosures shall be used.

5. Enclosures shall be freestanding, pedestal-mounted, or equipment skid-mounted, as indicated. Internal control components shall be mounted on a removable mounting pan. Mounting pan shall be finished white.

6. Provide screened weep holes for draining condensation.

F. Disconnect Switches

1. Heavy duty, fusible, single throw switches shall be rated not less than 65 KA at 480 VAC.

2. Horsepower rated

3. UL listed

4. Padlockable in "Off" position and door interlock

5. Enclosure per area classification in Section 26 00 00 – Electrical Work, General.

6. 480 V, 3-phase, 3-pole (6-pole when used with 2-speed motor).

7. Auxiliary control contact as applicable and where indicated.

8. As manufactured by **G.E., Eaton Electrical, Square D,** or equal.

G. Identification of panel-mounted devices, conductors, and electrical components shall be in accordance with Section 26 00 00 – Electrical Work, General.

H. Panel-mounted devices shall be mounted a minimum of 3-feet above finished floor elevation, but not higher than 6’-6” above finished floor, unless noted otherwise.

2.2 PANEL/STATION COMPONENTS

A. Pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30-mm. Miniature style devices are not acceptable. Devices shall be as manufactured by **General Electric, Eaton Electrical, Square D,** or equal.

1. Lens colors shall be red for "run," "open," or "on"; green for "stopped," "closed," or "off"; and amber for alarm.

2. Pilot lights shall be full voltage, push-to-test, LED cluster type.

3. Provide hazardous location type pilot devices in classified locations.

B. Relays shall be 3 PDT with 10 amp contacts, plug-in type with indicating light, rectangular blades and provided with sockets for screw-type termination and hold-down clips. Relays shall be as manufactured by **Square D, Potter Brumfield,** or equal.

C. Elapsed time meters shall be non-resettable type, read to a maximum of 99999.9 hours and shall be as manufactured by **General Electric, Eaton Electrical,** or equal.

D. Magnetic starters shall be:

1. NEMA rated, Size 1 minimum. IEC or dual NEMA/IEC rated type are not acceptable.

2. FVNR type unless indicated otherwise.

3. Combination starters with magnetic only instantaneous trip circuit breakers such as **Eaton Electrical HMCP, General Electric Mag-Break,** or equal. Breakers shall be rated 65 KA minimum.

4. Control transformers shall be provided with primary and secondary fuses, 120 V maximum control voltage. VA rating of transformer shall be based on devices on the control schematic.

E. Terminal strips shall be provided for every panel and shall be the flanged fork or ring lug type suitable for No. 12 AWG stranded wire minimum. Provide 25 percent spare terminals in each panel.

F. Time delay relays shall be combination on delay and off delay (selectable) with adjustable timing ranges. Provide socket with screw terminal connections and retaining strap. Time delay relays shall be **Square D, ATC, Eaton Electrical,** or equal.

2.3 FACTORY TESTING

A. Each panel/station shall be factory assembled and tested for sequence of operation prior to delivery.

2.4 SPARE PARTS

A. Provide a minimum of 10 percent spare lamps (minimum 2) and one spare lens for each color pilot lamp in each panel.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Panels/stations shall be installed in accordance with in Section 26 00 00 – Electrical Work, General and in accordance with the manufacturer's recommendations.

B. Panels/stations shall be protected at the site from loss, damage, and the effects of weather. Panels/stations shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion and humidity.

C. Panels/station interiors and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the Work.

D. Conduit, conductors, and terminations shall be installed in accordance with Section 26 00 00 – Electrical Work, General.

3.2 FIELD TESTING

A. Each panel/station shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.

END OF SECTION

SECTION 26 05 19 - WIRE AND CABLING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

B. In the event that motors provided are larger horsepower than the motors indicated, raceways, conductors, starters, overload elements, and branch circuit protectors shall be revised as necessary to control and protect the increased motor horsepower in accordance with Section 26 05 10 – Electric Motors. Revisions are part of the Work of this Section.

1.2 ACTION SUBMITTALS

A. The Contractor shall submit Shop Drawings in accordance with Sections 01 33 00 – Submittal Procedures and 26 00 00 – Electrical Work, General. Submit cable test results in accordance with this Section .

1.3 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall protect all cables from damage at all times.

B. Cable ends shall be protected from water entry in accordance with the manufacturer's recommended procedures. Cable ends shall not be left open in manholes or other locations subject to submergence. If the cable ends become submerged prior to splicing or termination, the cables shall be replaced in their entirety.

C. Cables shall be pulled into raceways in accordance with the manufacturer's requirements. Under no circumstances shall cable pulling tensions exceed the manufacturer's written instructions.

D. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

PART 2 -- PRODUCTS

EQUIPMENT

A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor and/or solid conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

B. Low Voltage Power and Lighting Wire

1. Wire rated for 600 volts in duct or conduit for power and lighting circuits shall be single conductor, Class B Type XHHW or XHHW-2 cross-linked polyethylene conforming to UL-44 - UL Standard for Thermoset-Insulated Wires and Cables.

THHN/THWN wire shall not be permitted to be used for any power or control wiring in this project, except as specifically permitted within control panels per Section 40 92 00 – Control Panels.

2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

3. 3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

4. Wiring for 600 volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

C. Low Voltage Control Wire

1. Low voltage control wire in duct or conduit shall be the same type as power and lighting wire indicated above.

2. Control wiring shall be No.14 AWG.

3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable,** or equal.

D. Instrumentation Cable

1. Instrumentation cable shall be rated at 300 volts, minimum.

2. Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color coded polyethylene: black-clear for 2 conductor cable and black-red-clear for 3 conductor cable.

3. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 18 or larger AWG stranded, tinned copper drain wire, and a PVC outer jacket with a thickness of 0.047-inches.

4. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 8719,** similar by **General Cable,** or equal.

5. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 8618,** similar by **General Cable,** or equal.

E. VFD Power Cable

1. VFD power cable shall be three (3) conductor, stranded copper, PVC jacketed, shielded type, tray cable (TC) rated 600 volts with three (3) symmetrical ground conductors. The individual conductors shall be UL listed as Type XHHW-2 or RWH-2 rated for 90 degrees C at wet and dry locations, with XLPE insulation.

2. VFD Cables shall be as manufactured by **Belden, Alpha**, **General Cable,** or equal.

F. Cable Splices and Terminations

1. Where cable lugs are required for power cable terminations, utilize compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Pressure type, twist-on connectors (wire nuts) will not be acceptable.

2. Pre-insulated fork tongue lugs shall be **Thomas & Betts, Burndy**, or equal.

3. General purpose insulating tape shall be **Scotch No. 33**, **Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M,** or equal.

4. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide, terminate and test all power, control, and instrumentation conductors.

B. The Contractor shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares for future use.

C. Conductors shall not be pulled into any raceway until raceway has been cleared of moisture and debris.

D. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.

E. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be neatly fanned out to terminals.

F. Single conductor cable in cable trays shall be No. 1/0 or larger and shall be of a type listed and marked for use in cable trays. Tray cable smaller than 1/0 shall be multi-conductor, with outer jacket.

3.2 FIELD ASSEMBLY

A. General

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.

2. In general, there shall be no cable splices in underground manholes or pullboxes. If splices are necessary, the cables shall be spliced using submersible cable splices, suitable for continuous submergence. Splices in underground manholes and pullboxes may be made only with the approval of the Engineer.

3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

B. Control Wire and Cable

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.

2. In motor control centers, and control panels, control wire and spare wire shall be terminated to terminal strips.

3. The Contractor shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Instrumentation Wire and Cable

1. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4 - 20 mA system.

2. Two and 3 conductor shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pullboxes with the prior approval of the Engineer. Such cable runs shall have only one splice per conductor.

D. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the Contractor. Cables rated above 2,000 volts shall be spliced or terminated only at equipment terminals indicated.

2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.

3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The Contractor shall submit the proposed termination procedure as a Shop Drawing.

4. VFD shielded power cables shall have the shield grounded at all locations where it is exposed.

E. Cable Identification

1. General: Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

2. Identification Numbers: The Contractor shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on "as built" drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

   a. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.

   b. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 480/277-volt system conductors shall be color coded as follows: Phase A - Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Color coding tape shall be used where colored insulation is not available. Colored identification tape may be used on conductors between the local disconnect and the load, where permitted by the NEC. Any phase changes necessary for proper rotation shall be made at the driven equipment where colored insulation is used. Phase changes may be made on the load side of the local disconnect, where phase colors are identified using tape.

   c. General purpose AC control cable shall be red. General purpose DC control cable shall be blue.

   d. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.

   e. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

3.3 FIELD QUALITY CONTROL

A. Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Section 01 33 00 – Submittal Procedures, prior to shipment of cable. The following field tests (in addition to the tests specified in Section 26 01 26 – Electrical Tests) shall be the minimum requirements:

   1. Insulation resistance testing, using a DC megohmeter, shall be performed on cables operating at more than 2,000 volts to ground. Time-resistance readings shall be taken and recorded at intervals of 30 seconds and one minute. Time-resistance voltage levels shall be per the cable manufacturer's recommendations.

2. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmeter.

3. Field testing shall be done after cable is installed in the raceways.

4. Field tests shall be performed by a NETA-certified test organization. Test results shall be submitted to the Engineer for review and acceptance.

5. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

B. Continuity Test: Control and instrumentation cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

END OF SECTION

SECTION 26 05 26 – GROUNDING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide the electrical grounding system, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 – Electrical Work, General apply to this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 ACTION SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures and Section 26 00 00 – Electrical Work, General.

1. Include with each submittal a copy of this specification section, with addenda updates included, and all referenced and applicable sections included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Shop Drawings

1. Submit manufacturer's product information for connectors, clamps, and all grounding system components, showing compliance with the requirements of this Section.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Components of the grounding electrode system shall be manufactured in accordance with UL 467 - Standard for Safety Grounding and Bonding Equipment, and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.

B. Grounding System

1. Grounding loop conductors shall be bare annealed copper conductors.

2. Conductors shall be No. 4/0 unless indicated otherwise.

3. Ground Rods

    a. Unless indicated otherwise, provide ground rods minimum of 3/4 inch in diameter, 10 feet long, and with a uniform covering of electrolytic copper metallically bonded to a rigid steel core.

    b. Provide corrosion-resistant copper-to-steel bond.

    c. The rods shall conform to UL 467.

    d. The rods shall be of the sectional type, joined by threaded copper alloy couplings.

4. Make buried, concrete-encased, or otherwise inaccessible cable-to-cable and cable-to-ground rod connections using exothermic welds by **Cadweld, Thermoweld,** or equal.

5. Exposed Connectors

    a. Exposed grounding connectors shall be of the compression type (connector-to-cable), constructed of high-copper alloy, and manufactured specifically for the particular grounding application.

    b. The connectors shall be **Burndy, O.Z. Gedney**, or equal.

6. Use grounding clamps to bond each separately-derived system to the grounding electrode conductors.

7. Equipment Grounding Circuit Conductors

    a. The conductors shall be the same type and insulation as the load circuit conductors.

    b. The minimum size shall be as indicated. Where not indicated, sizes shall conform to Table 250.122 of the National Electrical Code.

    c. Metallic conduit systems shall have an equipment grounding wires as well as being equipment grounding conductors themselves.

8. Grounding Materials Manufacturer, or Equal

    a. Copperweld

    b. Thermoweld

    c. Burndy

    d. Thomas and Betts

    e. **OZ Gedney**EXECUTION

2.2 PREPARATION

A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.

B. Provide a separate grounding conductor for each motor and connect at motor box. Provide a supplemental ground connection for motor shaft grounding rings, where applicable.

C. Do not use bolts for securing the motor box to the frame or the cover for grounding connectors.

D. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.

E. Route the conductors inside the raceway.

F. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each MCC section, switchboard, or panelboard.

G. Individually bond the raceway to the ground bus in the secondary section.

H. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.

I. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.

J. Interconnect the secondary switchgear MCC or panelboard neutral bus to the ground bus in the secondary switchgear compartment only at the service entrance point. For wye connected, 3 phase, separately derived systems with 3 wire distribution, connect the transformer neutral to the grounding electrode system at the transformer. Connections shall be in accordance with the NEC.

K. Provide the duct bank ground system as indicated, including trenching, splices, ground rods, and connections to equipment and structures.

L. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system. Provide additional grounding system testing in accordance with Section 26 01 26 – Electrical Tests.

M. Low Voltage Grounded System (600V or less)

1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.

2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.

3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.

N. Embedded Ground Connections

1. Underground and grounding connections embedded in concrete shall be UL-listed ground grid connectors.

2. The connection shall be made in accordance with the manufacturer's instructions.

3. Do not conceal or cover ground connections until the Engineer or an authorized representative has established that every grounding connection conforms to the requirements of the Contract Documents and has given the Contractor written confirmation.

O. Ground Ring

1. Furnish trenching and materials as necessary to install the ground ring as indicated.

2. The bonding conductor shall be in direct contact with the earth and of the indicated size.

3. Provide a minimum burial depth of 36 inches or as indicated on the Drawings, whichever is greater.

4. Re-compact disturbed soils to their original density in 6-inch lifts.

P. Ground Rods

1. Provide ground rods at the indicated locations.

2. A single electrode that does not have resistance-to-ground of 5 ohms or less shall be augmented by additional electrodes to obtain this value.

3. Take the resistance-to-ground measurement during dry weather, a minimum of 48 hours after a rainfall.

4. Rods forming an individual ground array shall be equal in length.

Q. Instrumentation Shield Grounding

1. Shielded instrumentation cable shall have its shield grounded at one end only unless the approved Shop Drawings indicate that the shield will be grounded at both ends.

2. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable.

3. The termination of the shield drain wire shall be on its own terminal screw.

4. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.

5. Connect the ground bus via a green No. 12 conductor to the main ground bus for the panel.

END OF SECTION

SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures, and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.

2. Submit dimensioned layout drawings of proposed embedded/encased raceway routings within concrete slabs.

3. Submit dimensioned layout drawings of cable tray routings, including elevations.

4. As-Built Drawings

a. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

b. Furnish the drawings to the Engineer in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Pull and junction boxes, fittings, and other indicated enclosures that are dedicated to the raceway system shall comply with the requirements of this Section.

2.2 CONDUIT

A. Rigid Aluminum (RAL) Conduits

1. Provide rigid aluminum conduit manufactured from 6063 alloy, temper T-1.

2. Provide rigid aluminum conduit manufactured in accordance with NEMA C80.5 – Electrical Rigid Aluminum Conduit, and UL-6A – Electrical Rigid Metal Conduit - Aluminum, Red Brass and Stainless Steel.

3. Manufacturer, or Equal

    a. **V.A.W. of America**

    b. **Alcoa**

B. Rigid Galvanized Steel (RGS) Conduit

1. Provide rigid steel conduit manufactured from mild steel, hot-dip galvanized inside and out.

2. Provide rigid steel conduit manufactured in accordance with NEMA C80.1 – Electrical Rigid Steel Conduit, and UL-6 – Electrical Rigid Metal Conduit - Steel.

3. Manufacturer, or Equal

    a. **Allied Tube & Conduit**

    b. **Triangle**

    c. **Wheatland Tube**

C. PVC Rigid Non-Metallic Conduit

1. Provide rigid non-metallic conduit manufactured from Schedule 40 PVC, as indicated, and sunlight-resistant.

2. Provide rigid non-metallic conduit manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit.

3. Manufacturer, or Equal

    a. **Carlon**

    b. **Cantex**

D. Rigid PVC-Coated Galvanized Steel (RPGS) Conduit

1. The conduit shall meet the requirements for RGS conduit as indicated above.

2. Bond a PVC coating to the outer surface of the galvanized conduit.

3. Ensure that the bond between the coating and the conduit surface is greater than the tensile strength of the coating.

4. Provide the inside surfaces and threads of the conduit with a 2-mil urethane coating.

5. Provide a PVC coating thickness not less than 40 mils.

6. The PVC-coated RGS shall be manufactured in accordance with the following standards:

    a. UL-6

b. ANSI C80.1

c. NEMA RN1 - PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

7. Manufacturer, or Equal

a. **Robroy Industries**

b. **O'Kote**

c. **Thomas & Betts**

E. Liquid-Tight Flexible Conduit

1. Provide liquid-tight flexible conduit constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket.

2. Provide liquid-tight flexible conduit manufactured in accordance with the requirements of UL-360 - Steel Conduits, Liquid-Tight Flexible.

3. Manufacturer, or Equal

a. **Anaconda, Sealtite**

b. **Electriflex, Liquatite**

F. Electrical Metallic Tubing (EMT) or Intermediate conduit (IMC) will not be accepted.

2.3 FITTINGS AND BOXES

A. General

1. For use with metallic conduit, provide cast and malleable iron fittings of the threaded type with 5 full threads.

2. Fittings and Boxes

a. Provide fittings and boxes with neoprene gaskets and non-magnetic stainless steel screws.

b. Attach covers by means of holes tapped into the body of the fitting.

c. Covers for fittings attached by means of clips or clamps will not be accepted.

3. Provide boxes larger than standard cast or malleable types manufactured of Type 304 or Type 316 stainless steel, NEMA 4X.

4. Terminations

a. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, Appleton, or equal.

b. In other than outdoor areas, provide sealed locknuts and bushings.

B. Cast Aluminum Fittings and Boxes

1. Provide cast aluminum boxes and fittings with less than 0.40 percent copper content, and use with aluminum conduit.

2. Manufacturer, or Equal

a. **O.Z. Gedney**

b. **Appleton**

c. **Crouse-Hinds**

C. Malleable Iron Fittings and Boxes

1. For use with galvanized steel conduit, provide fittings and boxes constructed of malleable iron or gray-iron alloy with zinc plating.

2. Manufacturer, or Equal

a. **O.Z. Gedney**

b. **Crouse-Hinds**

c. **Appleton**

D. PVC Fittings and Boxes

1. For use with rigid non-metallic conduit, provide fittings manufactured of solvent-welded PVC.

2. Provide boxes manufactured of PVC or fiberglass reinforced polyester (FRP).

3. Manufacturer, or Equal

a. **Carlon**

b. **Crouse-Hinds**

c. **Hoffman**

4. Provide welding solvent as required for the installation of non-metallic conduit and fittings.

E. Stainless Steel Boxes

1. Provide stainless steel boxes with PVC-coated RGS conduit and where indicated.

2. Provide NEMA 4X stainless steel boxes, constructed of Type 304 stainless steel.

3. Provide stainless steel of a minimum of 14-gauge thickness, with a brushed finish.

4. Door Hinges

a. Provide doors with full-length stainless steel piano hinges.

b. Non-hinged boxes will not be accepted.

5. Manufacturer, or Equal

a. **Hoffman**

b. **Rohn**

c. **Hammond**

F. Sheet Steel Boxes

1. Sheet steel boxes shall be galvanized steel outlet and switch boxes.

2. Manufacturer, or Equal

a. **Raco**

b. **Steel City**

c. **Appleton Electric**

2.4 WIREWAY

A. General

1. Provide wireway of the lay-in type and NEMA-rated for the area in which it is to be installed in accordance with the requirements of Section 26 00 00 – Electrical Work, General.

2. Separate power, control, signal and communications cables by grounded metallic dividers in wireways or run in separate wireways.

B. Fittings and Covers

1. Provide fittings and sections with non-magnetic stainless steel screws.

2. Attach covers by hinges and clamps to the bodies.

3. Covers attached by means of clips or screws will not be accepted.

4. Provide covers and bodies constructed of aluminum or minimum 14-gauge steel.

C. Grounding

1. Ground the steel and aluminum wireway bodies.

2. Provide steel dividers with steel wireways or aluminum dividers with aluminum wireways, and ground by means of an individual grounding conductor.

3. Non-metallic dividers will not be accepted.

D. Terminations

1. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Run wiring in raceway unless indicated otherwise.

B. Install raceways between equipment as indicated.

C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.

D. Bends and Offsets

1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.

2. Provide factory elbows wherever possible.

E. Combined Raceways

1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the Engineer.

2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.

3. Permission from the Engineer shall not relieve the Contractor of responsibility to meet national, state and local requirements.

4. Do not combine wiring for redundant systems into single raceways.

F. Routing

1. Where raceway routings are indicated, follow those routings to the extent possible.

2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the Contractor's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.

4. Adjust routings in order to avoid obstructions.

G. Coordination

1. Coordinate between trades prior to installing the raceways.

2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.

H. Support rod attachment for ceiling-hung trapeze installations shall meet the seismic requirements in the area where the Project is located.

I. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – Electrical Work, General.

J. Install exposed raceways parallel or perpendicular to structural beams.

K. Expansion Fittings

1. Install expansion fittings with external bonding jumpers wherever exposed raceways cross building expansion joints.

2. Install expansion/deflection fittings where conduit movement is expected in more than one dimension, and where conduits transition out of structures in locations where differential settlement may occur.

3. Encased Expansion Fittings

a. Install encased expansion fittings wherever encased conduits cross building expansion joints.

b. Deflection type fittings shall not be required for encased conduits crossing an expansion joint within a single structure.

4. Provide expansion and expansion/deflection fittings constructed of the same material as the raceway to which they are installed.

L. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.

M. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.

N. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

3.2 CONDUIT

A. Provide exposed conduit manufactured of rigid aluminum, except as follows and unless indicated otherwise:

1. For conduit containing only grounding system bonding conductors, provide Schedule 80 PVC conduit.

B. Conduit encased in concrete shall be Schedule 40 PVC.

C. Concrete Encasement

1. Where PVC or RGS conduit is stubbed up from a concrete encasement, provide a PVC-coated RGS elbow.

2. The conduit shall emerge from the concrete in a direction perpendicular to the surface whenever possible.

3. Do not encase conduit in the bottom floor slab below grade.

D. Size

1. Provide exposed conduit of 3/4-inch minimum trade size.

2. Provide encased conduit of one-inch minimum trade size.

E. Install supports at distances required by the NEC.

F. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.

G. Penetrations

1. Provide conduit passing through walls or floors with plastic sleeves.

2. Perform core drilling in accordance with the requirements of Section 26 00 00 – Electrical Work, General.

3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

H. Conduits embedded within a slab, wall, or beam (other than those merely passing through) shall meet the following requirements:

1. Conduits with their fittings embedded within a column shall not displace greater than 4 percent of the gross area of cross section;

2. Conduits shall not be larger in outside dimension than 1/3 the overall thickness of the slab, wall, or beam in which it is embedded; and,

3. Conduits shall not be spaced closer than 3 outside diameters on centers.

I. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.

J. Coat threads with a conductive lubricant before assembly.

K. Joints

1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.

2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.

3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.

4. Replace conduit with wrench marks.

5. Where installed in chemical or fuel containment areas, the conduit shall not have joints or fittings located below the top of the containment area to prevent entry of chemicals or fuel into the conduit system.

L. Slope

1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.

2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.

3. Take extreme care in order to avoid pockets or depressions in the conduit.

M. Where conduits from duct banks enter building walls below grade, transition to PVC-coated RGS at least 12” outside the wall. Installation of PVC-coated rigid steel conduit though a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.

N. Connections

1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.

2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.

3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.

O. Provide conduit seal fittings in hazardous classified locations, in strict accordance with the NEC.

P. Provide conduit, fittings, and boxes required in hazardous classified areas that are suitably rated for the area, and provide in strict accordance with NEC requirements.

Q. Duct sealant shall be foam duct sealant such as **Polywater FST or approved equal.** Provide duct sealant at the following locations:

1. Where required by NEC Article 300.7.

2. In areas where chlorine gas or fumes from sodium hypochlorite exist to prevent passage of gas through the raceway system.

R. Empty Conduits

1. Tag empty conduits at both ends to indicate the final destination.

2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.

3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

S. Identification of Conduits

1. Identify conduits at ends and at pulling points.

2. Identification shall be the unique conduit number assigned in the Contract Documents.

3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.

4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

5. Provide conduit identification by a stamped or engraved non-corroding metal tag attached to the conduit bushing.

6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – Electrical Work, General, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.

7. Markings with a pen or paint will not be accepted.

T. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.

2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the Contractor shall assign one following the numbering scheme used in the Contract Documents.

3. Provide box identification by a stamped or engraved non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – Electrical Work, General, and attached to the box or enclosure.

4. Markings with a pen or paint will not be accepted.

U. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

END OF SECTION

SECTION 26 05 36 - WIRING DEVICES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide wiring devices, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 – Electrical Work, General apply to this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit complete catalog cuts of switches, receptacles, enclosures, covers and appurtenances, marked to clearly identify the proposed materials.

2. Submit documentation showing that the proposed materials comply with the requirements of NEC and U.L.

3. Submit documentation of the manufacturer's qualifications.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Devices shall carry the U.L. label, and shall be designed for use with stranded copper conductors.

B. Color

1. General purpose duplex receptacles and toggle switch handles shall be Brown everywhere except unless otherwise indicated.

2. Special purpose receptacles shall have a body color as indicated.

C. Receptacles and switches shall be of specification grade and shall conform to NEMA WD-1, Federal Specifications W-C-596E and W-S-896E, respectively.

2.2 LIGHTING SWITCHES

A. Toggle switches shall be AC only type switch.

1. 20A, 120/277V, Single, Double, 3-Way and 4-Way, Respectively

a. **Leviton**: 1221-2, 1222-2, 1223-2, 1224-2
b. **Hubbell:** HBL1221, HBL1222, HBL1223, HBL1224
c. **Pass and Seymour:** PS20AC1, PS20AC2, PS20AC3, PS20AC4
d. **Or Equal**

2.3 GENERAL PURPOSE RECEPTACLES

A. Duplex receptacles shall be of the polarized 3-wire type for use with a 3-wire cord with grounded lead, and one designated stud shall be permanently grounded to the conduit system in accordance with NEC article 406.4.

B. Dry Areas

1. NEMA Configuration #5-20R: duplex receptacle rated 125V, 20A

a. **Leviton:** #5362
b. **Hubbell:** #HBL5362
c. **Pass and Seymour:** #5362A
d. **Or Equal**

2. NEMA Configuration #5-30R single receptacle rated 125V, 30A

a. **Leviton:** #5371
b. **Hubbell:** #HBL9308
c. **Or Equal**

C. Damp/Wet Areas

1. Receptacles for damp/wet locations shall be weather-resistant with extra duty, in-use listed covers in accordance with NEC Article 406.8.

D. GFCIs

1. Ground-fault circuit-interrupting receptacles (GFCIs) shall be installed at the indicated locations and as required by the NEC.

2. GFCIs shall be duplex receptacles, of specification grade, and tripping at 5 mA.

3. GFCI ratings shall be 125V, 20 amperes, NEMA WD-1, Configuration 5-20R, and capable of interrupting 5,000 amperes without damage.

4. GFCIs shall be weather resistant-listed in accordance with NEC Article 406.8.

5. Feed-through-type GFCIs serving standard receptacles will not be permitted.

a. **Leviton:** G5362-WT
b. **Hubbel:** GFR5362SG
c. **Or Equal**

2.4 ENCLOSURES AND COVERS

A. Surface-mounted switches and receptacles shall be housed in FS or FD-type weatherproof conduit fittings.

B. Switch and receptacle covers on surface-mounted boxes shall be constructed of die-cast copper-free aluminum.

1. **Appleton**: FSK
2. **Crouse-Hinds**: DS185 and WLRD-1
3. **Hubbell Killark**: FZ and FC
4. **Or Equal**

C. In finished areas, switch and receptacle covers shall be constructed of stainless steel.

D. Wet Locations

1. Receptacles in wet locations shall be provided with a hinged non-metallic Clear cover/enclosure marked "Suitable for Wet Locations when in use" and "UL Listed."

2. Provide a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base.

a. **Appleton**: WCIU
b. **Crouse-Hinds**: TP74
c. **Hubbell TayMac:** Extra Duty
d. Or Equal

2.5 NAMEPLATES

A. Provide nameplates or equivalent markings on the switch enclosures to indicate the ON and OFF positions of each switch.

B. ON and OFF for 3-way or 4-way switches will not be accepted.

C. Provide receptacles for special purposes with nameplates indicating their use.

D. Nameplates shall meet the requirements of Section 26 00 00 – Electrical Work, General.

PART 3 -- EXECUTION

3.1 GENERAL

A. Perform Work in accordance with the requirements of the NEC.

3.2 CONNECTION

A. Rigidly attach wiring devices in accordance with the NEC and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets centered under or on the device, unless otherwise indicated.

C. Nameplates shall meet the requirements of Section 26 00 00 – Electrical Work, General, and shall consist of a red plate with white letters a minimum of 1/4 inch tall.

3.3 GROUNDING

A. Devices, including switches and receptacles, shall be grounded in accordance with NEC, Article 250, and Section 26 05 26 – Grounding.

B. Switches and associated metal plates shall be grounded through the switch mounting yoke, outlet box, and raceway system.

C. Flush Receptacles

1. Flush receptacles and their metal plates shall be grounded through positive ground connections to the outlet box and grounding system.

2. Maintain the ground to each receptacle by a spring-loaded grounding contact to the mounting screw, or by a grounding jumper, each making a positive connection to the outlet box and grounding system at all times.

D. Receptacles served from an uninterruptible power supply shall be provided with an isolated grounding conductor from the serving power panelboard.

3.4 FIELD TESTING

A. Provide checkout, field, and functional testing of wiring devices in accordance with Section 26 00 00 – Electrical Work, General.

B. Test each receptacle for polarity and ground integrity, using a standard receptacle tester.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide underground raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. Manholes, pullboxes, and fittings that are dedicated to the underground raceway system shall comply with the requirements of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures, and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit complete catalog cuts of all raceways, fittings, pullboxes, and manholes, marked where applicable in order to show proposed materials and finishes.

C. As-Built Drawings

1. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

2. Show routings, burial depths, manhole and handhole locations and sizes, and where applicable, connections to drainage systems.

3. Furnish the drawings to the Engineer in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

PART 2 -- PRODUCTS

2.1 MANHOLES AND PULLBOXES

A. Frames and Covers

1. Provide traffic-type covers with an H-20 loading, except as otherwise indicated.

2. Identify manhole and pullbox covers as "ELECTRIC" by providing raised letters cast into the covers.

3. Provide frost-proof and water-tight grey iron frames and covers with solid lids and inner lids, and with 28-inch clear openings.

4. Bolt the covers and lids to cast-in-place steel frames using corrosion-resistant hardware.

5. Factory-prime the frames.

6. Provide covers constructed of cast-iron, and provide pick holes.

7. Provide frames with a 1/2-inch drilled and tapped hole and lug in order to accommodate a No. 4/0 AWG bare stranded copper conductor connected to a ground rod and the ground conductor of power cables passing through the manhole.

8. Manhole frames and covers shall be **Neenah Foundry No. NF-1755GT18** or equal.

B. Equip manholes and pullboxes with pulling-in irons, opposite and below each ductway entrance.

C. Provide manholes and pullboxes with closed bottoms; open-bottom manholes and pullboxes will not be accepted.

D. Provide PVC ductbank conduits with end bells.

E. Brackets

1. Provide non-metallic, non-conductive brackets and stanchions in manholes as required for racking wiring through the manholes. Attach to manhole walls using stainless steel anchors and hardware.

2. Brackets and stanchions: **Underground Devices, Inc.,** or equal.

F. Precast Manholes and Pullboxes Manufacturer, or Equal

1. **Jensen Precast**

2. **Mack**

3. **Quikset**

4. **U.S. Precast**

2.2 DUCTBANKS

A. Provide underground ducts constructed of Schedule 40 PVC.

B. Encase ducts in red-dyed concrete with steel reinforcing bars.

C. Provide concrete with a 3,000-psi compressive strength conforming to the requirements of Section 03 31 00 – Cast-in-Place Concrete.

D. Colorant

1. The concrete shall be dyed red throughout the ducts; surface treatment will not be accepted.

2. Provide colorant consisting of an integral red-oxide coloring pigment in the proportion of 8 pounds per cubic yard of concrete.

3. The costs, if any, of cleaning coloring pigment from the concrete delivery equipment and other related cleanings shall be considered as part of the Work.

E. Ductbanks

1. Ductbanks shall contain a No. 4/0 bare stranded copper ground wire.

2. The ground wire shall be continuous through the ductbank and terminate at power distribution equipment and the grounding grid.

F. Identification Tape

1. Provide continuous lengths of underground warning tapes located 12 inches above and parallel to the ductbanks.

2. Provide tape consisting of 6-inch wide polyethylene film, imprinted with "CAUTION - ELECTRIC UTILITIES BELOW."

3. Tape Manufacturer, or Equal: **Brady**

PART 3 -- EXECUTION

3.1 GENERAL

A. Install underground raceways between manholes and pullboxes as indicated.

B. Raceway systems shall be electrically and mechanically complete before conductors are installed.

C. Provide bends and offsets that are smooth and symmetrical, and fabricated with tools designed for this purpose.

D. Use factory elbows wherever possible.

E. To the extent possible, follow the raceway routings as indicated on the Drawings.

F. Adjust the indicated routings as necessary in order to avoid obstructions.

G. Coordination with Other Trades

1. Coordinate with other trades prior to installation of raceways.

2. The lack of coordination shall not be justification for extra compensation.

3. Perform removal and re-installation to resolve conflicts as part of the Work.

3.2 DUCTBANKS

A. Install ductbanks in accordance with the following criteria:

1. Assemble the duct using high-impact, non-metallic spacers and saddles in order to provide conduits with vertical and horizontal separation.

2. Set the plastic spacers every 5 feet.

3. Anchor the duct array every 5 feet in order to prevent movement during the placement of concrete.

4. Lay the duct on a grade line of at least 3 inches per 100 feet, sloping towards pullboxes or manholes.

5. Install the duct and adjust the pullbox and manhole depths such that the top of the concrete envelope is a minimum of 18 inches below grade and a minimum of 24 inches below roadways.

6. Accomplish changes in direction of the duct envelope by more than 10 degrees horizontally or vertically by using bends with a minimum radius 24 times the duct diameter.

7. Stagger duct couplings a minimum of 6 inches.

8. Provide select backfill or sand for the bottom of the trench.

9. Cleaning

    a. Clean each bore of the completed ductbank by drawing through it a standard flexible mandrel, one foot long and 1/4 inch smaller than the nominal size of the duct.

    b. After passing the mandrel, draw through a wire brush and swab.

10. For spare raceways that are not indicated to contain conductors, provide a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway.

B. Grout duct entrances smooth, and terminate ducts with flush end bells.

C. Assemble sections of pre-fabricated manholes and pullboxes using waterproof mastic, and set on a 12-inch bed of gravel as recommended by the manufacturer or as required by field conditions.

D. Provide watertight ductbank penetrations through walls of manholes, pullboxes, and building walls below grade.

E. Terminate concrete-encased ductbanks at building foundations.

F. Where ducts enter buildings, provide duct sealant in every duct at the building-end of the duct run to prevent water or condensation entry from the duct bank into the building. Duct sealant shall be **Polywater FST, Polywater FST-Mini,** or equal.

G. When duct enters the building on a concrete slab on grade, do not encase the duct but transition to rigid steel PVC-coated conduits on stub-ups.

H. Sealing

1. Where an underground conduit enters a structure through a concrete roof or a membrane-waterproofed wall or floor, provide a **Link-Seal** or equal sealing device.

2. Use the sealing device with rigid steel conduit.

3. Transition from PVC to rigid steel conduit prior to building entry.

END OF SECTION

SECTION 26 05 73 – PROTECTIVE DEVICE STUDIES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall perform the indicated short circuit and protective device studies for the electrical power system in accordance with the Contract Documents.

B. The Work of this Section shall include protection studies for motors with solid state overload and overcurrent protection devices.

C. It is the responsibility of the Contractor to obtain the information required from the electric utility and appropriate vendors.

1.2 QUALIFICATIONS

A. Short circuit studies, protective device evaluation studies, arc-flash hazard analysis studies, and protective device coordination studies shall be performed by a manufacturer who has been regularly engaged in short circuit and protective device coordination services for a period of at least 15 years.

B. The indicated studies shall be signed by the professional electrical engineer, registered in the State of Utah, responsible for the studies.

C. The studies shall utilize computer programs with proven reliability and accuracy for performing 3-phase fault-duty calculations.

1.3 CONTRACTOR SUBMITTALS

A. The indicated studies shall be submitted and approved by the Engineer prior to final approval of the distribution equipment Shop Drawings and release of equipment for manufacture.

B. An initial short circuit study shall be submitted and reviewed before the Engineer will approve the Shop Drawings for medium-voltage switchgear, transformers, or 480-volt distribution equipment.

C. An initial protective device coordination study shall be submitted with 90 days after the approval of the initial short circuit study.

D. The short circuit, arc-flash hazard analysis, and protective device coordination studies shall be updated prior to Project Substantial Completion; utilize characteristics of as-installed equipment and materials.

E. The adequacy of the equipment "withstand" and interruption ratings shall be approved by the Engineer.

1.4 MANUFACTURERS' SERVICES

A. The low-voltage switchboard manufacturer shall furnish the services of a qualified field engineer and necessary tools and equipment in order to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the power system coordination study.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 GENERAL

A. The studies shall include development of single-line and impedance diagrams of the power system.

B. The diagrams shall identify components considered in the study and the ratings of power devices, including transformers, circuit breakers, relays, fuses, busses, and cables.

C. The resistances and reactances of cables shall be identified in the impedance diagram.

D. The studies shall contain written data from the electric utility company regarding maximum available short circuit current, voltage, and X/R ratio of the utility power system.

E. The studies shall include every protective device and feeder included within the Work.

F. The first upstream overcurrent device outside the Work shall be used as a fixed reference.

G. The studies shall include all portions of the electrical distribution system for normal and standby power sources down to and including the 480-volt distribution system.

3.2 SHORT CIRCUIT STUDY

A. The short circuit study shall be performed with the aid of a digital computer program, and shall be in accordance with the following Standards:

ANSI/IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
ANSI/IEEE 242	Recommended Practice for Protection, and Coordination of Industrial, and Commercial Power Systems
ANSI/IEEE C 37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
ANSI/IEEE C 37.13	Low-Voltage AC Power Circuit Breakers Used in Enclosures

3.3 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device evaluation study shall be performed in order to determine the adequacy of circuit breakers, molded case switches, and fuses.

B. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the attention of the Engineer.

C. Do not utilize series-rated circuit breakers to meet short circuit requirements for this project.

D. Devices shall be fully rated to withstand available fault currents.

3.4 PROTECTIVE DEVICE EVALUATION STUDY

A. A protective device coordination study shall be performed in order to develop the necessary calculations to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low-voltage breaker trip characteristics and settings.

B. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the Engineer's attention.

3.5 TIME/CURRENT COORDINATION CURVES

A. As a minimum, the time/current coordination curves for the power distribution system shall include the following items plotted on 5-cycle log-log graph paper:

1. time/current curves for each protective relay, circuit breaker, or fuse demonstrating graphically that the settings will provide protection and selectivity within industry standards

2. Each curve shall be identified, and tap and time dial settings shall be specified.

3. Provide individual curves for each feeder unless identical to others.

4. Selectivity

a. Time/current curves for each device shall be positioned to provide the maximum selectivity to minimize system disturbances during fault clearing.

b. Where selectivity cannot be achieved, the Engineer shall be notified as to the cause.

c. Recommendations shall be included for alternate methods that would improve selectivity.

5. time/current curves and points for cable and equipment damage.

6. circuit interrupting device operating and interrupting times

7. Indicate maximum fault values on the graph.

8. sketch of bus and breaker arrangement

9. magnetizing inrush points of transformers

10. thermal limits of dry-type and liquid-insulated transformers (ANSI damage curve)

11. Every restriction of the ANSI and National Electrical Code shall be followed, and proper coordination intervals and separation of characteristics curves shall be maintained.

3.6 ARC FLASH STUDY

A. An arc flash study shall be performed with the aid of a digital computer program in order to determine the “Arc Flash Protection Boundary” and “Personal Protective Equipment”

(PPE) levels for applicable electrical distribution equipment, stand-alone disconnects, starters, and VFDs in the power distribution system.

B. The arc flash study shall be performed in conjunction with short circuit calculations and protective device coordination.

C. The arc flash study shall be in accordance with the latest version of the following Standards:

1. NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces

2. IEEE 1584 IEEE guide for performing Arc Flash Hazard Calculations

3. OSHA (29 CFR PART 1910) Occupational Safety and Health Standards for General Industry

4. ANSI Z535.4 Product Safety Signs and Labels

D. The recommended values for the “Arc Flash Protection Boundary” and PPE levels, based on the arc flash study results, shall be tabulated in the study.

E. Labeling

1. The digital computer program shall provide the “Arc Flash Protection Boundary” and PPE values in a format that can be directly printed on to labels.

2. The Contractor shall provide these labels in accordance with Section 26 00 00 – Electrical Work, General.

3.7 FINAL SUMMARY REPORT

A. Summarize the results of the indicated power system studies in a final report.

B. The report shall include the following items:

1. single-line diagram

2. impedance diagram

3. tabulation of all protective devices identified on the single line diagram

4. time/current coordination curves

5. specific recommendations, if any

6. test instrumentation, condition, and connections, as applicable, for each study

7. computerized fault current calculations

8. any suggested changes to the protection scheme or equipment selection that will result in improved system reliability and safety

9. recommendations to minimize the arc flash energy

C. The report shall include information concerning the computer program used for the study, as well as a general discussion of the procedure, items, and data considered in the preparation of the study.

D. Submit 3 bound copies of the report to the Engineer.

3.8 PROTECTIVE DEVICE TESTING, CALIBRATION, AND ADJUSTMENT

A. Test, calibrate, and adjust the protective relays and circuit breaker trip devices in accordance with the recommendations in the power system coordination study.

B. Calibrate the MCPs as in accordance with the recommendations in the power system study.

C. Adjustments shall be made prior to energizing any electrical equipment.

END OF SECTION

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SECTION 26 12 16 – PANELBOARDS AND GENERAL PURPOSE DRY TYPE TRANSFORMERS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide panelboards and general purpose dry-type transformers, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 01 33 00 – Submittal Procedures and Section 26 00 00 - Electrical Work, General.

B. Shop Drawings

1. Transformers

a. Dimension drawings

b. Technical certification sheets

c. Drawing of conduit entry/exit locations

d. Transformer ratings, including:

1) Voltage

2) Continuous current

3) Basic impulse level for equipment over 600 volts

4) KVA

e. Descriptive bulletins

f. Product sheets

2. Panelboards

a. Breaker layout drawings with dimensions and nameplate designations

b. Component list

c. Drawings of conduit entry/exit locations

d. Assembly ratings including:

1) Short circuit rating

2) Voltage

3) Continuous current

e. Cable terminal sizes

f. Descriptive bulletins

g. Product sheets

h. Installation information

i. Seismic certification and equipment anchorage details

PART 2 -- PRODUCTS

2.1 GENERAL

A. Transformers

1. The transformers shall be dry-type, designed, manufactured, and tested in accordance with the latest applicable standards of ANSI and NEMA.

2. Transformers shall be UL-listed and bear the UL label.

B. Panelboards

1. Panelboards shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1-Panelboards, as well as the provisions of UL 50 - Safety Enclosures for Electrical Equipment and UL 67 - Safety Panelboards. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208 volt, 3 phase operation or 120/240 volt for single phase operation as indicated. Power panelboards shall be rated for 480 volts, 3 phase, 3 wire operation, unless indicated otherwise.

2. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.

2.2 TRANSFORMERS

A. Energy Efficiency: Standard dry-type transformers shall meet the energy efficiency requirements of the Department of Energy Code of Federal Regulations (10 CFR PART 431), DOE 2016 Efficiency Levels.

B. Ratings

1. KVA and voltage ratings shall be as indicated.

2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96 - Guide for Loading Dry Type Distribution and Power Transformers

3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Up to 9 kVA	40 dB
10 to 50 kVA	45 dB
51 to 150 kVA	50 dB

C. Construction

1. Insulation Systems

a. Transformers shall be insulated as follows:

1) 2 kVA and smaller: 150 deg C insulation system based upon 80 deg C rise.

2) 3 to 15 kVA: 185 deg C insulation system based upon 115 deg C rise.

3) 15 kVA and larger: 220 deg C insulation system based upon 150 deg C rise.

b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 deg C maximum ambient.

c. Insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

2. Transformer windings shall be copper.

3. Transformers shall have four 2-1/2 percent taps, 2 above and 2 below 480 volts.

4. Transformer shall include vibration dampeners between the core and the enclosure to minimize and isolate sound transmission.

D. Manufacturers: **General Electric, Eaton, Schneider Electric/Square D Company, or equal**.

2.3 PANELBOARDS

A. Ratings

1. Panelboards rated 240 VAC or less shall have short circuit ratings not less than 10,000 amperes RMS symmetrical or as indicated by the Short Circuit Study, whichever is greater.

2. Panelboards rated 480 VAC shall have short circuit ratings not less than 65,000 amperes RMS symmetrical or as indicated by the Protective Device Study, whichever is greater.

3. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

B. Construction

1. Lighting and power distribution panels shall have tin-plated copper bus bars.

2. Breakers shall be one, 2, or 3 pole as indicated, with ampere trip ratings as required by the equipment. Breakers shall be quick-make and quick-break, inverse time trip characteristics, to trip free on overload or short circuit, and to indicate trip condition by the handle position.

3. The panels shall have hinged doors with combination catch and latch. The front panels shall be so arranged that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall have inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.

4. Panelboards shall be rated for the intended voltage.

5. Circuit breakers shall be interchangeable and capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units. No plug-in circuit breakers will be acceptable.

6. Lighting and power distribution panels which are not part of a motor control center shall be constructed in accordance with Section 26 00 00 – Electrical Work, General. Panels shall have the necessary barriers, supports, and liberal wiring gutters. Trim screws shall be stainless steel. Panelboard parts of metal other than copper, aluminum, or stainless steel shall be cadmium plated.

7. Panelboards shall be UL listed except for special enclosures which are not available with UL listing.

8. Panelboards shall be suitable for use as service entrance where indicated.

C. Manufacturers: **General Electric, Eaton, Schneider Electric/Square D Company, or equal**

D. Surge Protection Devices (SPD)

1. Provide integral SPDs. SPDs shall conform to Section 26 43 00 – Surge Protection Devices.

2. SPD units shall be rated for the voltage and phase service of the panel at 120 kA per phase.

PART 3 -- EXECUTION

3.1 GENERAL

A. Work of this Section shall be installed as indicated in Section 26 00 00 – Electrical Work, General.

END OF SECTION

SECTION 26 29 00 – LOW-VOLTAGE MOTOR CONTROL CENTERS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide motor control centers (MCCs), complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 – Electrical Work, General, apply to the Work of this Section.

C. In the event that provided motors are of greater horsepower than the indicated motors, revise the raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased motor horsepower in accordance with Section 26 05 10 – Electric Motors.

D. Single Manufacturer

1. The MCCs shall be the end product of one manufacturer in order to standardize appearance, operation, maintenance, spare parts, and manufacturer's services.

2. This requirement, however, does not relieve the Contractor of overall responsibility for the Work.

E. Coordination

1. The equipment provided under this Section shall operate the electric motor driver with the driven equipment as indicated under other equipment Sections.

2. The MCC manufacturer shall be provided with the following information, at a minimum:

a. Section 46 10 00 – Equipment General Provisions

b. relevant Division 43 and Division 23 Sections for each piece of equipment driven by the MCC

c. Section 26 00 00 – Electrical Work, General

d. Section 26 05 10 – Electric Motors

e. Section 26 05 15 – Industrial Control Panels

f. Section 26 01 26 – Electrical Tests

g. the Electrical Contract Drawings

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 26 00 00 – Electrical Work, General.

B. Furnish the following equipment information in the Shop Drawings:

1. NEMA rating and color of enclosure
2. horizontal and vertical bus ampacities, voltage rating, interrupting capacity, and materials of construction
3. ground bus size and material of construction
4. conduit entrance provisions
5. main incoming line entry provision (top or bottom)
6. control unit nameplate schedule
7. circuit breaker types, frames, and settings
8. starter NEMA sizes, auxiliary contact provisions, and coil voltage
9. relays, timers, pilot devices, control transformer VA and fuse sizes
10. MCC Ladder Diagrams
    a. Furnish custom elementary schematic ladder diagrams for each compartment.
    b. The ladder diagrams shall include remote devices.
    c. Submittals not meeting these requirements will not be reviewed further and will be returned to the Contractor.
11. short circuit rating of the complete assembly
12. replacement parts lists and operation and maintenance procedures
13. seismic design certification of the anchoring system in accordance with Section 26 00 00 – Electrical Work, General
14. time-current curves for protective devices
15. RVSS and VFD Equipment Information
    a. name of starter and drive manufacturer
    b. type and complete model number
    c. assembly drawing and nomenclature, including enclosure dimensions, mounting and anchoring details, and internal layout
    d. detailed schematics, including external wiring connections
    e. maximum heat dissipation capacity in kW
    f. altitude de-rating information
16. factory test data certifying compliance with requirements of similar equipment from the same manufacturer

C. Furnish an Owner's Manual, including:

1. manufacturer's two-year warranty

2. field test report

D. Furnish the Manufacturer's Service Representative's resume, including the following documentation:

1. copy of the proposed representative's Factory Training Certificate

2. number of years experience servicing the manufacturer’s MCCs and VFDs

3. a statement that the individual is authorized to inspect, test and perform field service and repairs

E. Spare Parts List

1. Furnish spare parts information for parts required by this Section as well any other spare parts recommended by the MCC manufacturer.

F. Startup and Testing Report

1. Within 15 days after completion of startup and testing, the Contractor shall submit a report for the MCC.

2. The report shall contain the following documentation:

a. the device name, serial number, rating, and complete model number of each MCC

b. a complete listing of all tests performed and the results of each test

c. a complete listing of all circuit breaker and overload settings, fuse ratings, settings, setpoints and configuration information for VFDs and equipment or devices with adjustable settings

d. documentation for training that was provided to the OWNER’s personnel, including topics covered, instructor's name and contact information, and a list of attendees

PART 2 -- PRODUCTS

2.1 GENERAL

A. The manufacturer of the low-voltage motor control center shall also manufacture at least the following:

1. molded case circuit breakers, up to and including 225 ampere frame size

2. disconnect switches

3. magnetic motor starters

4. control and timing relays rated at 600 volts AC

5. pushbuttons, lights and selector switches, including remote mounted control stations

6. meters, including ammeter, voltmeter, and solid-state metering devices

B. Single Manufacturer

1. Devices of the same type shall be products of the same manufacturer.

2. This requirement applies to control devices, custom-fabricated equipment, and insofar as practical to equipment manufactured on a production basis.

C. Lighting transformers and panelboards shall be in accordance with the requirements of Section 26 12 16 – Panelboards and General Purpose Dry-Type Transformers.

D. Motor control centers shall conform to the standards for NEMA Class IIS, Type B diagrams and wiring.

E. MCC Schedule

MCC DESIGNATION	LOCATION
MCC-G	Grit Building Electrical Room
MCC-B (existing)	Biobrox Building Electrical Room
MCC-H (existing)	Headworks Electrical Room

2.2 DESIGN, CONSTRUCTION, AND MATERIAL REQUIREMENTS

A. The motor control centers shall be 600-volt class and suitable for operation on a 3-phase, 60-Hz system.

B. The system operating voltage and number of wires shall be as indicated.

C. Power

1. The motor control center shall receive power from a 3-phase, delta- connected 480-volt power distribution system.

2. Power distribution from the MCC shall be 480-volt, 3-phase, 3-wire.

D. Enclosure

1. The enclosure shall be of NEMA Type 1.

2. The variable frequency drive (VFD) and solid-state soft starter (RVSS) compartments may be of NEMA Type 1, gasketed, provided that ventilation inlet openings are covered by externally replaceable dust filters.

3. Compartment doors shall be interlocked with compartment circuit breakers, fitted with a maintenance override.

4. Latches for panelboard compartments shall have butterfly heads or another hand operable method that does not require tools to operate.

E. Size and Arrangement

1. Motor control centers shall be configured as mechanical groupings of control center units, assembled into a lineup of control center sections.

2. Each control section shall be nominally 90 inches tall by a minimum of 20 inches deep.

3. MCCs shall be designed to not exceed the indicated spatial requirements, including spaces, spares, and future compartments.

4. MCCs shall be subject to rejection if they exceed the indicated lengths, where allotted space is critical.

5. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing that the MCC includes the spares, space, and future provisions as indicated.

6. Switches and circuit breakers used as switches shall be located such that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6 feet, 7 inches above the floor, including the height of the concrete pad.

7. Starter compartments shall not be less than 12” high.

F. Components

1. Busses

a. Provide a continuous tin-plated copper ground bus, full width of the motor control center line-up.

b. Horizontal Busses

1) The main horizontal bus shall be of tin-plated copper, and located within an isolated compartment.

2) The bus shall be rated for 600 amperes minimum, but in no case less than the main lug or main breaker frame size.

c. Vertical Busses

1) The vertical bus in each section shall consist of a single tin-plated copper conductor per phase, with a current capacity of not less than 300 amps.

2) The vertical bus shall be completely isolated and insulated, and shall extend the full height of the section wherever possible.

d. Power buses shall be braced to withstand 65,000 amperes, minimum.

2. Wireways

a. Provide a separate vertical wireway adjacent to each vertical unit, covered by a hinged door.

b. Each individual unit compartment shall be provided with a side barrier to permit pulling wire in the vertical wireway without disturbing adjacent unit components.

c. Full height (72-inch) compartments or sections are not required to have a separate wireway.

G. Cabinets

1. Structural members shall be fabricated of not less than 12-gauge steel, and side and top panels and doors shall be fabricated of not less than 14-gauge steel.

2. Spaces designated as SPACE or BLANK shall include blank hinged doors and vertical bus bars.

3. Control units inside compartments shall be clearly identified with tags or stencil markings.

4. Identification

a. Each control unit, including spares, spaces and blanks, lights, and devices shall be identified by an engraved nameplate.

b. Identification shall include the indicated circuit number.

c. Each motor control center shall be fitted with the manufacturer's nameplate which shall include the NEMA Standard electric rating and other pertinent data, including manufacturer, sales order number, date of manufacture, and place of manufacture.

5. Fans, heat exchangers, transformers, capacitors, junction boxes, and other devices shall not be mounted on the outside of the motor control center enclosure.

6. Protective Coating

a. The finish for motor control center shall be light grey: ANSI 61 or 49.

b. The panels shall be coated with 2 coats of primer inside and out, and 2 coats of enamel finish.

c. External colors other than ANSI 61 or 49 will not be accepted.

H. Surge Protective Devices (SPDs)

1. Provide SPDs where indicated. Provide a line side circuit breaker for each SPD. SPDs and line side circuit breakers shall be rated as indicated or as required.

2. SPDs shall meet the requirements of Section 26 43 13 – Surge Protective Devices for Low-Voltage Electrical Power Circuits.

2.3 MAIN AND FEEDER CIRCUIT BREAKERS (480 V)

A. Circuit breakers having a frame size of 150 amperes or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units.

B. Circuit breakers with a frame size of 225 amperes to 1,200 amperes shall be molded case with interchangeable thermal, and adjustable magnetic trip with the following adjustments:

1. long-time setting (by changing the unit)

2. long-time delay

3. short-time setting

4. short-time delay

5. instantaneous setting

6. ground-fault setting

7. ground-fault delay

C. The interrupting capacity of the main and feeder branch circuit breakers shall be a minimum of 65,000 RMS symmetrical amperes.

D. Service disconnects rated 1000 amps or greater shall provide for ground fault protection of the equipment.

E. Circuit breaker disconnect operators shall be capable of accommodating 3 padlocks for locking in the OPEN position.

F. Circuit breaker auxiliary contacts shall be furnished where indicated.

2.4 MOTOR STARTERS

A. Motor starters shall be mounted in standard motor control center assemblies, arranged as indicated.

B. Components

1. Each motor starter unit shall consist of a combination magnetic contactor and short circuit protective device, mounted in a completely enclosed cubicle.

2. The short circuit protective device shall be an instantaneous, magnetic-only, adjustable circuit breaker, commonly described as a motor circuit protector (MCP). MCP’s shall be set within the NEC limits for short circuit protection, and shall be set to the lowest possible setting without nuisance tripping.

3. Circuit breakers provided as part of a motor starter unit shall be capable of being padlocked in the OPEN position.

4. Resetting of thermal overload elements shall be possible with the unit door closed.

5. Provide 3-phase overload trip units to suit the full load current of the equipment installed, and the trip unit shall be adjusted as required for power factor correction capacitors.

C. Magnetic Starters

1. Magnetic starters shall have auxiliary contacts as indicated, including N-O and N-C contacts as indicated, plus one each spare N-O and N-C contact.

2. The combination motor starters shall be drawout-type for Size 5 and below.

3. The fixed-type unit assembly shall be constructed such that it can be easily removed from its panel after disconnecting the wires to the terminal block and withdrawing from the primary bus.

4. Removal of a unit assembly shall be possible without rear access and without disturbing any other unit in the motor control center.

D. Control Power Transformer

1. Each starter unit shall have its own control power transformer, with a 115-volt grounded secondary.

2. Provide one secondary fuse and 2 primary fuses.

3. Control power transformers shall be sized to accommodate the indicated control devices.

4. Local control devices shall be mounted independently of the cover door.

5. Starters shall have a local red RUN indicator, and a green OFF indicator to indicate the presence of control power when the motor is not energized.

6. Starters shall be provided with elapsed time meters, HAND-OFF-AUTO selector switches, and other devices as indicated.

7. Cubicle control wires shall be terminated at a pull-apart disconnecting terminal block located at the cubicle.

E. Identification

1. The motor control center manufacturer shall be responsible for identifying each control wire within each motor starter unit with wrap-around permanent plastic markers.

2. Each control wire shall be identified at both ends.

F. Full-Voltage Starters

1. Full-voltage motor starter units shall be NEMA Size 1 or larger.

2. Each combination starter shall be rated for a minimum 65,000 RMS symmetrical amperes.

G. NEMA Ratings

1. Motor starters shall be designed to NEMA ratings.

2. Starters designed to IEC ratings or with dual IEC/NEMA ratings will not be accepted, either as part of an MCC, as remote starters, or as part of an equipment package.

H. Unless otherwise indicated, 2-speed starters shall be of the 2-winding type.

I. Variable Frequency Drives

1. Variable frequency drives (VFDs) shall be in accordance with the requirements of Section 26 29 23 – Variable Frequency Drives.

2. An externally mounted line reactor, cooling fan, and bypass contactor will not be accepted.

3. Full-voltage bypass contactors, input contactors, output contactors and other components shall be provided where indicated.

2.5 CONTROL DEVICES

A. Control devices shall be in accordance with the requirements of Section 26 05 15 – Industrial Control Panels.

B. Metering

1. Provide solid-state metering where indicated.

2. Include CTs and PTs of ratios as indicated or as recommended by the MCC manufacturer.

3. The CT leads shall terminate on shorting type terminal blocks, and the shorting bar shall be grounded to the MCC ground bus.

4. Solid-state metering shall be **G.E. "PQM", Cutler-Hammer "DP-4000," Square D "Power-Logic**," or equal.

2.6 FACTORY TESTS

A. Provide the manufacturer's standard electrical and mechanical production tests and inspections for motor control centers and their components.

B. The tests shall include electrical continuity check, dielectric tests for each circuit, and inspection for proper functioning of components including controls, protective devices, metering, and alarm devices.

2.7 SPARE PARTS

A. The Contractor shall furnish the following for each MCC:

1. Unit Control Transformer: one of each size furnished in magnetic starters installed

2. Bezels: 3 of each color installed for pilot indicators

3. Panel Lamps: one dozen of each type (form, voltage and current rating) installed

4. Control Fuses: one dozen of each type (form, voltage and current rating) installed

5. Relays: one of each type and size installed

B. Spare parts shall be identified by MCC number, type, size, and manufacturer.

2.8 MCC MANUFACTURER, OR EQUAL

A. **Cutler-Hammer "Freedom 2100" Series**

B. **General Electric "8000 Line"**

C. **Square D, Model 6**

PART 3 -- EXECUTION

3.1 GENERAL

A. The Contractor shall install motor control centers in accordance with the manufacturer's published instructions.

B. Conduit installation shall be coordinated with the manufacturer's as-fabricated drawings such that conduit stub-ups are within the area allotted for conduit.

C. Conduit shall be stubbed up in the section that contains the devices to which conductors are terminated.

3.2 STORAGE AND HANDLING

A. If stored at the Site, motor control centers shall be stored in a clean, dry space.

B. Factory wrapping shall be maintained or an additional heavy plastic cover shall be provided to protect units from dirt, water, construction debris, and traffic.

C. The storage space shall be heated or the MCC space heaters shall be energized.

D. Motor control centers shall be handled carefully to avoid damage to motor control center components, enclosure, and finish.

E. Damage shall be repaired before installation.

3.3 MANUFACTURER'S SERVICES

A. General

1. An authorized Service Representative of the manufacturer shall be present at the Site for 3 Work Days in order to provide the services listed below.

2. For the purpose of this paragraph, a Work Day is defined as an 8-hour period, excluding travel time.

3. The service representative's resume shall be approved by the Engineer before training is scheduled.

B. Inspection, Startup, Field Adjustment

1. The Service Representative shall supervise the following items, and shall certify that the equipment and controls have been properly installed, aligned, and readied for operation:

a. installation of the equipment

b. inspection, checking, and adjusting of the equipment

c. startup and field testing for proper operation

d. performance of repairs to correct any discrepancies or problems revealed during startup and testing

e. performance of field adjustments to ensure that the equipment installation and operation comply with the indicated requirements

f. Preparation and submittal of a report covering startup and testing, including a listing of equipment settings and parameters at the end of startup and testing.

3.4 INSTALLATION

a. Motor control centers shall be installed on 3-1/2-inch concrete pads and in accordance with the requirements of Section 26 00 00 – Electrical Work, General.

B. After leveling and shimming, the Contractor shall anchor motor control centers to the concrete pads, and shall grout such that no space exists between the pad and support beams.

C. The Contractor shall:

1. torque bus bar bolts to manufacturer's recommendations, and tighten sheet metal and structure assembly bolts;

2. adjust motor circuit protector (MCP) devices to the instantaneous trip setting position recommended for the actual horsepower and full load amps of the motor;

3. verify that overload devices are proper for equipment installed;

4. make necessary changes in overload devices as required for motors having power factor correcting capacitors;

5. touch up scratches after the equipment has been installed;

6. verify that nameplate, and other identification is accurate; and

7. provide high-voltage switchboard matting in front of the MCC, in accordance with the requirements of Section 26 00 00 – Electrical Work, General.

3.5 FIELD TESTS

A. Provide a visual and mechanical inspection after installation, as follows:

1. Inspect for physical damage, proper anchorage, and grounding.

2. Verify that the ratings of the thermal overload heaters match the motor full-load current nameplate data.

3. Check tightness of bolted connections.

B. Electrical Tests

1. Insulation Tests

a. Measure the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute.

b. The test voltage and minimum acceptable resistance shall be in accordance with manufacturer's recommendations.

c. Measure the insulation resistance of each starter section phase-to-phase and phase-to-ground with the starter contacts closed and the protective device open.

d. The test voltage and minimum acceptable resistance shall be in accordance with the manufacturer's recommendations.

e. Measure the insulation resistance of each control circuit with respect to ground.

2. Verify the proper operation of control logic in each mode of control.

END OF SECTION

SECTION 26 29 23 – VARIABLE FREQUENCY DRIVE UNITS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General

1. The Contractor shall provide variable frequency drive (VFD) units, complete and operable, as indicated in accordance with the Contract Documents.

2. It is the intent of this Section to require complete, reliable, and fully tested variable frequency drive systems suitable for attended or unattended operation.

B. The requirements of Section 26 00 00 – Electrical Work, General, apply to the Work of this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to standardize appearance, operation, maintenance, spare parts, and manufacturer's services.

2. This requirement, however, does not relieve the Contractor of overall responsibility for the Work.

D. Coordination

1. Equipment provided under this Section shall operate the electric motor driver and the driven equipment as indicated under other equipment specification Sections.

2. The Contractor's attention is specifically directed to the need for proper coordination of the Work under this Section and the Work under the equipment Section with the Work under Section 26 05 10 – Electric Motors.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures, except that Shop Drawing information for the drives shall be submitted as part of the information for the driven equipment.

B. Shop Drawings: Include the following information:

1. Equipment Information

a. name of drive manufacturer

b. type and model

c. assembly drawing and nomenclature

d. maximum heat dissipation capacity in kW

2. conduit entrance provisions

3. circuit breaker type, frames, and settings

4. information related to relays, timers, pilot devices, control transformer VA, dV/dT devices, line reactors and fuse sizes, including catalog cuts

5. Ladder Diagram

    a. Submit the system schematic ladder diagram and interconnection diagrams.

    b. The schematic ladder diagram shall include remote devices.

    c. The ladder diagram shall incorporate the control logic on the corresponding elementary schematic as indicated.

    d. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the Contractor stamped "REJECTED."

6. factory test data certifying compliance of similar equipment from the same manufacturer with requirements of this Section

C. The Technical Manual shall include the following documentation:

1. manufacturer's 2-year warranty

2. harmonic analysis report

3. field test report

4. programming procedure and program settings

D. Spare Parts List

1. Submit information for parts required by this Section plus any other spare parts recommended by the controller manufacturer.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The Contractor shall provide a total of 2 variable frequency drives.

B. Equipment to be operated through variable frequency drives shall include the following:

Quantity	Equipment	HP	Constant or Variable Torque (C/V)	RPM	Bypass (Y/N)	Enclosure Type
2	Intermediate Pump	20	C	1800	N	In MCC-H

2.2 EQUIPMENT

A. General

1. The power supply shall be an adjustable frequency inverter designed to convert incoming 3-phase, 480-volt, 60-Hertz power to a DC voltage and then to adjustable frequency AC by use of a 3-phase inverter.

2. Current-source inverters will not be accepted.

3. Inverters shall be sized to match the KVA and inrush characteristics of the motors actually provided.

4. The Contractor shall be responsible for matching the controller to the load (variable torque or constant torque) as well as the speed and current of the actual motor being controlled.

5. The Contractor shall provide "clean power" 18-pulse VFD's for VFDs that are operating motors greater than 50 HP.

B. Inverter

1. The inverter shall be of a voltage-source design, producing a pulse-width-modulated type output.

2. Six-step and current-source inverters will not be accepted.

3. Inverters shall be capable of delivering the nameplate horsepower exclusive of service factor without the need for mandatory thermostats or feedback tachometers.

4. The VFD shall vary both the AC voltage and frequency simultaneously in order to operate the motor at required speeds.

C. The minimum VFD inverter efficiency shall be 95 percent at 100 percent speed and load, and 85 percent efficiency at 50 percent speed and load.

D. Power Outage

1. The VFD shall shut down in an orderly manner when a power outage occurs on one or more phases.

2. Upon restoration of power and a START signal, the motor shall restart and run at the speed corresponding to the current process input signal.

E. The VFD shall be provided with the following features:

1. inrush current adjustment between 50 and 110 percent of motor full load current (factory set at 100 percent)

2. overload capability at 110 percent for 60 seconds for variable torque loads and 150 percent for constant torque loads.

3. adjustable acceleration and deceleration

4. input signal of 4 - 20 mA from process

5. output speed signal of 4 - 20 mA; Signals other than 4 - 20 mA will not be accepted.

6. Upon loss of input signal, the VFD shall operate at a preset speed.

7. a minimum of 2 selectable frequency jump points in order to avoid critical resonance frequency of the driven system.

8. additional devices and functions as indicated

9. Ethernet TCP/IP I/O communications to transmit VFD data to/from a plant PLC-based control system

F. The VFD shall be provided with, as a minimum, the following protection features:

1. input line protection with metal oxide varistor (MOV) and RC network

2. protection against single phasing

3. instantaneous overcurrent protection

4. electronic overcurrent protection

5. ground fault protection

6. overtemperature protection for electronics

7. protection against internal faults

8. ability to start into rotating motor (forward or reverse rotation)

9. additional protection and control as indicated and as required by the motor and driven equipment

G. The VFD shall be designed and constructed to satisfactorily operate within the following service conditions.

1. Elevation

a. elevation to 3300 feet

b. For elevation greater than 3300 feet, the VFD shall be derated in accordance with the manufacturer's recommendation

2. Ambient Temperature: 0 to 40 degrees C

3. Humidity: 0 to 95 percent, non-condensing

4. AC Line-Voltage Variation: plus 10 percent to minus 10 percent

5. AC Line-Frequency Variation: plus and minus 2 Hertz

H. Electrical equipment provided in addition to the adjustable frequency inverter for each drive shall include:

1. 2-1/2-percent (minimum) line reactor integral to the drive enclosure.

2. Provide a dV/dT filter device at the motor or VFD output per the manufacturer’s recommendation. Submit documentation demonstrating where such devices are required, along with mounting and cabling requirements.

3. fused 480-to-120-volt control transformer to provide system control power for the logic and pilot lamps.

4. Provide an input circuit breaker.

5. Heaters

    a. Provide overload heaters with auxiliary contacts in order to protect the motors in both VFD and bypass modes.

    b. Refer to the Elementary Schematics indicated on the Drawings.

    c. The heaters shall be sized for the motor actually being provided.

I. Inverter Signal Circuits

1. The inverter signal circuits shall be isolated from the power circuits and shall be designed to accept an isolated 4-20 mA signal in the automatic mode of operation.

2. The inverter shall follow the setting of a remote or local potentiometer control while in the manual mode.

3. Refer to the Elementary Schematic indicated on the Drawings for speed control and START/STOP methods.

4. Access to set-up and protective adjustments shall be protected by key-lockout.

5. The following operator monitoring and control devices for the inverter shall be provided on the face of the VFD enclosure, either as discrete devices or as part of a multi-function microprocessor-based keypad access device:

    a. AUTO/HAND selection switch

    b. While in AUTO, the inverter shall operate from the remote ethernet input, and while in HAND control shall operate from a local speed potentiometer.

    c. speed indicator calibrated in percent speed

    d. inverter fault trip pilot light and output alarm contacts

    e. trip reset pushbutton

    f. RUN and OFF indicating lights

    g. Provide other controls and readouts as indicated on the Elementary Schematics indicated on the Drawings.

J. Properly identified screw type terminal boards shall be provided for interconnection to remote controls and instrumentation.

K. Pilot devices, control relays, time delay relays, elapsed time meters, and indicators provided as a part of the VFD equipment package shall meet the applicable requirements of Section 26 05 15 – Industrial Control Panels.

2.3 HARMONIC ANALYSIS FOR DRIVES

A. The Contractor shall perform a harmonic study of the facilities included in this Project.

B. The following assumptions shall be utilized for the harmonic analysis:

1. The distribution system is a "general" system as classified by IEEE 519 under low voltage systems.

2. Assume 90 percent of total plant operating load is motor load and 10 percent is resistive.

3. Assume a 70 percent plant diversity factor (i.e., 70 percent of the total plant load is operating), with motors other than VFDs operating at 90 percent of their nameplate horsepower.

4. Assume all VFDs are operating

5. Report

a. Results of the harmonic analysis shall be submitted prior to VFD shipment.

b. Excessive harmonic distortion shall be specifically denoted.

c. Corrective measures shall be submitted for action by the Engineer.

2.4 SPARE PARTS

A. The Contractor shall furnish the spare parts listed below, suitably packaged and labeled with the corresponding equipment number.

B. Modified Parts

1. At any time prior to Substantial Completion, the Contractor shall notify the Engineer in writing about any manufacturer's modification of spare part numbers, interchangeabilities, or model changes.

2. If the Engineer determines that the modified parts no longer apply to the equipment provided, the Contractor shall furnish other applicable parts as part of the Work.

C. The following spare parts shall be furnished:

1. Provide one set of spare power fuses of each form, voltage, and current rating.

2. Provide 10 spare control and power fuses of each type and rating.

3. Provide 10 panel lamps of each type (form, voltage, and current rating).

4. Provide one of each type of circuit board, as applicable:

a. control board

b. power board

c. diode bridge

d. transistor module

5. Provide one of each size and type power diode and transistor.

6. Provide one set of any special tools required for maintenance of the VFD units

2.5 Manufacturers, or equal

A. **Eaton**

B. **Mitsubishi**

C. **Rockwell Automation**

PART 3 -- EXECUTION

3.1 MANUFACTURER'S SERVICES

A. General

1. An authorized service representative of the manufacturer shall be present at the Site for 3 Days to furnish the services listed below.

2. For the purpose of this Paragraph, a Day is defined as an 8-hour period excluding travel time.

B. The authorized service representative shall supervise the following and shall certify that the equipment and controls have been properly installed, aligned, and readied for operation:

1. installation of the equipment

2. inspection, checking, and adjusting the equipment

3. startup and field testing for proper operation

4. performing field adjustments such that the equipment installation and operation comply with requirements

C. Instruction of Owner's Personnel

1. The authorized representative shall instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with test equipment.

2. The instruction shall be specific to the VFD models provided.

3. Training shall be scheduled a minimum of 3 weeks in advance of the first session.

4. Training shall include individual sessions for 4 shifts of plant personnel.

5. Proposed training materials shall be submitted for review, and comments shall be incorporated.

6. Training materials shall remain with the trainees.

7. The Owner may videotape the training for later use with the Owner's personnel.

3.2 INSTALLATION

A. Conduit stub-ups for interconnected cables and remote cables shall be located and terminated in accordance with the drive manufacturer's recommendations.

B. Programming

1. The Contractor shall perform programming of drive parameters required for proper operation of the VFDs included in this project.

2. Submit records of programming data in the equipment Technical Manual, including setup and protective settings.

3.3 FIELD TESTING

A. Testing, checkout, and startup of the VFD equipment in the field shall be performed under the technical direction of the manufacturer's service engineer.

B. Under no circumstances shall any portion of the drive system be energized without authorization from the manufacturer's representative.

C. Verify proper operation of control logic in every mode of control.

D. Harmonic Analysis

1. The Contractor shall test the completed installation for actual harmonic distortion at the point of common coupling.

2. Harmonic analysis shall be performed in accordance with IEEE 519 - Harmonic Control and Reactive Compensation of Static Power Converters at unit full load using a harmonic analyzer by **Fluke**, or equal

3. Tests shall demonstrate that the harmonic voltage and current distortion levels at the point of common coupling do not exceed a magnitude of 5 percent of the fundamental, with the maximum number of drives, as permitted by the process, in operation and in conformance with the applicable requirements of IEEE-519.

4. Provide a report that shall include the following:

a. expected harmonic voltage (THD) through the 35th harmonic, calculated with isolation transformers

b. actual RMS value and measured percentage of the THD in the field

c. suggested corrective action(s) where measured harmonics exceed the limits specified herein

END OF SECTION

SECTION 26 41 23 - LIGHTNING PROTECTION SYSTEM

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor, through a qualified Subcontractor, shall design and provide a lightning protection system, complete and operable, as indicated in accordance with the Contract Documents.

B. The lightning protection Subcontractor shall be certified by the Lightning Protection Institute (LPI), for both the design and the installation of the lightning protection system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes

NFPA 780 Standard for the Installation of Lightning Protection Systems

NFPA 70 National Electric Code

UL 96A Lightning Protection Components

LPI-175 Lightning Protection Institute Installation Code

1.3 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings in accordance with the requirements of Sections 01 33 00 – Submittal Procedures and 26 00 00 – Electrical Work, General.

1. Products: Furnish manufacturer’s catalog data for all materials.

2. Drawings

a. Furnish a scaled drawing of the facility showing the lightning protection system.

b. The drawing shall show, at a minimum:

1) the location of air terminals

2) the routing of conductors

3) connections to the electrical grounding system and ground rods

4) details of air terminal mounting and bonding to vents, chimneys, antennas, and other metallic structures

3. Cross-reference the materials provided with the manufacturer’s catalog numbers and cuts.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Products shall be UL-listed for use in lightning protection systems.

B. Products shall be Class I for structures not greater than 75 feet high and Class II for structures higher than 75 feet.

C. Air terminals for aluminum roofs or structures shall be of aluminum construction.

D. Air Terminals

1. Air terminals shall project a minimum of 10 inches above the objects protected, and shall be located at intervals not exceeding 20 feet along ridges and around the perimeter of flat roof or gently sloping roofs.

2. Flat or gently sloping roofs exceeding 50 feet in width shall be provided with additional air terminals at intervals not exceeding 50 feet on the flat or gently sloping area.

3. Locate air terminals within 24 inches of the roof edge and outside corners of the protected area.

4. Provide air terminals for metal stacks, flues, and mechanical equipment having a metal thickness of less than 3/16 inch and not within a zone of protection of an air terminal.

5. Equipment with a metal thickness 3/16 inch or greater shall be bonded in accordance with code requirements.

6. Air terminals shall be No. 71, 1/2-inch by 24-inch (or longer, as required), constructed of solid copper, and shall use air terminal bases of cast bronze construction for non-aluminum roofs.

E. Conductors

1. Structures Less than 75 Feet High

a. With Aluminum Roofs

1) Main size conductors on the roof shall be No. A28, Class I aluminum lightning conductor, consisting of 28 strands of 14 AWG aluminum wire weighing 115 lbs. per 1000 feet.

2) Secondary bonding conductors shall be No. A10, secondary bonding conductor, consisting of 10 strands of 14 AWG aluminum wire.

3) Down Conductors

a) Down conductors shall be No. 29, Class I copper lightning conductor.

b) Conceal down conductors in exterior wall construction.

c) Use bimetallic connectors for the transition from aluminum roof conductors to copper down conductors.

4) Provide buildings over 60 feet high with a conductor counterpoise cable constructed of 29/17 copper in conformance with NFPA code requirements.

b. With Non-Aluminum Roofs

1) Main size conductors on the roof shall be No. 29, Class I copper lightning conductor, consisting of 29 strands of 17 AWG copper wire weighing 190 lbs. per 1000 feet.

2) Secondary bonding conductors shall be No. 14, secondary bonding conductor, consisting of 14 strands of 17 AWG copper wire.

3) Down Conductors

a) Down conductors shall be No. 29, Class I copper lightning conductor.

b) Conceal down conductors in exterior wall construction.

4) Provide buildings over 60 feet high with a conductor counterpoise cable constructed of 29/17 copper in conformance with NFPA code requirements.

2. Structures Higher than 75 Feet

a. With Aluminum Roofs

1) Main size conductors on the roof shall be No. A37, Class II aluminum lightning conductor, consisting of 37 strands of 13 AWG aluminum wire weighing 190 lbs. per 1000 feet.

2) Secondary bonding conductors shall be No. A10, secondary bonding conductor, consisting of 10 strands of 14 AWG aluminum wire.

3) Down Conductors

a) Down conductors shall be No. 28, Class II copper lightning conductor.

b) Conceal down conductors in exterior wall construction.

c) Use bimetallic connectors for the transition from aluminum roof conductors to copper down conductors.

4) Provide buildings over 60 feet high with a conductor counterpoise cable constructed of 28/14 copper in conformance with NFPA code requirements.

b. With Non-Aluminum Roofs

1) Main size conductors on the roof shall be No. 28, Class II copper lightning conductor, consisting of 28 strands of 14 AWG copper wire weighing 375 lbs. per 1000 feet.

2) Secondary bonding conductors shall be No. 14, secondary bonding conductor, consisting of 14 strands of 17 AWG copper wire.

3) Down Conductors

a) Down conductors shall be No. 28, Class II copper lightning conductor.

b) Conceal down conductors in exterior wall construction.

4) Provide buildings over 60 feet high with a conductor counterpoise cable constructed of 28/14 copper in conformance with NFPA code requirements.

F. Miscellaneous Hardware

1. Provide miscellaneous hardware as may be required for the installation of the lightning protection system.

2. The hardware shall be compatible with the indicated air terminal and conductor materials.

3. Nuts, bolts, and other fasteners shall be constructed of stainless steel.

G. Corrosion Protection

1. Provide corrosion protection at the junctions of dissimilar metals and at locations where the components of the lighting protection system may be subjected to corrosion.

2. Use bimetallic connectors and fittings for splicing and bonding dissimilar metals.

3. Bimetallic connectors shall be located not less than 18 inches above grade.

4. Copper components within 24 inches of a chimney or vent emitting corrosive gases shall be protected by a hot-dipped lead coating or by another method as approved by the Engineer.

H. Grounding Materials

1. Ground rods and ground conductors shall conform to the requirements of Section 26 05 26 – Grounding.

2. Down conductors shall be connected to the ground rods using exothermic weld connections.

I. Structural Steel System

1. Structural steel may be substituted for down conductors.

2. The main steel columns shall be grounded an average maximum distance of 60 feet using Class II material.

3. Roof penetrations from steel to perimeter cables shall be at intervals not exceeding 100 feet in accordance with the requirements of UL 96A, LPI 175, and NFPA 780.

4. Use exothermic welds for steel connections.

PART 3 -- EXECUTION

3.1 GENERAL

A. The lightning protection system shall be installed in accordance with applicable code requirements by a Subcontractor certified in the following organizations:

1. NFPA

2. LPI

3. UL

B. Bends in conductors shall be gradual, utilizing a radius of 8-inches or greater and forming an angle of at least 90 degrees.

3.2 ROOF PENETRATIONS

A. Roof penetrations shall be made using a conduit sleeve passing through a pitch pocket.

B. The Contractor shall construct the pitch pockets in such a way as to maintain the roofing warranty required under Division 7 in full force.

3.3 INTERCONNECTIONS OF METALS

A. Metal bodies within 6 feet of the conductor shall be bonded to the system with approved fittings and conductor.

B. Bonding of metallic objects and systems at roof levels and elsewhere on the structure shall be complete.

C. The primary bonds for metal bodies of conductance, which shall include the following items, shall be bonded with appropriate fittings and full-size conductor:

1. roof exhaust fans

2. HVAC units with related piping ductwork

3. exhaust vents and other roof piping systems

4. cooling towers and rail systems

5. window-washing tracks

6. antenna masts for TV, radio, or microwave

7. flag poles

8. roof handrails

9. decorative screens

10. roof ladders

11. skylights

12. metal plumbing stacks

D. Exterior architectural metal fascia, curtain walls, or mullions, which extend the full height of the structure, shall be bonded, if not inherently bonded through the building frame.

E. Metal Bodies of Conductance

1. Metal bodies of inductance located within 6 feet of a conductor or object with secondary bonds shall be bonded with secondary cable and fittings.

2. Typical of these are:

a. roof flashings

b. parapet coping

c. gravel guards

d. isolated metal building panels or siding

e. roof drains and down spouts

f. roof insulation vents

g. other sizeable miscellaneous metal fabrications

3.4 INSPECTION AND ACCEPTANCE

A. The lightning protection system shall be inspected, tested, and certified.

B. The Contractor shall retain the services of an independent inspector.

C. An LPI/UL Certificate of Inspection shall be furnished to the Engineer.

END OF SECTION

SECTION 26 43 00 - SURGE PROTECTION DEVICES (SPD)

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).

B. SPDs furnished under this Section shall be ANSI/UL 1449 Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

C. The requirements of Section 26 00 00 – Electrical Work, General, apply to the Work of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Standards:

1. ANSI/UL 1449, Fourth Edition, Safety Surge Protective Devices

2. IEEE C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits

3. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connect to Low-Voltage (1000V and Less) AC Power Circuits

4. UL 1283, Safety Electromagnetic Interference Filters

5. NFPA 70, National Electric Code

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.

C. Product Data:

1. Manufacturer’s technical information, including catalog information.

2. Manufacturer's technical specifications with assembly and component ratings.

D. Certifications: Certification that SPD devices comply with standards referenced in this Section.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have at least five (5) years' experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least 5 installations in satisfactory operation for at least five (5) years each.

B. Component Supply and Compatibility:

1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.

2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.

3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

PART 2 -- PRODUCTS

2.1 GENERAL

A. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.

B. SPD shall be suitable for operation under the following environmental conditions:

1. Relative Humidity: Zero to 95%, non-condensing

2. Frequency: 47 to 63 Hz

3. Temperature: Zero to 149°F

4. SPD operating voltage shall be suitable for the associated SPD location(s).

5. SPD shall be suitable for internal and external mounting. SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:

a. Section 26 00 00 – Electrical Work, General

b. Section 26 29 00 – Low Voltage Motor Control Centers

c. Section 26 12 16 – Panelboards and General Purpose Dry Type Transformers

C. SPD shall include a surge suppression path for each mode as required for the system configuration. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit current rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:

1. Line-to-line

2. Line-to-neutral

3. Line-to-ground

4. Neutral-to-ground

D. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.

E. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115% of nominal system operating voltage.

F. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	**208Y/120**	**480Y/277**
L-N,L-G, N-G	800	1200
L-L	1200	2000

G. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	**Application**	**Per Phase**	**Per Mode**
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

H. Provide SPD equipped with the following accessories:

1. Surge counter with display for indicating the number of surges detected.

2. LED indicators for monitoring device status.

3. Audible alarm and silence switch for indicating an inoperative condition.

4. Dry contacts, “form C”, for remote annunciation of unit status.

I. Source Quality Control: Perform manufacturer’s standard factory tests on equipment. Tests shall be in accordance with ANSI/UL 1449.

J. Manufacturers: **General Electric, Schneider Electric/Square D Company, or equal**

PART 3 -- EXECUTION

3.1 GENERAL

A. Install SPD in accordance with equipment manufacturer’s written recommendations and instructions and the Contract Documents.

B. Where an SPD cannot be installed integral with the equipment to which it is connected, conductor length between suppressor and connection point shall be as short and as straight as possible.

END OF SECTION

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SECTION 26 50 00 - LIGHTING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Codes

NFPA 70	National Electric Code
NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum)
UL-595	Standard for Safety Marine-Type Electric Lighting Fixtures
UL-924	Standard for Safety Emergency Lighting and Power Equipment

1.3 CONTRACTOR SUBMITTALS

A. Furnish the following product information in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Furnish the following information:

1. Interior Luminaires
    a. Catalog data sheets and photos
    b. Luminaire finish and metal gauge
    c. Lens material, pattern, and thickness
        1) Candlepower distribution curves in 2 or more planes
    d. Candlepower chart, 0 to 90 degrees
    e. Lumen output chart
    f. Average maximum brightness data in foot-lamberts
    g. Coefficients of utilization for zonal cavity calculations
    h. Mounting or suspension details
    i. Heat exchange and air handling data
2. Exterior Luminaires
    a. Catalog data sheets and photos
    b. Luminaire finish and metal gauge

c. Lens material, pattern, and thickness

d. IES lighting classification and isolux diagram

e. Fastening details to wall

3. Lamps

a. Voltages

b. Colors

c. Approximate life (in hours)

d. Approximate initial lumens

e. Lumen maintenance curve

f. Lamp type

4. Photocells

a. Voltage and power consumption

b. Capacity

c. Contacts and time delay

d. Operating levels

e. Enclosure type and dimensions

f. Temperature range

PART 2 -- PRODUCTS

2.1 LUMINAIRES

A. General

1. Additional Work requirements are indicated in the Luminaire Schedule on the Drawings.

2. Where normal use lighting is provided with integral emergency battery option, provide additional hot (unswitched) wire to the luminaire.

B. Provide minimum 18 AWG wire leads with fused inputs.

C. Provide components that are accessible and replaceable without removing the luminaire from the ceiling.

D. Exterior Installations

1. Installations shall be UL-labeled as "Suitable for Wet Locations."

2. When factory-installed photocells are provided, the entire assembly shall be UL-labeled.

E. Emergency Lighting

1. Power Pack

a. Self-contained

b. 120/277 V

c. Battery as per luminaire schedule

d. Indicator switch in accordance with the requirements of UL 924

2. Lighted, push-to-test pushbutton and indicator

3. Capability of providing full illumination for 1-1/2 hours in emergency mode

4. Capability of full recharge in 24 hours, automatically initiated upon resumption of normal line voltage

5. Capability of protecting against excess charging and discharging

6. Solid state charger

7. Normal and emergency led indicating lights

8. Mounting stand (as applicable)

9. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

F. Exit Signs

1. Internally illuminated

2. Universal mounting type

3. Battery as per luminaire schedule

4. Battery charger

5. LED-type emergency and normal indicating lights

6. Press-to-test button

7. Directional arrows

2.2 LAMPS

A. See Luminaire Schedule

2.3 LIGHTING CONTROL

A. Photocell

1. Photo Control: automatic ON-OFF switch

2. Housing: self-contained; die-cast aluminum; unaffected by moisture, vibration, or temperature changes

3. Settings: ON at dusk; OFF at dawn

4. Provide a time delay feature in order to prevent false switching.

5. Field-adjustable to control operating levels

6. Manufacturer, or Equal

a. **Tork**

b. **Paragon**

PART 3 -- EXECUTION

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.

2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to the building as required to safely mount the luminaire.

4. Install the luminaire plumb and level.

5. The mounting heights indicated for wall-mounted or pendant-mounted luminaires are from the bottom of the luminaire to finished floor or finished grade, whichever is applicable.

6. Install each luminaire outlet box with a galvanized stud.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

2. Space single-stem hangers on continuous-row fluorescent luminaires 48 inches apart.

3. Provide twin-stem hangers on single luminaires.

C. Unfinished Areas

1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.

2. Luminaire Suspension

    a. Provide 3/8-inch threaded galvanized steel hanger rods.

    b. Scissor-type hangers will not be accepted.

3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.2 LAMPS

A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 CLEANUP

A. Remove labels and other markings, except the UL listing mark.

B. Wipe the luminaires inside and out in order to remove construction dust.

C. Clean the luminaire plastic lenses with an antistatic cleaner only.

D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.

E. Replace defective lamps at the Date of Substantial Completion.

END OF SECTION

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SECTION 31 10 00 - SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes all those measures required during the Contractor's initial move onto the site to protect existing fences, structures and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees or other objects dislodged during the construction process: clearing, grubbing and stripping; and regrading of areas to receive embankment fill.

B. The Contractor is required to protect and preserve all things designated to remain. Where Contractor's operation causes damage or injury to trees and plants designated to remain, an arborist or other qualified professional shall be employed by the Contractor, at no additional cost to the Owner, to repair the damage or provide adequate replacement to the Owner's satisfaction where damage is beyond repair.

1.2 SITE INSPECTION

A. Prior to moving onto the Project site, the Contractor shall inspect the site conditions and review maps of the existing plant site and off-site pipeline routes and facilities delineating the Owner's property and right-of-way lines.

B. Contractor shall submit photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site preparation.

C. The Contractor shall identify and accurately locate utilities and other subsurface structural, electrical, and mechanical conditions. Existing conditions shall be incorporated into the record drawings for the project.

1.3 DEFINITIONS

A. The following definitions apply to the Work of this Section:

1. Clearing is defined as cutting trees, removing fences and posts, removing curbs and other improvements to prepare the site for grubbing and stripping.

2. Grubbing is defined as the below grade part of clearing to remove roots, small piping, irrigation systems, etc., to prepare the site for stripping.

3. Stripping is defined as removing a surface layer of soil and organic material, sod, topsoil, and other unsuitable material as defined in Section 31 30 00 – Earthwork, to a depth that earthwork can proceed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TREE PROTECTION

A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.

2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.

B. Do not excavate within drip line of trees, unless otherwise indicated.

C. Where excavation for new construction is required within drip line of trees, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.

2. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.

4. Cover exposed roots with wet burlap to prevent roots from drying out. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.

1. Employ a qualified arborist, licensed in jurisdiction where project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.

2. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.3 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.

2. Arrange to shut off indicated utilities with utility companies.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Engineer's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.4 PRIMARY PLANT SITE ACCESS

A. Develop any necessary access to the site, including barrier facilities to be installed at the beginning of construction in order to prohibit entry of unauthorized persons.

B. Utility Interference: Where existing utilities interfere with the Work of this Section, notify the Engineer and work around the interferences until a directive is issued.

3.5 CLEARING, GRUBBING, AND STRIPPING

A. All construction areas shall be cleared of grass and weeds to at least a depth of six inches and cleared of structures, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the Work's subsequent usefulness or obstruct its operation. Loose boulders within 10 feet of the top of cut lines shall be incorporated in landscaping or removed from the site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction, as directed by the Engineer.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove all stumps, roots, buried logs, and all other objectionable material. Debris or waste shall be totally removed if they are found on the site. All objectionable material from the clearing and grubbing process shall be removed from the site and wasted in approved safe locations in compliance with state and federal regulations.

C. The area to be affected by construction that have not been pre-excavated to the subgrade elevation shall be removed and placed in the designated stockpile areas, and/or incorporated into landscaped areas or other nonstructural embankments.

D. For all areas that have not been previously disturbed, including staging areas and temporary construction easements, topsoil-salvaging operation shall immediately follow clearing operations. The area shall be stripped of topsoil to a depth of 8 inches. Unsuitable materials, specified in Section 31 30 00, shall not be considered topsoil. The Contractor shall strip to the depth indicated regardless of the material encountered. All stripped topsoil shall be stockpiled within stripped areas in stockpiles not to exceed 15 feet in height. Vegetation shall be ground or chipped to a mulching consistency and mixed with the stripped soil. Stockpiles shall be placed away from high construction traffic areas and shall be fenced and signed to prevent accidental use as fill prior to topsoil replacement.

E. Upon completion of Work within the construction areas stripped of topsoil, the stored topsoil shall be respread over the disturbed areas. Topsoil shall be spread in about a 6-inch layer. Respread topsoil shall match the existing terrain as much as possible. Interfaces between restored disturbed areas and undisturbed areas shall be chain

dragged to eliminate obvious edges. All tracks and equipment marks shall be chain dragged or hand raked away. Replaced topsoil shall be thoroughly watered for dust control upon completion of the respreading operations. Once topsoil replacement has been completed, no vehicles or other motorized equipment shall be allowed to travel on the finished surface.

F. Unless otherwise indicated, native trees larger than three inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if not necessary for the Contractor's choice of means and methods, shall be arranged with the property owner and be removed and replaced at no increased cost to the Owner.

G. Except in areas to be excavated, holes and other holes resulting from Work of this section shall be backfilled with suitable material in accordance with Section 31 30 00 – Earthwork.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 30 00 - EARTHWORK

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all earthwork indicated and required for construction of the Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

29 CFR 1926	OSHA Safety and Health Regulations for Construction
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM D 422	Method for Particle-Size Analysis of Soils
ASTM D 1556	Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2,700 kN-m/m^3)
ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2901	Test Method for Cement Content of Freshly Mixed Soil Cement
ASTM D 2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods
ASTM D 4253	Test Methods for Maximum Index Density of Soils using a Vibratory Table
ASTM D4254	Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4832	Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D 5971	Practice for Sampling Freshly Mixed Controlled Low Strength Material (CLSM)

ASTM D 6023	Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)
ASTM D 6024	Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application
ASTM D 6103	Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)

1.3 CONTRACTOR SUBMITTALS

A. The Contractor's attention is directed to the provisions of Subpart P, 29 CFR 1926 of the OSHA Safety and Health Standards for Construction, which relate to protection of employees in excavations. The Contractor shall submit, for information to the Engineer, the project excavation plan and the name of the Contractor's competent person, prior to commencing any excavation.

B. Submit samples of all materials proposed to be used in the work in accordance with the requirements in Section 01 33 00 - Submittal Procedures. Sample sizes shall be as determined by the testing laboratory.

C. Submit dewatering and water removal plan prior to performing any dewatering or water removal.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General: Fill, backfill, and embankment materials shall be suitable material.

B. Suitable Materials: Suitable material is defined as selected or processed clean, well graded earth material, sands and gravels free of excessive fines, less than 20 percent rock and boulders larger than 4 inches, grass, roots, brush, vegetation, or other deleterious materials.

C. Fill and backfill materials within 6 inches of any structure or pipe shall be smaller than 1 inch in any dimension.

1. Suitable materials may be obtained from onsite excavations, may be processed onsite materials, or may be imported. If imported materials are required by this Section or to meet the quantity requirements of the Project, provide the imported materials at no additional expense to the Owner, unless a unit price item is included for imported materials in the bidding schedule. Onsite materials shall be stockpiled and segregated prior to use.

2. The following types of suitable materials are defined:

Type A (Granular Backfill): Crushed rock or gravel, and sand well graded and readily compacted, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
No. 40	15 - 60

No. 200 0 - 15

Type B (Crushed Rock): Manufactured angular, crushed rock, non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/8-inch	100
No. 4	30 - 50
No. 200	0 - 5

Type C (Sand Backfill): Sand non-plastic, meeting the following gradation requirements:

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	80 - 100
No. 10	30-50
No. 40	10-30
No. 200	7 - 15

Squeegee is not acceptable as sand backfill.

Type D (Select Backfill): Suitable material that can be readily compacted and meets the requirements of AASHTO M 145 classification A-1-a, non-plastic, well graded with a maximum particle size of 2 inches.

Sieve Size	Percentage Passing
2-inch	100
No. 10	30-50
No. 40	15-30
No. 200	0 - 15

Type E (Pea Gravel Backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a No. 4 sieve.

Type F (Drainrock): Crushed rock or gravel conforming to one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing		
Sieve Size	3-inch Max.	2-inch Max.	3/4-inch Max.
3-inch	100	-	-
2-inch	90 - 100	100	-
1-1/2 inch	70 - 100	90 – 100	-
3/4 inch	0 - 50	0 – 15	100
1/2-inch	-	-	95 - 100
3/8-inch	0 - 10	0 - 5	70 - 100
No. 4	0 - 25	-	-
No. 8	0 - 5	-	-
No. 200	0 - 3	-	0 - 3

Type G (Type II Aggregate Base): Well-graded, clean, hard, tough, durable, and sound mineral aggregates consisting of crushed stone, or crushed gravel, free of organic matter and contamination from chemical or petroleum products meeting State specification requirements and conforming to the following Table and gradations:

Aggregate Properties			
	Aggregate Class		
	A	B	
Dry Rodded Unit Weight	Not less than 75 lb/ft^3		AASHTO T 19
Liquid Limit/Plastic Index	Non-plastic	PI $\leq$ 6	AASHTO T 89 AASHTO 90
Aggregate Wear	Not to exceed 50 percent		AASHTO T 96
Gradation	Table 2		AASHTO T 11 AASHTO T 27
CBR with a 10 lb surcharge measured at 0.20 inch penetration	70% Minimum	N/A	AASHTO T 193
Two Fractured Faces	50% Min	N/A	AASHTO T 335

Sieve Size	Percentage Passing
1 ½ -inch	100
1-inch	90 - 100
3/4-inch	70 - 85
1/2-inch	65 - 80
3/8-inch	55 - 75
No. 4	40 - 60
No. 16	25 - 40
No. 200	8 - 13

Type H (Graded Drainrock): Graded drainrock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting and drying. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	Percentage Passing
1-inch	100
3/4 inch	90 - 100
3/8-inch	40 - 100
No. 4	25 - 40
No. 8	18 - 33
No. 30	5 - 15
No. 50	0 - 7
No. 200	0 - 3

Type I: (Levee Material): Clayey sand to sandy clay obtained from off-site borrow sources or from onsite excavations, processed to the extent required to produce a material with a maximum size of 4 inches, well-graded from coarse to fine, and free from roots, sticks, organic matter, concrete, asphalt and other deleterious material. Levee material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
4-inch	100
No. 4	50 - 70
No. 200	30 - 50

Type J (Cement-Treated Backfill): Material which consists of Type F material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901.

The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633.

Type K (Topsoil): Stockpiled topsoil material which has been obtained at the site by removing soil to a depth as defined in Section 31 10 00 - Site Preparation. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

Type M (Aggregate Subbase): Crushed rock aggregate subbase material non-plastic that can be compacted readily by watering and rolling to form a stable base. The sand equivalent value shall not be less than 18 and shall meet one of the following gradation requirements, as shown on the Drawings or approved by the Engineer:

	Percentage Passing	
Sieve Size	3-inch Max.	2-inch Max.
3-inch	100	-
2-inch	90 - 100	100
1-1/2 inch	-	95 - 100
1-inch	70 - 90	-
No. 4	30 - 65	30 - 65
No. 16	15 - 40	15 - 40
No. 200	2 - 12	2 - 12

Type N (trench plug): Low permeable fill material, a nondispersable clay material having a minimum plasticity index of 10.

Type O (Controlled Low Strength Material (CLSM)): CLSM shall consist of a mixture of portland cement, aggregate, fly ash, water, and approved admixtures conforming to the following requirements:

3. Blended Hydraulic Cement: Comply with ASTM C595, Type IL (10) (MS), grey color.

4. Aggregate: Clean imported sand and gravel or selected material from the excavation, imported material, or a combination thereof as approved by the Engineer. Maximum aggregate size shall be 1 to 3 inches. The soluble sulfate content of aggregate in the mixture shall not exceed 0.3 percent by dry weight.

5. Water: Potable quality.

6. Fly Ash: Class C, ASTM C 618 or approved alternate.

7. The minus 200 sieve fraction shall be nonplastic, as defined by ASTM D 4318. By this standard, a soil is considered nonplastic if either the liquid or plastic limit cannot be determined, or if the plastic limit is equal to or greater than the liquid limit.

8. Proportion the CLSM to be a flowable, nonsegregating, self-consolidating low shrink slurry. The Contractor shall determine the materials and proportions used to meet the requirements of these Specifications.

9. The unconfined compressive strength at 7 days shall be a minimum of 100 psi and a maximum of 300 psi. Contractor shall form a minimum of six test cylinders with proposed materials to confirm design strength and mix design. Four of the cylinders shall be broken at 7 days in conformance with applicable concrete cylinder specifications and results provided to Engineer. The remaining two cylinders shall be

broken by Contractor at discretion of Engineer. Initial mix design and cylinder breaks shall be completed at least 21 days prior to use of the material on the jobsite. Final mix approval and use of the material shall not occur prior to confirmation of strength by the cylinder breaks.

10. The temperature of the CLSM discharged into the trench shall be below 90 degrees F.

11. CLSM backfill under concrete structures shall be protected during curing as specified Section 03 31 00 - Cast-in-Place Concrete.

12. CLSM shall be tested in accordance with ASTM D 4832, ASTM D 5971, ASTM D 6023, and ASTM D6103

Type P: (Suitable Trench Backfill): Suitable material that can be readily compacted, with less than 35 percent passing the No. 200 sieve and a plasticity index of 10 or less.

2.2 UNSUITABLE MATERIAL

A. Unsuitable materials include but are not limited to the materials listed below.

1. Soils which, when classified under ASTM D 2487 - Classification of Soils for Engineering Purposes, fall in the classifications of Pt, OH, CH, MH, or OL.

2. Soils which cannot be compacted sufficiently to achieve the density indicated for the intended use.

3. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, slag, and any material which may be classified as hazardous or toxic according to applicable regulations.

4. Soils that contain greater concentrations of chloride or sulfate ions, or have a soil resistivity or pH less than the existing onsite soils.

5. Topsoil, except as allowed below.

B. All unsuitable excavated material shall be disposed off site.

2.3 USE OF FILL, BACKFILL, AND EMBANKMENT MATERIAL TYPES

A. Use the types of materials as designated herein for all required fill, backfill, and embankment construction hereunder.

B. Where these Specifications conflict with the requirements of any local agency having jurisdiction or with the requirements of a pipe material manufacturer, notify the Engineer immediately. In case of conflict between types of pipe embedment backfills, use the agency-specified backfill material if that material provides a greater degree of support to the pipe, as determined by the Engineer. In case of conflict between types of trench or final backfill types, use the agency-specified backfill material if that material provides the greater in-place density after compaction.

C. Fill and backfill types shall be used in accordance with the following provisions:

1. Embankment fills shall be constructed of Type P material, as defined herein, or any mixture of Type P and Type A through Type F materials.

2. Pipe zone backfill, as defined under "Pipe and Utility Trench Backfill" below, shall consist of the following materials for each pipe material listed below.

    a. Mortar coated pipe, concrete pipe, and uncoated ductile iron pipe shall be provided with Type A or C material in the pipe zone.

    b. Coal tar enamel coated pipe, polyethylene encased pipe, tape wrapped pipe, and other nonmortar coated pipe shall be backfilled with Type C material in the pipe zone.

    c. Plastic pipe and vitrified clay pipe shall be backfilled with Type C material in the pipe zone.

    d. Where pipelines are installed on grades exceeding 4 percent, and where backfill materials are graded such that there is less than 10 percent passing a No. 4 sieve, trench plugs of Type J or N material shall be provided at maximum intervals of 200 feet unless indicated otherwise.

    e. Type O material shall be used in the pipe zone where shown on plans, specified, or required by the Engineer for special crossings or other locations, or where otherwise approved.

    f. Type E material will not be allowed for backfill within the pipe zone.

3. Trench zone backfill for pipelines as defined under "Pipe and Utility Trench Backfill" shall be Type D backfill material.

4. Final backfill material for pipelines under paved areas, as defined under "Pipe and Utility Trench Backfill" shall be Type G backfill material. Final backfill under areas not paved shall be the same material as that used for trench backfill.

5. Trench backfill and final backfill for pipelines under structures shall be Type A or B, except where concrete encasement is required by the Contract Documents.

6. Aggregate base materials under pavements shall be Type G material constructed to the thicknesses indicated. Aggregate subbase shall be Type M material.

7. Backfill around structures shall be Type P material, or Types A through Type F materials, or any mixture thereof, except as shown.

8. Backfill materials beneath structures shall be as follows:

    a. Drainrock materials under hydraulic structures or other water retaining structures with underdrain systems shall be Type H material.

    b. Under concrete hydraulic structures or other water retaining structures without underdrain systems, Types F, G or H materials shall be used.

    c. Under structures where groundwater must be removed to allow placement of concrete, Type F material shall be used. Before the Type F material is placed, filter type geotextile fabric shall be placed over the exposed foundation.

    d. Under all other structures, Type F, G or H material shall be used.

9. Backfill used to replace pipeline trench overexcavation shall be a layer of Type F material with a 6-inch top filter layer of Type E material or filter fabric to prevent migration of fines for wet trench conditions or the same material as used for the pipe zone backfill if the trench conditions are not wet.

2.4 PIPELINE MARKING TAPE

A. Metallic Tape: Tape shall be minimum 5.5 mils thick aluminum foil imprinted on one side, encased in high visibility inert polyethylene jacket. Tape shall be a minimum of 6 inches wide. Imprinted lettering shall be 1 inch tall, permanent black, as indicated. Joining clips shall be manufacturer's standard tin or nickel coated. Tape shall be as manufactured by Reef Industries (Terra "D") or equal.

B. Plastic Tape: Tape shall be minimum 4-mil thick polyethylene which is impervious to alkalais acids, and chemicals and solvents which are likely in the soil. Tape shall be a minimum of 6 inches wide and lettering shall be 1-inch tall permanent black on a colored background. Tape shall be manufactured by Reef Industries (Terra Tape) or equal.

C. Warning Tape: Warning tape manufactured for marking and identifying underground utilities continuously inscribed with a description of utility, colored as follows:

1. Red; Electric.

2. Yellow; Gas, oil, steam, and dangerous materials.

3. Orange: Telephone and other communications.

4. Blue: Water Systems.

5. Green: Sewer Systems.

2.5 MATERIALS TESTING

A. All soils testing of samples submitted by the Contractor will be done by a testing laboratory of the Owner's choice and at the Owner's expense. At its discretion, the Engineer may request that the Contractor supply samples for testing of any material used in the work.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System: References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487. The Contractor shall be bound by all applicable provisions of said ASTM D 2487 in the interpretation of soil classifications.

E. The testing for chloride, sulfate, resistivity, and pH will be done by a testing laboratory of the Owner's choice and at the Owner's expense.

PART 3 - EXECUTION

3.1 EXCAVATION – GENERAL

A. General: Except when specifically provided to the contrary, excavation shall include the removal of all materials of whatever nature encountered, including rock and all obstructions of any nature that would interfere with the proper execution and completion of the Work. The removal of said materials shall conform to the lines and grades indicated or ordered. Unless otherwise indicated, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the site prior to performing any excavation or placing any fill. Furnish, place, and maintain all supports and shoring that may be required for the sides of the excavations. Excavations shall be sloped or otherwise supported in a safe manner in accordance with safety requirements of the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Maximum Length of Open Trench: The maximum length of open trench in urban and rural areas shall not exceed 500-feet at each pipe installation heading beyond the end of the installed pipeline, or the requirements of the agency with jurisdiction, whichever is lesser.

C. Construction Delays: In the case of any construction delay in excess of five calendar days, whether Contractor or Owner caused, the Contractor shall backfill the excavation, install temporary paving including temporary traffic markings, and restore traffic to pre-construction condition to minimize disruption to traffic and the community at no additional cost to the Owner.

D. Removal and Exclusion of Water: Remove and exclude water, including storm water, groundwater, irrigation water, and wastewater, from all excavations. Dewatering wells, well points, sump pumps, or other means shall be used to remove water and continuously maintain groundwater at a level at least 2 feet below the bottom of excavations before the excavation work begins at each location. Water shall be removed and excluded until backfilling is complete and all field soils testing has been completed.

3.2 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION

A. Excavation Beneath Structures and Embankments: Except where otherwise indicated for a particular structure or ordered by the Engineer, excavation shall be carried to the grade of the bottom of the footing or slab. Where indicated or ordered, areas beneath structures or fills shall be overexcavated. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched. When such overexcavation is indicated, both overexcavation and subsequent backfill to the required grade shall be performed. When such overexcavation is not indicated but is ordered by the Engineer, such overexcavation and any resulting backfill will be paid for under a separate unit price bid item if such bid item has been established; otherwise payment will be made in accordance with a negotiated price. After the required excavation or overexcavation has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Paved Areas: Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the bottom of the paving thickness. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of

maximum density. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

C. Notification of Engineer: Notify the Engineer at least 3 days in advance of completion of any structure excavation and allow the Engineer a review period of at least 1 day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

3.3 PIPELINE AND UTILITY TRENCH EXCAVATION

A. General: Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with widths as indicated.

B. Trench Bottom: Except when pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe zone. Excavations for pipe bells and welding shall be made as required.

C. Open Trench: The maximum amount of open trench permitted in any one location shall be [500 feet, or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater]. All trenches shall be fully backfilled at the end of each day or, in lieu thereof, shall be protected in accordance with Section 01 50 10 – Protection of Existing Facilities. The Contractor shall provide temporary 6-foot chain link fencing panels for protection of all open excavations and trenches within public streets, residential areas, and all other locations with the exception of unimproved open areas where excavations and/or pipeline trenches that can be safely sloped in accordance with current OSHA standards to provide safe access without the use of shoring devices. Temporary fencing panels shall fully enclose open excavations and trenches, and shall remain in place during all non-working hours.

D. Trench Overexcavation: Where trenches are indicated to be overexcavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade of the bottom of the pipe bedding.

E. Overexcavation: When ordered by the Engineer, whether indicated on the Drawings or not, trenches shall be overexcavated beyond the depth and/or width shown. Such overexcavation shall be to the dimensions ordered. The trench shall then be backfilled to the grade of the bottom of the pipe bedding. Overexcavation less than 6 inches below the limits on the Drawings shall be done at no increase in cost to the Owner. When the overexcavation ordered by the Engineer is 6 inches or greater below the limits shown, or wider, additional payment will be made. Said additional payment will be made under separate unit price bid items for overexcavation if such bid items have been established; otherwise payment will be made in accordance with a negotiated price.

F. Where pipelines are to be installed in embankments, fills, or structure backfills, the fill shall be constructed to a level at least one foot above the top of the pipe before the trench is excavated.

G. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield so that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls. If the trench walls cave in or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3.4 OVEREXCAVATION NOT ORDERED OR INDICATED

A. Any overexcavation carried below the grade ordered or indicated, shall be backfilled to the required grade with the indicated material and compaction. Such work shall be performed at no additional cost to the Owner.

3.5 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled to preserve it for replacement. Excavated material may be placed on the lawn; provided, that a drop cloth or other suitable method is employed to protect the lawn from damage. The lawn shall not remain covered for more than 72 hours. Immediately after completion of backfilling and testing of the pipeline, the sod shall be replaced and lightly rolled in a manner so as to restore the lawn as near as possible to its original condition. Provide new sod if stockpiled sod has not been replaced within 72 hours.

3.6 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, trees shall be protected from injury during construction operations. No tree roots over 2 inches in diameter shall be cut without express permission of the Engineer. Trees shall be supported during excavation by any means previously reviewed by the Engineer.

3.7 BACKFILL – GENERAL

A. Backfill shall not be dropped directly upon any structure or pipe. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed. Backfill around water retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed. Structures shall not be constructed on CLSM backfill until the CLSM has obtained a 7-day minimum cure.

B. Except for drainrock materials being placed in overexcavated areas or trenches, backfill shall be placed after all water is removed from the excavation, and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally. Do not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

D. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have all loose sloughing, or caving soil and rock materials removed. All materials disturbed from their intact condition that are 4 inches or larger in least dimension or aggregates of soil material thicker than 4 inches shall be removed from the excavation walls and base prior to placing pipe or any backfill material. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

3.8 PLACING AND SPREADING OF BACKFILL MATERIALS

A. Backfill materials shall be placed and spread evenly in layers. When compaction is achieved using mechanical equipment, the layers shall be evenly spread so that the depth of each uncompacted layer shall not exceed 8 inches of compacted thickness.

B. During spreading, each layer shall be thoroughly mixed as necessary to promote uniformity of material in each layer. Pipe zone backfill materials shall be manually spread around the pipe so that when compacted the pipe zone backfill will provide uniform bearing and side support.

C. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

D. Where the backfill material moisture content is too high to permit the indicated degree of compaction the material shall be dried or mixed with drier material until the moisture content is satisfactory.

3.9 COMPACTION OF EARTH FILL, BACKFILL, AND EMBANKMENT MATERIALS

A. Each layer of Types A, B, C, G, H, I, and K backfill materials as defined herein, where the material is graded such that at least 10 percent passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density. Equipment that is consistently capable of achieving the required degree of compaction shall be used and each layer shall be compacted over its entire area while the material is at the required moisture content.

B. Each layer of Type E and J backfill materials shall be compacted by means of at least 2 passes from a flat plate vibratory compactor. When such materials are used for pipe zone backfill, vibratory compaction shall be used at the top of the pipe zone or at vertical intervals of 24 inches, whichever is the least distance from the subgrade.

C. Fill on reservoir and structure roofs shall be deposited at least 30 days after the concrete roof slab has been placed. Equipment weighing more than 10,000 pounds when loaded shall not be used on a roof. A roller weighing not more than 8,000 pounds shall be used to compact fill on a roof.

D. Pipe zone backfill materials that are granular, shall be compacted by using vibratory compactors.

E. Equipment weighing more than 10,000 pounds shall not be used closer to structure walls than a horizontal distance equal to the depth of the fill at that time. Hand operated power compaction equipment shall be used where use of heavier equipment is impractical or restricted due to weight limitations.

F. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand operated, vibratory compactors and rollers. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

G. Compaction Requirements: The following compaction test requirements shall be in accordance with ASTM D 1557, method C. Compaction shall be obtained with the moisture content within plus or minus 2 percent of the optimum moisture content. Where agency or utility company requirements govern, the highest compaction standards shall apply.

Location or Use of Fill	Percentage of Maximum Density
Pipe embedment backfill for flexible pipe	90
Pipe bedding and overexcavated zones under bedding for flexible pipe, including trench plugs	90
Pipe embedment backfill for steel yard piping	---
Pipe embedment backfill for rigid pipe	90
Pipe zone backfill portion above embedment for rigid pipe	90
Pipe bedding and overexcavated zones under bedding for rigid pipe	90
Final backfill, beneath paved areas or structures	95
Final backfill, not beneath paved areas or structures	85
Trench zone backfill, beneath paved areas and structures, including trench plugs	95
Trench zone backfill, not beneath paved areas or structures, including trench plugs	90
Embankments and fills	90
Embankments and fills beneath paved areas	

or structures	95
Backfill beneath structures and hydraulic structures	95
Backfill and fill around structures on reservoir or structure roof	90
Topsoil (Type K material)	80
Aggregate base or subbase (Type G or M material)	95

3.10 PLACEMENT OF CLSM

A. Following placement and anchoring of the pipe, remove all loose soil from trench walls and floor. Remove any unstable soil at the top of the trench, which might fall into the trench during placement of the CLSM.

B. Prior to placement of CLSM, the pipeline steel temperature shall be controlled as specified in Section 02570 - Steel Pipe.

C. Deliver the CLSM to the trench in ready mix trucks and utilize pump or chutes to place the CLSM in the trench. Direct CLSM to one side of the pipe, taking care not to displace the pipe at any time. Continue placing CLSM on one side of the pipe until CLSM has gone under the pipe and up the other side to a depth of 1.5 feet above the pipe bottom. Use at least two hand-held vibrators to continuously liquefy and move CLSM into all voids. Adjust water in mixture to maintain fluid consistency but maintain strength requirements. Continue placing CLSM on both sides of the pipe continuously using two vibrators for every 30 feet of pipe run.

D. Maintain stability of pipe throughout CLSM placement. CLSM will likely require placement in lifts to prevent pipe flotation. No movement of the pipe caused by flotation will be allowed. If any movement occurs, the CLSM material shall be removed and the pipe placed back on line and grade. Any damage to the pipeline system caused by movement of the pipe shall be removed and/or repaired in full conformance with these Contract Documents at no additional cost to the Owner. Remove all sloughed material or other debris from top of previously placed CLSM.

3.11 PIPE AND UTILITY TRENCH BACKFILL

A. Pipe Zone

1. The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane 6 inches below the bottom surface of the pipe and a plane at a point 12 inches above the top surface of the pipe. The bedding is defined as that portion of pipe zone backfill material between the bottom of the trench and the bottom of the pipe. The embedment is defined as that portion of the pipe zone material between the bedding and a plane at a point 6 inches above the top surface of the pipe.

2. After compacting the bedding, perform a final trim using a string line for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe. Excavation for pipe bells and welding shall be made as required.

3. The pipe zone shall be backfilled with the indicated backfill material. Exercise care to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

4. If a moveable trench shield is used during backfill operations the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer. Do not displace the pipe or backfill while the shield is being moved.

B. Trench Zone: After the pipe zone backfills have been placed, backfilling of the trench zone may proceed. The trench zone is defined as that portion of the vertical trench cross-section lying between a plane 12 inches above the top surface of the pipe and a plane at a point 18 inches below the finished surface grade, or if the trench is under pavement, 18 inches below the roadway subgrade.

C. Marking Tape Installation

1. Continuously install metallic marking tape along the pipe at a depth of 3 feet below finish grade.

2. Continuously install plastic marking tape along the pipe at the elevation indicated on the Drawings.

D. Final Backfill: Final backfill is all backfill in the trench cross-sectional area within 18 inches of finished grade, or if the trench is under pavement, all backfill within 18 inches of the roadway subgrade.

3.12 FIELD TESTING

A. General: All field soils testing will be done by a testing laboratory of the Owner's choice at the Owner's expense except as indicated below.

B. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557. Field density in-place tests will be performed in accordance with ASTM D 1556 or by such other means acceptable to the Engineer.

C. In case the test of the fill or backfill show noncompliance with the required density, perform remedies as may be required to ensure compliance. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner, paid by the Contractor, at no additional cost to the Owner.

D. Provide test trenches and excavations including excavation, trench support, and groundwater removal for the Owner's field soils testing operations. The trenches and excavations shall be provided at the locations and to the depths required by the Owner. All Work for test trenches and excavations shall be provided at no additional cost to the Owner.

E. Frequency of Testing

1. Backfill around structures and in embankments shall be tested every 300 square ft of each lift of placement.

2. CLSM shall be tested each batch being placed or every 300 cubic yards that is placed.

3. Pipe backfill shall have one test every 80 feet (2 joints) of backfill placed.

END OF SECTION

SECTION 32 12 16 – A.C. PAVEMENT AND BASE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall perform all work associated with A.C. Pavement and Base, as shown and specified herein including all labor, materials, equipment supplies and facilities associated with providing of finished product satisfying all the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Moisture-Density Relations of Soils and Soil - Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (45-mm) Drop7
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures using Saturated Surface-Dry Specimens.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Submittal Procedures. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the Engineer.

B. Prior to Delivery to Site:

1. Mix Design: Submit current mix design dated within one year of submittal listing:

a. Date of mix design

b. Asphalt cement source, type and chemical composition.

c. Aggregate gradation target.

d. Asphalt cement target percentage, dust to asphalt ratio, moisture sensitivity (tensile strength ratio), stability, flow and voids in the bituminous mix.

2. Before changing mix design, submit new design to Engineer 10-days prior to placing pavement for review and evaluation of changes.

3. Type and number of compaction and finish rollers.

C. At Delivery: Supply a batch ticket identifying:

1. Serial Number of ticket.

2. Date and truck number.

3. Job name, location and mix identification.

4. Type, grade and weight of asphalt.

5. Type, grade and weight of aggregate.

6. Mix design method.

D. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than two laboratory trial batch tests will be paid by the Owner but the Contractor shall furnish the materials at no cost to the Owner. Any additional trial batch testing required shall be performed at the expense of the Contractor.

1.4 QUALITY ASSURANCE

A. Use a laboratory that follows and complies with ASTM D 3666.

B. Do not change aggregate source, asphalt source or mix design without Engineer's prior written approval.

C. Reject product and work that does not meet the requirements of this Section.

D. Remove product that is found to be defective after installation and install acceptable product at no additional cost to the Owner.

E. Foreman of paving crew shall have completed at least five projects of similar size and nature.

1.5 WEATHER

A. Do not pave until air temperature is 45 degrees F and rising.

B. Cease paving if air temperature falls below 50 degrees F.

C. Do not pave is surface is wet or if rain, snow or other precipitation is expected.

D. Do not pave if wind or ground cools the mix material before compaction.

1.6 ACCEPETANCE

A. General: Acceptance is by lot.

B. Materials:

1. Lot is one day's production.

2. At the source:

a. Aggregate: Verify gradation. Collect sample form the conveyor belt or stockpile if belt is not accessible.

b. Paving Asphalt: Asphalt shall meet the requirements of this section and shall satisfy the limits identified in the Utah Department of Transportation's "Manual of Instructions – Part 8 Materials"

c. Mix Temperature shall not exceed 325 degrees F in the transport vehicle.

3. At the Site:

a. A sub-lot is 500 tons.

b. Obtain one random sample per sub-lot behind the paver before compaction or at locations exhibiting non-uniform appearance.

4. At the Laboratory:

a. Air voids shall be evaluated on the basis of laboratory compacted samples.

b. Dust to asphalt ratio.

c. Asphalt content and aggregate gradation.

5. If material does not meet any requirement of the specification, the Engineer may direct that the sub-lot be removed and replace with a material meeting the specification requirements at no additional cost to the Owner.

C. Installation:

1. Observation of Contractor's field quality control testing does not constitute acceptance.

2. Opening a paved surface to traffic does not constitute acceptance:

3. Reject any mixes exceeding 325 degree F in transport vehicle.

    a. Dispose of cold mix in paver hopper as thin spread underlay.

4. Grade, Cross Slope: Verify that tolerance is not exceeded.

5. Compaction:

    a. For compaction a lot is 1,000 square yards or any part thereof.

    b. Core Density: A lot is acceptable if the average core density does relative to ASTM D 2041 is 93 percent, with no individual test less than 89 percent.

    c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.

    d. Cores shall be tested per ASTM D 2725 for core density and ASTM D 2041 (Rice) for maximum theoretical density.

    e. Other non-destructive testing methods may be used during placement to aid in establishing a rolling pattern and determining the required compaction effort. However, density acceptance will be by core densities.

6. Thickness:

    a. For thickness a lot is 1,000 square yards or any part thereof.

    b. Core Thickness: A lot is acceptable if the average core thickness is not less than 0.25 inches less than the specified thickness.

    c. At least two test locations shall be sampled per ASTM D 3665 and three core samples shall be collected per each test location per ASTM D 5361. Core samples shall be full depth.

    d. Cores shall be tested per ASTM D 3549 for thickness.

7. Lots that are not acceptable may be rejected and the Engineer may direct that the lot be removed and replaced at no additional cost to the Owner.

1.7 UNTREATED BASE COURSE

A. The untreated base course shall consist of select material, either natural or crushed and shall be graded as follows:

Sieve Size	Gradation Ideal Gradation
3/4 inch	100
3/8-inch	75-95
No. 4 sieve	55-70

No. 16 sieve	30-40
No. 200 sieve	2-10

1.8 TACK COAT

A. Tack coat shall be emulsified asphalt Grade SS-1 or SS-1h, CSS-1 or CSS-1h diluted with one part water to one part emulsified asphalt, undiluted asphalt Grade RS-1 or CRS-1, or paving asphalt Grade AR-1000. Emulsified asphalt shall comply with the requirements of AASHTO M 140 (ASTM D 977) or M 208 (ASTM D 2397); paving asphalt shall comply with the requirements of AASHTO M 226 (ASTM D 3381).

1.9 ASPHALT CEMENT (AC)

A. Petroleum Asphalt that complies with table 2 of ASTM D 3381 except as follows:

1. Replace ductility at 77 deg F. with ductility at 39.2 deg. F. Use the following values:

a. AC - 10: greater than 15

b. AC - 20: greater than 5

2. Delete the loss on heating requirement on the residue from the “Thin-Film Oven Test”.

B. Substitute Performance Graded Asphalt Binder (PGAB)

1. PGAB asphalt meeting the requirements of ASTM D 6373 may be substituted for AC asphalt cement as follows:

a. AC - 10 – PGAB 58-22 or PGAB 58-28

b. AC - 20 – PGAB 64-22

1.10 AGGREGATE

A. Aggregate shall be clean, hard, durable, angular and sound consisting of crushed stone, crushed slag, crushed gravel, sand, or a combination of two or more of these materials.

B. Source Suitability: Use the following requirements to determine the suitability of the aggregate source and not for project control.

1. Coarse Aggregates:

a. Angularity (fractured faces), ASTM D 5281: 50 percent maximum by weight of particles with at least 2 fractured faces.

b. Hardness (toughness), ASTM C 131: 40 percent minimum wear of aggregate retained above the No. 4 sieve unless specific aggregates having higher values are known to be satisfactory.

c. Flat or elongated particles, ASTM D 4791: 20 percent maximum retained above the 3/8 inch sieve has a 3:1 length to width ratio.

2. Fine Aggregates:

a. Friable Particles, ASTM C 142: 2 percent maximum passing the No. 4 sieve.

b. Plasticity, ASTM D 4318: Aggregate passing the no. 40 sieve shall be non-plastic even when filler material is added to the aggregate.

1) Liquid Limit: Less than 25

2) Plastic Limit: Less than 6

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

1.11 ADMIXTURES

A. Mineral filler shall comply with ASTM D 242.

B. Antistrip shall be heat stable cement slurry of lime slurry.

1.12 MIX DESIGN

A. Material Designation:

1. Asphalt Cement shall be AC-20.

2. Aggregate gradation shall be DM-3/4.

3. Traffic Classification shall be medium.

B. Design Aggregate Gradation: The job-mix formula for the asphalt-aggregate surface course mixture shall be within the following gradation limits as percent passing by weight, ASTM C 136:

Aggregate Gradations				
Sieve Size	DM-1	DM-3/4N	DM-3/4	DM-1/2
1 inch	100			
3/4 inch		100	100	
1/2 inch	75-91	74-99		100
3/8 inch		69-91	75-91	
No. 4	47-61	49-65	46-62	60-80
No. 8		33-47		
No. 16	23-33	21-35	22-34	28-42
No. 50	12-22	6-18	11-23	11-23
No. 200	3-7	2-6	3-7	3-7

1. Dry-rodded Unit weight per ASTM C 29 shall be a minimum of 75 pounds per cubic foot.

2. Weight Loss or soundness per ASTM C 88 shall be a maximum of 16 percent using sodium sulfate.

3. Clay Content or cleanliness per ASTM D 2419shall be determined by the sand equivalent value after passing through the dryer or prior to the drum mixer at the following levels:

   a. 45 percent minimum for Medium Traffic Classification

   b. 60 percent minimum for Heavy Traffic Classification.

C. Design Mixture Test Criteria: Use the Marshall volumetric mix design, AI MS-2: price and payment procedures.

Mix Design Criteria			
Criteria	Traffic Classification		
	Light	Medium	Heavy
Number of Compaction Blows	35	50	75
Stability, lbs. (minimum), ASTM D 5581	750	1200	1800
Flow, in 0.01 inch units, ASTM D 5581	10-18		
Voids in Mineral Aggregate (VMA), percent min., ASTM D 3203 Nominal Maximum Particle Size 1” 3/4” 1/2” 3/8”	 13 14 15 16.5		
Voids in Bituminous Mix (percent)	3-5		
Dust to Asphalt Ratio	0.8 – 1.6		
Moisture Sensitivity, ASTM D 4867	>0.8 with freeze thaw conditioning and test specimen compacted at 6-8 percent air voids		
Notes Traffic Classifications:			

Light – Parking lots, driveways, light traffic residential streets, light traffic farm roads. (ESAL $<10^4$ per year)

Medium – Residential streets, rural farm and residential roads (Class II); Urban minor collector streets, rural minor collector roads (Class III). (10^4<ESAL<10^6 per year)

Heavy – Urban Minor arterial and light industrial streets, rural major collector and minor arterial highways (Class IV); Urban major arterial and heavy industrial streets, freeways, expressways, arterial highways, rural interstate, and other principal arterial highways (Class V). (ESAL > 10^6 per year)

1.13 SOURCE QUALITY CONTROL

A. General: Supplier shall randomly collect samples per ASTM D 3665. The same sample point shall be used for all samples of a particular material.

1. Aggregate sampling shall be per ASTM D 75.

2. Asphalt Cement sampling shall be per ASTM D 140.

B. Asphalt-aggregate mix shall be sampled per ASTM D 979 and test for:

1. Air Voids per ASTM D 3203.

2. Paving Asphalt Content per ASTM D 6307.

3. Aggregate Gradation per ASTOM D 5444

4. Tensile strength of bitumen-aggregate mixtures per ASTM D 4867.

C. Mixing plant shall meet the requirements of ASTM D 3515.

1.14 PAVEMENT MARKING PAINT

A. Pavement marking paint shall be a product specifically formulated for use on asphalt concrete pavement and shall have a proven record of performance and durability. The paint striping materials shall conform with the State of Utah Standard Specifications for Road and Bridge Construction and its addenda.

PART 2 -- EXECUTION

2.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 31 30 00 – Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the specified grade and cross section.

2.2 UNTREATED BASE COURSE

A. Untreated base course shall be provided where shown and to the thickness indicated. Imported untreated base course shall be delivered to the job site as uniform mixtures and

each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6 inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6 inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 96 percent of maximum density when measured in accordance with ASTM D 1557 with no test below 92 percent of maximum density. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the specified grade or cross-section.

2.3 TACK COAT

A. A tack coat shall be applied to existing paved surfaces where new asphalt concrete is to be placed on existing pavement. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd. Paving asphalt shall be applied at the rate of approximately 0.05 gal/sq yd.

2.4 CONSTRUCTION EQUIPMENT

A. Lay Down Machine shall have tracks when operating on fabrics, geogrids or pavement mats hotter than 180 degrees F.

B. Compactors shall be static or vibratory, steel wheel rollers. Pneumatic tire rollers may be used for intermediate rolling only.

2.5 ASPHALT CONCRETE

A. At the time of delivery to the work site, the temperature of mixture shall not be higher than 320 degrees F, and shall not be less than indicated below:

Minimum Asphalt Concrete Temperature, degrees F

Air Temperature	Compacted Mat Thickness					
	3/4 inch	1 inch	1-1/2 inch	2 inch	3 inch	4 inch +
45-50	-	-	-	-	280	265
50-59	-	-	-	280	270	255
60-69	-	-	285	275	265	250
70-79	285	285	280	270	265	250
80-89	280	275	270	265	260	250
90+	275	270	265	260	250	250

B. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

C. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed especially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the Engineer may waive the self-propelled requirement.

D. Spreading, once commenced, shall be continued without interruption.

E. The mix shall be compacted immediately after placing. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

F. Compaction shall be completed before temperature drop to 180 degrees F.

G. Do not leave unsafe butt joints if paving operations stop.

H. Barricade or eliminate fall off edges.

I. Joints

1. Construct joints to have the same texture, density and smoothness as other section of the new pavement course.

2. Clean contact surfaces and apply tack coat. Ensure continuous bond between old and new pavement or between successive day's work.

3. Offset longitudinally joints a minimum of 12 inches in succeeding courses and offset transverse joints a minimum of 6 feet to avoid a vertical joint through more than one course. In the tops course restrict longitudinal joints to either side of the lane lines.

4. Prevent traffic, including construction traffic, from crossing vertical edges. Apply tack coat to vertical edges prior to making another pass with the paver if the mix has cooled to 90 degrees F.

2.6 TOLERANCES

A. Lift thickness shall not be less than 2 times the maximum aggregate size nor more than 3 inches (compacted thickness) or the limits established by the pneumatic or vibratory compactor equipment manufacturer, whichever is less.

B. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

2.7 BITUMINOUS SURFACE PATCHING

A. Where pits are excavated through bituminous surfaced roads, driveways, parking areas, etc., the surface shall be restored and maintained as follows:

1. A temporary gravel surface shall be placed and maintained after the required backfill and compaction of the trench has been accomplished.

2. The gravel shall be placed to such depth as to provide six inches below the pavement and shall be brought flush with the paved surface.

3. The area over trenches to be resurfaced shall be graded and rolled with a roller weighing not less than twelve tons, or with the rear wheels of a five-yard truck loaded to capacity, until the subgrade is firm and unyielding. Mud or other soft or spongy material shall be removed and the void filled with gravel and rolled and tamped thoroughly in layers not exceeding six inches in thickness. The edges of trenches which are broken down during the making of subgrade shall be removed and trimmed neatly before resurfacing.

4. Before any permanent resurfacing is placed, the Contractor shall trim the existing paving to clean, straight lines as nearly parallel to the centerline of the trench as practicable.

5. Existing bituminous paving shall be cut back a minimum of six inches beyond the limits of any excavation of cave-in along the trench so that the edges of the new paving will rest on at least six inches of undisturbed soil.

6. As soon as is practical, weather permitting, the bituminous surface shall be restored by standard paving practices to the thickness specified herein.

7. Pavement restoration shall include tacking of pavement of edges and subbase with MC 70-250 bituminous material and placing rolling plant hot mix bituminous material to the level of the adjacent pavement surfaces.

2.8 PROTECTION AND REPAIR

A. General: All work is at no additional expense to the Owner.

B. Protection:

1. Protect all structures, including curb, gutter, sidewalks, street fixtures, delineators, signs, guard rails and guide posts.

2. Remove all spatter, over-coat or mar.

3. Do not discharge bituminous materials into borrow pits, roadside ditches, gutters or other areas.

4. Protect hot pavement from traffic until mixture has cooled enough not to become marked.

5. Protect neighborhood, storm drains and downstream wetland and fish habitats.

C. Repair

1. When thickness is deficient, place additional material over deficient areas. Do not skin patch. If necessary, mill for inlay.

2. Repair defective seams, edges and joints.

3. Remove and replace unacceptable paving.

2.9 PAVEMENT MARKING

A. Pavement marking paint shall be applied where indicated only when the pavement surface is dry and clean, and when the air temperature is above 40 degrees F. Pavement marking shall commence no sooner than 21 days after completion of pavement installation. All equipment used in the application of pavement marking shall produce stripes and markings of uniform quality with clean and well-defined edges that conform to the details and dimensions shown. Drips, overspray, improper markings, and paint material tracked by traffic shall be immediately removed from the pavement surface by methods previously reviewed by the Engineer.

END OF SECTION

SECTION 33 05 07 – POLYVINYL CHLORIDE (PVC) PIPE (AWWA C900 AND C905, MODIFIED)

PART 1 --GENERAL

1.01 SUMMARY

A. The Contractor shall provide polyvinyl chloride (PVC) pressure pipe, complete in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

ANSI/AWWA C104/A21.5	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile Iron Pipe
ANSI/AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings 3-in Through 48-in for Water and Other Liquids
ANSI/AWWA C111/A21.11	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI/AWWA C600	Installation of Ductile-Iron Water Mains and Appurtenances
ANSI/AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe 4-in Through 12-in for Water Distribution
ANSI/AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe 14-in Through 48-in for Water Distribution
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins
PPI Technical Report TR 3/4	Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials
AWWA Manual M23	PVC Pipe - Design and Installation

1.03 CONTRACTOR SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings of pipe, fittings, and appurtenances in accordance with the requirements in Section 01 33 00 – Submittal Procedures. Manufacturer's literature for metallic locating tape.
   1. Showing dimensions and details of pipe joint fittings, fitting specials, valves and appurtenances.
   2. Detailed layout, spool or fabrication drawings showing pipe spools, spacers, adapters, connectors, fittings and pipe supports not indicated in the Contract Documents.
   3. Manufacturer's product data and samples of all materials proposed for use on the work.

B. Certifications: A certified affidavit of compliance for pipe and other products or materials under this Section.

C. Test Reports:
   1. Hydrostatic proof test reports.
   2. Sustained pressure test reports.
   3. Burst strength test reports.

D. The Contractor shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

E. Owner's Manual
   1. Manufacturer's technical data and installation instructions.
   2. Manufacturer's certificates of compliance indicating that all materials provided under this Section meet the requirements of the Contract Documents.

1.04 QUALITY ASSURANCE

A. Inspection: Pipe shall be subject to inspection at the place of manufacture.

B. During manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. Tests: Materials used in manufacture of the pipe shall be tested in accordance with the requirements of this Section and the referenced standards, as applicable.

D. The Contractor shall perform said material tests. The Engineer shall have the right to witness testing; provided that the Contractor's schedule is not delayed for the convenience of the Engineer.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished as a part of the Work.

1.05 INSPECTION

A. All pipe may be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards as supplemented by the requirements herein. The Contractor shall notify the District in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During the manufacture of the pipe, the District shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

1.06 SOURCE QUALITY CONTROL

A. Except as modified herein, pipe shall be tested in accordance with the requirements of this Section and AWWA C900 or C905, as applicable.
   1. The Contractor shall perform said material tests in accordance with the requirements of the Contract Documents. The Owner shall have the right to

witness all testing conducted by the Contractor; provided, that the Contractor's schedule will not be delayed for the convenience of the Owner.

2. All expenses incurred in obtaining samples for testing shall be borne by the Contractor at no increased cost to the Owner.
3. In addition to those tests specifically required, the Owner may request additional samples of any material for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 --PRODUCTS

2.01 GENERAL

A. PVC pressure pipe (4-inch through 12-inch) shall conform to the applicable requirements of ANSI/AWWA C900 subject to additional requirements herein.

B. PVC pressure pipe (14-inch through 48-inch) shall conform to the applicable requirements of ANSI/AWWA C905 subject to additional requirements herein.

C. Each piece of pipe and fitting shall be clearly labeled to identify its size, pressure class and manufacture date.

2.02 PIPE DESIGN CRITERIA

A. General: PVC pressure pipe shall be designed in accordance with the requirements of ANSI/AWWA C900 and ANSI/AWWA C905.

B. Polyvinyl Chloride (PVC) pipe shall have outside diameter dimensions conforming to cast iron pipe and shall be the diameter and class indicated on the plans. The pipe shall meet the pressure class requirements indicated on the drawings, and shall meet the requirements of Table 2 of AWWA C900 or C905 as applicable.

C. PVC pipe shall be provided in standard 20 foot lengths, unless otherwise specified, detailed or required on the approved plans. Shorter lengths, up to 10 feet, will be permitted when authorized by the Engineer. Field cut lengths of pipe used as closures may not be shorter than 2 feet in length, and must be approved by the Engineer.

2.03 PIPE

A. The pipe shall be of the diameter and pressure class specified or shown, shall be furnished complete with rubber gaskets, and all specials and fittings shall be provided as required in the Contract Documents. Unless otherwise noted, diameters shown in the Contract Documents shall refer to Cast-Iron Pipe Equivalent Outside Diameters (CIOD), conforming to the requirements of AWWA C900 or C905 as appropriate.

B. Additives and Fillers: Unless otherwise allowed in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F and for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred of resin). If requested by the Engineer, the additive and filler content shall be determined using the pyrolysis method as specified in ASTM D 2584.

C. Color: Pipe for use in potable or culinary water systems, or directly attached to potable or culinary water systems shall be white or blue. Pipe used in irrigation, reuse, utility water or any other non-potable use shall be purple.

D. Joints: Except where specifically noted or where designated as “fusible PVC,” joints for buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing a rubber ring joint. The bell and coupling shall be the same thickness as of the pipe barrel, or greater thickness. The sealing ring groove in the coupling shall be of the same design as the groove in cast iron fittings and valves available from local water works supply distributors. No restrained joint PVC pipe will be allowed. When the spigot end of pipe is to be inserted into a mechanical joint fitting, the beveled end of the pipe shall be removed prior to insertion. Solvent weld joints are not permitted.

E. Joint shall be sealed with an elastomeric gasket meeting the requirements of ASTM F 477 and ASTM D3139. Gaskets and lubricants shall be made from materials that are compatible with the plastic material and with each other when used together. They shall not support the growth of bacteria and shall not adversely affect the potable qualities of the water that is to be transported. One elastomeric gasket shall be furnished with each length of bell-end pipe.

F. Joint Deflection: Deflection at the joint shall not exceed 1.5 degrees or the maximum deflection recommended by the manufacturer. No deflection of the joint shall be allowed for joints which are over-belled or not belled to the stop mark.

2.04 FITTINGS

A. Fittings shall be ductile iron fittings meeting the requirements of Section 40 05 19 – Ductile Iron Pipe and of AWWA C110 and/or AWWA C153. Fittings shall be wrapped in polyethylene encasement per AWWA C-105 and all hardware shall be coated with a non-oxide grease.

B. Where fabricated PVC fittings are specifically required:
   1. Fittings (4-inch through 12-inch) shall conform to the applicable requirements of ANSI/AWWA C900 subject to additional requirements herein.
   2. Fittings (14-inch through 48-inch) shall conform to the applicable requirements of ANSI/AWWA C905 subject to additional requirements herein. All fabricated PVC fittings 14-inch and larger shall include fiberglass reinforcement permanently bonded to the outside surfaces of the fitting.

C. All ductile iron fittings shall be lined in accordance with Section 40 05 19 – Ductile Iron Pipe. Fittings shall be cement-mortar lined ductile, coated with a bituminous material and shall conform to the requirements of AWWA Standard C110 and C111 with a minimum rated working pressure of 250 psi. The cement lining shall conform to the requirements of AWWA Standard C104

D. Each fitting shall be clearly labeled to identify its size and pressure class.

E. All fittings and valves shall be restrained against thrust forces by concrete thrust blocks furnished and installed as indicated in the Drawings.

2.05 TRACER WIRE

A. Tracer wire shall be N0. 12 AWG copper wire, PVC jacketed for underground services.

2.06 SERVICE SADDLES

A. Bronze bodied saddles with double bronze straps or full circle body clamp double bolted to each side of the saddle shall be used on pipe sizes 4 inch through 12 inch. The saddle body shall be manufactured from cast bronze in accordance with ASTM B62 or B584 and AWWA C800. The single strap shall have double bolts on each end of the strap to connect it to the bronze saddle. The ears of the strap shall turn inward and rest against the inside of the strap. The gasket shall be Buna N. The saddle shall be threaded with 1 inch or 2 inch iron pipe threads.

PART 3 --EXECUTION

3.01 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the Engineer, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the Contractor shall promptly remove such defective materials from the Site.

B. Installation shall conform to the requirements of AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

C. The Contractor shall install all the pipe closure sections, fittings, valves and appurtenances shown on the approved plans, including bolts, nuts, gaskets and joining materials.

D. The Contractor shall excavate sufficiently in advance of pipe laying operations to enable the alignment and profile to be revised to clear existing utilities and to align with existing connection points.

E. PVC pipe which has been gouged shall not be used. PVC pipe which has received minor scratches during handling may be used solely at the discretion of the Engineer.

F. The Contractor shall maintain the interior of the pipe clean, sanitary and free from foreign materials. At all times when the work of installing pipe is not in progress, all openings into the pipe and the ends of the pipe in the trenches shall be kept tightly closed to prevent the entrance of animals and foreign materials. To prevent unwanted water intrusion, open ends of pipe shall be closed temporarily with a watertight bulkhead.

G. Do not install any pipe contaminated with a petroleum product (inside or outside).

H. Do not install any pipe that shows evidence of exposure to sunlight, age, surface deterioration, or other physical damage. The decision of the Engineer shall be final as to the acceptability of the pipe to be installed.

3.02 HANDLING AND STORAGE

A. Handling: Pipe, fittings and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories

shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches. The pipe shall be hoisted with mechanical equipment using a cloth belt sling or a continuous fiber rope which avoids scratching the pipe. A chain is not permitted. Pipes up to 6 inches in diameter can be lifted by hand.

B. Storage: Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe shall be supported uniformly while being stored in such a way as to prevent sagging or bending and be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.03 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 30 00 – Earthwork. Care shall be taken to ensure that pipe zone material is compacted and in full contact with the haunches of the pipe and that the pipe is fully supported.

3.04 INSTALLATION

A. Bell-and-spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day’s work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints, and couplings. Anchors and supports shall be provided where indicated and where necessary for fastening work into place. Fittings shall be independently supported.

C. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.

D. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

E. Pipe shall be cut by means of saws, power driven abrasive wheels, or pipe cutters, which will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling tool, portable type sander, or abrasive disc.

F. Pipe end shall be secure at all times and care shall be taken to prevent any foreign object, dirt, rocks, debris, rubbish, tools, etc from entering the pipe. Pipe end shall be

capped at the end of each days laying operations. Provided required minimum separation from adjacent utilities are satisfied.

G. Install PVC pipe such that the indelible identification strip markings on each pipe section are continuously aligned for the total length of the pipeline being installed. Orient the strip marking upward to the 12 o'clock position (top) of the trench opening.

H. Assemble the pipe joint using the lubricant supplied by the manufacturer. Ensure lubricant is NSF certified for use in potable water systems. Insert the spigot end into the bell or coupling to the proper insertion mark. Check that the elastomeric ring has not left the groove during assembly by passing a feeler gauge around the completed joint.

I. Tapping saddles shall be installed a minimum of 5 feet from the edge of the saddle to any pipe joint or other saddle. Multiple taps of 6 inches or larger shall not be made in the same length of pipe without the approval of the Engineer.

3.05 INSTALLATION OF METALLIC LOCATING TAPE

A. Polyvinyl chloride pipelines shall be provided with a metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finished grade **OR** above top of pipe. The Contractor shall furnish manufacturer's literature, completely describing the tape proposed to be furnished. No tape shall be used prior to receipt of written approval of the Engineer.

3.06 INSTALLATION OF LOCATOR WIRE

A. Polyvinyl chloride pipelines shall be provided with locator wire secured to the pipe with surface connections provided at all valve boxes and hydrants and as required to maintain a maximum distance between connections of no greater than 500 feet. Tracer wire shall be laid along the top of the pipe and held in place with ties or hitches. The ties or hitches shall be spaced not more than 10 feet apart. The copper wire is to be used in the future as a means of locating the pipe with an electronic-type pipe locator.

3.07 FIELD TESTING AND DISINFECTION

A. Field testing shall conform to the requirements of Section 33 13 00 – Water Pipeline Testing and Disinfection as applicable.

END OF SECTION

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SECTION 33 13 00 - WATER PIPELINE TESTING AND DISINFECTION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall perform flushing and testing of all pressure pipelines and appurtenant piping and disinfection of all pipelines and appurtenant piping for potable and fire water, complete.

B. This specification applies to all pipelines requiring hydrostatic tests (water medium) regardless of the pipeline service medium.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C206	Field Welding of Steel Water Pipe
ANSI/AWWA C651	Disinfecting Water Mains

1.3 CONTRACTOR SUBMITTALS

A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval a minimum of 7 days before testing is to start.

B. A copy of the Utah Pollutant Discharge Elimination System (UPDES) permit application shall be submitted a minimum of 30 days prior to the proposed date to start testing. A copy of the approved UPDES permit shall be submitted prior to the start of testing.

C. Chlorine residual test data and bacteriological test data shall be submitted to document the results of the pipeline disinfection. Tests shall be conducted 24 hours after the start of disinfection.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

B. Used pressure gauges shall be recertified prior to testing.

C. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

D. Liquid chlorine shall be in accordance with the requirements of ANSI/AWWA B301. Liquid chlorine shall be used only:
   1. In combination with appropriate gas flow chlorinators and ejectors;
   2. Under the direct supervision of an experienced technician;
   3. When appropriate safety practices are observed.

E. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of ANSI/AWWA B300 - Hypochlorite.

PART 3 - EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting water pipelines shall be furnished by the Contractor. The Contractor shall make all necessary provisions for conveying the water from the source to the points of use, and disposal of the water (and dechlorinating - where applicable).

B. All pressure pipelines shall be tested. Disinfection shall be accomplished by chlorination for all pipelines providing potable water or connected to a potable water system. All chlorinating and testing operations shall be performed in the presence of the Engineer.

C. Disinfection operations shall be scheduled as late as possible during the contract time period so as to assure the maximum degree of sterility of the facilities at the time the Work is accepted by the Owner. Samples for bacteriological testing shall be collected by the Contractor, and testing shall be performed by the Owner laboratory and at the expense of the Contractor. Results of the bacteriological testing shall be satisfactory with the State Department of Health or other appropriate regulatory agency.

D. Pipeline pressure tests will include the following tests:
   1. Air test of double welded lap joints.
   2. Hydrostatic pressure test of the complete pipeline, in segments as required to match pipe pressure class.
   3. Contractor shall conduct the discharge in accordance with the Utah Pollutant Discharge Elimination System (UPDES) permit from the Utah Division of Environmental Quality (UDEQ). The Contractor shall apply a reducing agent to the discharged water to neutralize the chlorine residual and meet the chlorine residual limit required under the permit. The Owner shall conduct the water quality sampling of the discharge as required by the permit. The Contractor shall notify local agencies, secure appropriate other permits and approvals, and provide erosion control measures for any releases as appropriate. Release of water after pipeline testing and disinfection have been completed shall be only if acceptable to the Engineer.

E. Notification: Notify the Engineer at each of the following stages:
   1. Three working days prior to the start of filling the pipeline with water.
   2. Three working days prior to the start of chlorination.
   3. Twenty-four hours before withdrawing samples for bacteriological testing.
   4. Three working days prior to the start of flushing.

3.2 VISUAL INSPECTION

A. All welds shall be 100% visually inspected in accordance with ANSI/AWS D1.1, Table 6.1; Visual Inspection Acceptance Criteria for Statically Loaded Non-Tubular Connections.

3.3 AIR TEST

A. All double welded lap joint or double gasket Carnegie joint shall be pressure tested to a minimum of 40-psi air pressure for a period of 10 minutes per AWWA C206. No air leakage will be allowed.

B. If the test pressure drops below 40 psi, paint the welds with a soap solution. Mark any leaks indicated by the escaping gas bubbles.

C. Any joints which leak shall be repaired and retested.

3.4 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate. Test all pipelines either in sections or as a unit. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of 14 days. The test shall be made by closing valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment. Provide sufficient temporary air tappings in the pipelines to allow for evacuation of all entrapped air in each pipe segment to be tested. After completion of the tests, such taps shall be permanently plugged. Care shall be taken to see that all air vents are open prior to and during filling.

B. The pipeline shall be filled at a rate not to exceed 2-feet per second as calculated by using the cross-sectional area based on the inside diameter of the pipe and which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pocket. No personnel shall be within or enter any vault or confined space subject to flooding during the initial filling and for a 24 hour period. After the 24 hour period bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

C. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for distribution and transmission pipelines shall be 150 percent of the working pressure in the pipeline measured at the lowest point of the pipeline section being tested. The test pressure for yard piping shall be as indicated on the Piping Schedule measured at the lowest point of the pipeline section being tested. No pressure test will be required for a reservoir overflow line. All visible leaks shall be repaired in a manner acceptable to the Engineer.

D. The maximum allowable leakage for distribution and transmission pipelines shall be 10 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 40-foot

or greater lengths between joints and with rubber-gasketed joints and 20 U.S. gallons per inch of diameter per mile of pipe per 24 hours for pipe with 20-foot or less lengths between joints and with rubber-gasketed joints. The maximum leakage for yard piping shall be as shown on the Piping Schedule. Pipe with welded joints shall have no leakage.

E. In the case of pipelines that fail to pass the prescribed leakage test, determine the cause of the leakage, take corrective measures necessary to repair the leaks, and again test the pipelines at no additional cost to the Owner.

F. The pipeline shall be drained after successful completion of the hydrostatic test.

3.5 DISINFECTING PIPELINES

A. General: All potable water pipelines shall be disinfected in accordance with the requirements of ANSI/AWWA C651 - Disinfecting Water Mains as modified herein.

B. Prior to disinfecting the pipeline for potable water services and before placing into service for other water pipelines, flush the pipeline to remove any debris, rocks, or other foreign material that may have entered the pipe. Flushing shall be carried out such that the velocities in the pipe exceed 2.5 feet per second. Provide all required material, labor and equipment to complete flushing. Contractor shall provide the water for flushing. Make appropriate provision and preparations for disposal of flushing water, satisfying all local, state and federal rules, laws, regulations and ordinances.

C. Continuous Feed Method: Disinfect in accordance with ANSI/AWWA C651 except that:
   1. The water in the pipe shall contain 50 mg/l free chlorine.
   2. After 24 hours of disinfection, the residual free chlorine shall be at least 25 mg/l at the pipeline extremities.

D. Slug Feed Method: Disinfect in accordance with ANSI/AWWA C651.

E. Chlorinating Valves: During the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.

F. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. If there is any question that the chlorinated discharge will cause damage to the environment, a reducing agent shall be applied to the water to neutralize thoroughly the chlorine residual remaining in the water. See the appendix of AWWA C651 for acceptable neutralization methods for heavily chlorinated water.

G. Sampling Ports: The Contractor shall provide sampling ports along the pipeline as defined in AWWA C651. Taps may be made at manways and air valves to help facilitate the spacing requirement.

H. Bacteriological Testing: After final flushing and before the pipeline is placed in service, two consecutive sets of samples shall be collected at least 24 hours apart by the Contractor from the end of the line and at other locations as designated by the Engineer, and shall be tested by the Owner for bacteriological quality in accordance with the requirements of AWWA C651. For this purpose, the pipe shall be refilled with

fresh potable water and left for a period of 24 hours before any samples are collected. If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the new main may be reflushed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated by the continuous-feed or slug method until satisfactory results are obtained – that being two consecutive sets of acceptable samples taken 24 hours apart.

3.6 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before they are installed. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

END OF SECTION

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SECTION 40 05 01 – PIPING GENERAL

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to piping in Divisions 33 and 40, on the Drawings, and as indicated in the Piping Schedule.

C. The Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The Drawings are not pipe construction or fabrication drawings. The Contractor shall prepare pipe spooling and fabrication drawings and shall submit them to the Engineer for review.

D. Where pipe layout details are not indicated on the Drawings, it is the Contractor's responsibility to develop the details necessary to design and construct piping systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Definitions

1. Pipe, piping, pipe work, pipe system, piping system, or similar words, singular or plural shall mean and include, any type of pipes, tubes, fittings, valves, piping specialties, appurtenances, supports, restraints, anchors, coatings and linings and items related to piping.

2. Submerged piping, underwater piping, or similar words shall include any piping located two feet above water surface in basins or tanks.

3. Potable water or similar words shall mean and include any type of potable water or process water that be deemed potable after treatment processes.

4. Corrosive service shall mean and include in locations listed below:

a. Buried locations

b. Submerged locations or submerged piping.

c. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.

d. Chemical handling areas

e. Inside trenches, containment walls, and curbed areas

f. Locations indicated or designated in the contract documents.

B. Reference Specifications

Division 33	Utilities
Division 40	Process Interconnections
01 33 00	Submittals Procedures
01 33 17	Structural Design, Support and Anchorage
01 74 30	Pressure Pipe Testing
09 96 00	High-Performance Coatings
40 05 07	Hangers and Supports for Process Piping

C. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B31	Boiler and Pressure Vessel Code, Section 9
ASME B31.1	Power Piping
ASTM International (ASTM)	
ASTM A193	Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM D792	Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D2564	Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC)
ASTM F436	Hardened Steel Washers
ASTM F467	Standard Specification for Nonferrous Nuts for General Use
ASTM F468	Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
ASTM F493	Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
American Welding Society (AWS)	
AWS D1.1	Structural Welding Code
American Water Works Association (AWWA)	
AWWA C115	Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges

AWWA C207	Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C606	Grooved and Shouldered Joints

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Pipe spooling and fabrication drawings shall indicate spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Welding Qualifications and Procedures

3. Pipe Supports: Submit pipe support fabrication drawings including calculations in accordance with Section 40 05 07 - Hangers and Supports for Process Piping.

4. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation, and restraint system if applicable.

5. Thermoplastic Pipe Joints: Submit solvent cement manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

6. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

7. Seals and Seating Materials: Submit elastomer material and manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

8. Modular Seals for Pipe: Manufacturer's catalog sheet showing materials and installation procedures.

9. Expansion Joints: Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature, and pressure ratings.

10. Flexible Connectors: Submit pressure and thermal expansion calculations.

C. Samples

1. Performing and paying for sampling and testing as necessary for certifications are the Contractor's responsibility.

D. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the Contractor.

2. A certification from the pipe fabricator that each pipe will be manufactured subject to the fabricator's or a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the manufacture of any pipe.

1.04 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be replaced with new materials.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Extent of Work

1. Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

2. Materials in contact with potable water or process water that be deemed potable after treatment processes shall be listed as compliant with NSF Standard 61.

B. Piping Supports

1. Pipes shall be adequately supported, restrained, and anchored in accordance with Section 40 05 07 – Hangers and Supports for Process Piping, and as indicated.

2. Piping support seismic and wind loads shall be sized in accordance with the design criteria as specified in Section 01 33 17 – Structural Design, Support and Anchorage and as shown on Structural Contract Drawings.

C. Lining

1. Application, thickness, and curing of pipe lining shall be in accordance with the applicable Sections of Division 33, unless otherwise indicated.

D. Coating

1. Application, thickness, and curing of coating on buried pipe shall be in accordance with the applicable Sections of Division 33 and Section 09 96 00 – High-Performance Coatings, unless otherwise indicated.

2. Pipes above ground or in structures shall be coated in accordance with Section 09 96 00 – High-Performance Coatings.

E. Pressure Rating

1. Piping systems shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

F. Inspection

1. Pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture, the Engineer shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.

G. Tests

1. Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards.

2. Welds shall be tested as indicated.

3. The Contractor shall be responsible for performing material tests.

H. Welding Requirements

1. Qualification of welding procedures used to fabricate pipe shall be in accordance with the provisions of AWS D1.1 - Structural Welding Code or the ASME Boiler and Pressure Vessel Code, Section 9, whichever is applicable.

I. Welder Qualifications

1. Welding shall be performed by skilled welders and welding operators who have adequate experience in the methods and materials to be used.

2. Welders shall be qualified under the provisions of AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9, whichever is applicable.

3. Machines and electrodes similar to those used in the Work shall be used in qualification tests.

4. Qualification testing of welders and materials used during testing is part of the Work.

2.02 PIPE FLANGES

A. General

1. Flanges shall be provided with flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated.

2. Flange faces shall be perpendicular to the axis of the adjoining pipe.

3. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for those pipes.

B. Pressure Ratings

1. 150 psig or less: Flanges shall conform to either AWWA C207 - Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In., Class D, or ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2. 150 psig to 275 psig: Flanges shall conform to either AWWA C207 Class E or Class F, or ASME B16.5, Class 150.

3. 275 psig to 700 psig: Flanges shall conform to ASME B16.5, Class 300.

4. Selection Based on Test Pressure

    a. Do not expose AWWA flanges to test pressures greater than 125 percent of rated capacity.

    b. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected.

C. Blind Flanges

1. Provide blind flanges in accordance with AWWA C207, or as indicated for miscellaneous small pipes.

2. Blind flanges for pipe diameters 12 inches and greater shall be provided with lifting eyes in the form of welded or threaded eye bolts.

D. Flange Coating

1. Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

E. Flange Fasteners

1. Unless otherwise shown on the drawings, or indicated in the applicable Sections of Divisions 33 and 40, Bolts and nuts shall conform to the following requirements;

    a. Threads shall be in accordance with ANSI/ASME B1.1, Class 2, UNC for bolt diameters 1” and smaller and UN8 for bolt diameters greater than 1”.

    b. Bolts shall have heavy hexagon heads and heavy hexagon nuts. Length of studs shall provide a projection of not less than 0.25 inch and no more than 0.5 inch through the nut when it is drawn tight.

    c. Thread studs on flange connections are not permitted except where space restrictions preclude the use of standard bolts and where approved by the Engineer.

    d. Through bolt holes shall be drilled in accordance with the applicable flange standard.

    e. All bolts fastening metallic flanges shall be provided with plain washers installed under the nut. Washer materials shall be of the same material as the bolt. If the through bolt holes are drilled larger than the applicable standard by 1/8 inch in diameter or more, bolts shall be also installed with a plain washer under the bolt head as well.

    f. All bolts fastening non-metallic flanges shall be provided with plain washers installed under both the bolt head and nut.

    g. Washer materials shall be of the same material as the bolt.

h. Anti-seize compound shall be used on carbon steel fasteners, and shall be Husk-ITT, Husky 2000; or equal.

i. Anti-galling compound used for stainless steel fasteners for other services shall be certified for potable water use and shall be Husk-ITT, Lube O'seal; Hercules, Real-Tuff; La Co, Slic-Tite; or equal.

2. Fastener Material Group Numbering System

a. Flange fasteners shall conform to the following material standards and shall be categorized within the Fastener Material Schedule Groups as indicated:

1) Material Group C1 (Carbon steel): ASTM A307 Grade B bolts, ASTM A563 Grade B nuts with ASTM F436 washers

2) Material Group C2 (Carbon steel): ASTM A193 Grade B7 bolts, ASTM A194 Grade 2H nuts with ASTM F436 washers

3) Material Group S1 (316 SS): ASTM A193, Grade B8M bolts, ASTM A194 Grade 8M nuts with Type 316 SS plain washers.

4) Material Group S2 (304 SS): ASTM A193, Grade B8 bolts, ASTM A194 Grade 8F nuts with Type 304 SS plain washers.

5) Material Group S3 (Hastelloy C-276): ASTM F468 N10276 bolts ASTM F467 N10276 nuts with type Hastelloy plain washers.

3. Fastener Material Group Numbers used in Non-Corrosive Service Applications

a. AWWA C115 ductile iron flanges - Material Group C1

b. AWWA C207 steel flanges - Material Group C2

c. ASME B31 group piping flanges – Material Group C2

d. Non-metallic pipe flanges - Material Group S1

e. Stainless steel pipe flanges and all others not listed above - Material Group S1

f. Where mating flanges are of different flange material standards and the specified Fastener Material Groups are in conflict, then fasteners of the higher grade shall be utilized unless otherwise indicated. For the purpose of this requirement, the Material Groups in order of decreasing grade shall be S1, C2, C1. Provide insulating flange sets for dissimilar metal flanged piping to electrically isolate the dissimilar piping.

g. Where gaskets of Teflon or Viton-A are required, fasteners of Material Group C2 shall be utilized for all C1 flange standards.

4. Fastener Material Group Numbers used in Corrosive Service Applications

a. All Flange fasteners shall be of Material Group S1 unless S2 and S3 are otherwise indicated on the drawings.

F. Insulating Flanges

1. Insulated flanges shall be provided with bolt holes 1/4-inch diameter greater than the bolt diameter.

G. Insulating Flange Sets

1. In order to prevent corrosion, insulating flange sets shall be furnished on all piping connections where two dissimilar metals are to be connected. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers, and a steel washer.

2. For bolt diameters 1-1/2 inches or smaller, insulating sleeves and washers shall be one piece and shall be made of acetyl resin.

3. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic material.

4. Insulating flange sets materials used for fluids other than general water and wastewater shall be made of materials compatible with the fluid services.

5. Insulating gaskets shall be full-face.

H. Insulating Flange Manufacturer, or Equal

1. JM Red Devil, Type E

2. Fluid Sealing Products, Inc.

3. Enpro Industries, Inc. (GPT)

I. Flange Gaskets

1. Gaskets for flanged joints used in general water and wastewater service shall be full faced type in accordance with AWWA C207, suitable for temperatures to 700 degrees F, a pH of one to 11, and pressures to 1000 psig.

2. Blind flanges shall be provided with gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange.

3. Ring gaskets will not be accepted unless otherwise indicated.

4. Unless otherwise indicated, flange gaskets up to 150 psi shall be EPDM sheet material, NSF 61 approved, **Garlock, Style 98206-U (unbranded), or similar products from John Crane, or equal**.

5. Unless otherwise indicated, flange gaskets up to 500 psi shall be aramid fiber with rubber binder material, NSF 61 approved, Garlock**, Style 3760-U (unbranded), or similar products from John Crane, or equal**.

6. Gaskets for flanged joints in PVC and CPVC piping used in general water and wastewater service shall be NSF 61 approved, full-faced, 1/8-inch thick, and made of fluoroelastomer having a durometer hardness of 50 to 70. Gaskets for pipe sizes up to 24-inch and 150 psi shall be Garlock Style XP or similar products from John Crane, or equal.

7. When the mating flange has a raised face, provide stainless steel flat ring gasket filler between the PVC flange and gasket and the adjacent flange.

8. Gaskets for flanged joints used in chemicals, hot air, ozone gas, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature. Consult gasket Manufacturer for recommended gasket material.

2.03 PIPE THREADS

A. Pipe threads shall be in conformance with ASME B1.20.1 - Pipe Threads, General Purpose (inch), and be made up with Teflon tape unless otherwise indicated.

B. Unless otherwise indicated, use metal FNPT and plastic MNPT for threaded pipe connections between metal and plastic pipes.

2.04 THREADED INSULATING CONNECTIONS

A. General

1. Threaded insulating bushings, unions, or couplings, as appropriate, shall be furnished for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials

1. Threaded insulating connections shall be constructed of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.05 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

A. Where indicated and where required in order to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures.

B. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 degrees F and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening.

C. Assemble the links using Type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe.

D. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material.

E. After the seal assembly is positioned in the sleeve, tighten the bolts against the pressure plates to expand the rubber links and form the watertight seal.

F. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.

G. Modular Mechanical Seals Manufacturer, or Equal

1. EnPro Industries Company (GPT), Link-Seal

2. Proco Products, Inc., Pen-Seal

2.06 CATHODIC PROTECTION

A. Where indicated, buried piping shall be cathodically protected in accordance with the requirements of the Contract Documents.

2.07 GLASS LINING

A. General

1. Ductile iron or steel pipe and fittings shall be glass-lined where indicated.

2. The glass lining shall be suitable for handling sewage, primary sludge, digested sludge, grit, and scum.

3. The lining shall be smooth, continuous, and suitable for prevention of grease and foam build-up.

4. The glass lining shall be capable of withstanding thermal shock of 350 degrees F (from 430 degrees F to 80 degrees F) without crazing, blistering, or spalling.

B. The glass lining shall consist of a vitreous material to meet or exceed the following criteria:

1. Unaffected by scraping with a sharp knife, simulating the effects of rodding.

2. Unaffected by the continuous application of live steam from a steam generator, immediately followed by a cold-water quench.

3. Unaffected by an 8-percent sulfuric acid solution at 148 degrees F for a 10-minute period.

4. A minimum thickness of 10 mils by micro test.

5. Spark-tested to be free of pinholes.

6. A hardness of 5 to 6 Mohs; and,

7. A density of 2.5 to 3.0 g/cu cm, measured by ASTM D 792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.

C. Application

1. Cast or ductile iron pipes and fittings shall be bored or machined smooth in order to remove voids or protrusions.

2. Steel pipe shall be seamless pipe, with internal fitting welds ground smooth, slag holes ground out, re-welded, and ground smooth.

3. Interior surfaces shall be grit-blasted to white metal, and lining shall be fused onto chemically clean metal at above 1400 degrees F.

4. Welded flanges shall be factory-installed before lining.

5. Threaded flanges or cast and ductile iron pipes shall be installed after lining.

6. Pieces shall be sealed and tested prior to shipment.

7. Finish shall be subject to the Engineer's approval.

D. Manufacturer, or Equal

1. Pfaudler, Inc.

2. A.O. Smith Corp.

3. U.S. Pipe

PART 3 -- EXECUTION

3.01 GENERAL

A. This section specifies the general installation requirements for piping, valves, and related items and shall be installed in accordance with the manufacturer's technical data and printed instructions. Specific piping materials, systems, appurtenances, and related installation and testing requirements are specified in related sections of Divisions 01, 33, and 40, and as noted on the Drawings and Pipe Schedules.

B. Piping shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

C. Contractor shall obtain the assistance of the pipe manufacturer to instruct the pipe fitters in the correct installation and support of the piping system. Valves and flanges attached to the pipe shall be provided with adequate supports.

D. Lined Piping Systems

1. The lining manufacturer shall take full responsibility for the complete, final product and its application.

2. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

3.02 INSTALLATION

A. Installation shall be free from defects. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true straight. Ends of threaded pipes shall be reamed and filed smooth. Groove ends shall be clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove. Fittings shall be equally cleaned before assembly.

B. Building gravity flow plumbing pipes shall be installed in a neat and workmanlike manner, in accordance with the prevailing plumbing and building codes. Pipes shall have the required slopes for proper drainage. Pipe locations inside buildings shall be coordinated with the rest of the Work to avoid interferences and to provide sufficient headroom. Installations shall be acceptable to the local plumbing inspector.

C. Supports and Anchors: Piping supports, thrust, and seismic restraints shall be provided where shown on the Drawing or were determined to be required in according to Section 40 05 07 - Hangers and Supports for Process Piping. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Pipe shall be firmly supported with fabricated or commercial hangers or supports.

D. Piping Joints: Pipe joints requirements shall conform to the applicable piping sections of Division 33 and Division 40.

1. Threaded Joints: Pipe threads shall be full and cleanly cut with sharp dies. Not more than 3 threads shall remain exposed after installation.

2. Welded Joints: Welded joints shall conform to the specifications and recommendations of ASME B 31.1 - Power Piping. Welding shall be done by skilled and qualified welders. Pipe surface residues, oxides, and heat stains are to be removed from a field weld and the affected areas adjacent by the use of stainless-steel wire brushes. For alloy and stainless-steel pipe, the post welding surfaces shall be cleaned with a pickle agent such as nitric/hydrofluoric acid solutions or pickle paste or equal, then complete removal of the agent by wash the surface thoroughly with clean water.

3. Flange Joints: Flanged joints shall be made with gaskets with bolts and nuts as specified. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

4. Fusion-Welded Joints: Fusion-welded joints shall be made with the manufacturer's recommended equipment on clean, dry pipe ends. The joints shall be made up at the recommended ambient temperatures, to the pipe manufacturer's written recommendations. The pipe supplier shall be consulted to obtain machinery and expertise for the joining by fusion welded of pipe and fittings. No pipe or fittings shall be joined by fusion by any of the Contractor's personnel unless they are adequately trained and qualified in the techniques involved. Butt fusion joining shall yield a joint strength equal to or greater than the tensile strength of the pipe. Socket fusion, extrusion welding and hot gas welding shall not be used for field connections.

5. Brazed and Soldered Joints: Brazed and soldered joints shall conform to the manufacturer’s recommendations and to the specifications and recommendations of ASME B 31.1 - Power Piping. Brazing shall be done by skilled and qualified welders. Prior to the application of flux, the ends of tubes shall be thoroughly dried and cleaned

6. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conform to AWWA C 606 – Joints, Grooved and Shouldered Type. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

7. Push On Joints: Push on joints and gasket installation shall be in accordance with the manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

8. Solvent-Welded Joints: Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept always closed and the joints shall be made up at the recommended ambient temperatures, to the pipe or cement manufacturer's written recommendations. PVC socket connections shall be joined with PVC cement conforming to ASTM D2564 Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC). CPVC socket connections shall be joined with CPVC solvent cement conforming to ASTM F493. For chemical service applications, solvent cement shall be formulated and labeled for use on that chemical.

9. Adhesive Joints: Adhesive joints shall be made with freshly-mixed 2-part epoxy on clean, dry pipe ends per pipe manufacturer recommendations. The joints shall be made up at the recommended ambient temperatures, to the pipe or adhesive manufacturer's written recommendations. Pipe ends shall be inserted to the full depth of the socket.

E. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

F. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment. Unless otherwise indicated for threaded pipe connections between metal and plastic pipes, use metal FNPT and plastic MNPT.

1. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

G. Isolation Joints / Dielectric Protection: Provide electrically isolate connections between dissimilar metal piping connections. Electrical checks shall be made to assure no contact is made between dissimilar metal piping elements.

1. Use dielectric couplings specially designed for the prevention of galvanic reaction between dissimilar metals.

2. For flanged connections, use stainless steel bolts with isolation bushings, washers, and full-face flange gaskets.

H. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction in order to avoid damage to embedded raceways and reinforcing bars.

I. Coating: Exposed pipes shall be coated with a finish coat to the pipe manufacturer's standard protective coating, with the manufacturer's recommended prime coat and a finish coat in accordance with Section 09 96 00 – High-Performance Coatings.

J. Low points in piping systems and drip legs in steam, gas, and air systems shall have drainage valves.

K. Care shall be taken to ensure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Gasket shall be centered properly on the contact surfaces.

2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected.

3. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

4. Flange Bolts

    a. Flange bolts shall be initially hand-tightened with the piping connections properly aligned.

    b. Bolts shall be tightened with a torque wrench in a staggered sequence to the recommended torque for the applicable piping material per AWWA or manufacturer's recommendation. Care shall be taken to avoid over-torquing the bolts especially on plastic flanged joints.

    c. Harness, thrust restraint, and tie rod bolts used for sleeve couplings, flange coupling adapters, or flexible joints shall be tightened gradually and equally at diametrically opposite sides until snug, in order to prevent misalignment and to ensure that all studs carry equal loads.

    d. In order to prevent induced stress or misalignment, do not over-torque connections to adjoining pump or equipment. Flanges shall not be deformed nor cracked.

3.03 INSPECTION

A. After completion of the Work, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be in a clean and functional condition.

B. Inspection: Finished installations shall be carefully inspected for proper joints and supports, interferences, and damage to pipe, fittings, and coating. Temporary plugs and covers shall be removed from openings and floor drains. Defective Work shall be repaired to the satisfaction of the field engineer or plumbing inspector.

3.04 FIELD TESTING FOR PRESSURE PIPING

A. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than two hours without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish test equipment, labor, materials, and devices as part of the Work. For additional testing requirements, refer to Section 01 74 30 – Pressure Pipe Testing.

B. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

C. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

3.05 FIELD TESTING FOR GRAVITY PLUMBING PIPING

A. Prior to enclosure or burying, drains and vents shall be tested in the presence of the local plumbing inspector and the Engineer for a period of not less than one hour, or as requested by the plumbing inspector if the request is more stringent. The Contractor shall furnish test equipment, labor, material, and devices as part of the Work. Defective Work shall be repaired to the satisfaction of the plumbing inspector, and the piping shall be re-tested until no leaks are found.

B. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

C. Testing and defective Work shall be repaired to the satisfaction of the plumbing inspector.

END OF SECTION

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SECTION 40 05 02 – PIPING IDENTIFICATION

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide identification for the piping and valves, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
09 96 00	High-Performance Coatings

B. Commercial Standards

American Society of Mechanical Engineers (ASME)	
ASME A13.1	Scheme for the Identification of Piping Systems

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Provide a list of the suggested wording for each pipe label and valve tag, prior to fabrication.

C. Samples

1. Sample of each type of identification device.

2. Sample of each proposed color required by the pipe color schedule.

PART 2 -- PRODUCTS

2.01 EXPOSED PIPING OR ABOVE GROUND PIPING IDENTIFICATION

A. Pipe markers, type as indicated below, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

1. Marker Type

a. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.

2. Marker Area: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

3. Lettering: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

4. Arrows: At least one arrow at each marker area, showing direction of flow.

B. Pipe 1-inch diameter and smaller or pipe not suitable for the marker type(s) listed above shall be identified with aluminum or stainless-steel pipe identification tags with stamped-in ¼-inch high identification lettering.

C. Manufacturer or Equal

1. Seton Identification Products, Opti Code Pipe Markers (adhesive type)

2. Grainger, Inc. (adhesive, snap around)

3. Marking Services, Inc..(adhesive, snap around)

2.02 BURIED PIPELINE IDENTIFICATION

A. Underground Warning Tape

1. Material:

a. Polyethylene tape or polyolefin film. The material and ink shall be chemically inert and shall not degrade when exposed to acids, alkalis and other destructive substances commonly found in soil.

b. 6-inch wide tape with a minimum 4 mil thickness.

c. Message: “CAUTION, LINE BURIED BELOW” with the name of the fluid service in black lettering on a colored background.

1) Water: Blue

2) Sewer: Green

3) Gas and other services: Yellow

4) Other services: colors as approved by the Owner.

2. Manufacturer, or Equal

a. Reef Industries, Inc.

b. Seton Identification Products

c. T. Christy Enterprises, Inc.

B. Tracer Wire

1. Material:

a. Solid copper conductor with 30 mil HMWPE.

b. 10 gauge or thicker wire.

2. Manufacturer, or Equal

    a. Kris-Tech Wire

    b. Corrpro Companies, Inc.

C. Witness Markers

1. Material:

    a. UV resistant glass fiber and resin reinforced thermosetting composite material.

    b. Constructed as a single pipe with pointer at the bottom end.

    c. Message of the markers “CAUTION, LINE BURIED BELOW” with the name of the fluid service, and the following information:

        1) Phone number for underground service alert.

        2) Phone number for Owner in case of emergency.

        3) Application station number and offset information if marker is not directly over the pipe.

        4) Name of buried appurtenance or fitting if applicable.

2. Manufacturers, or Equal

    a. Carsonite® Composite Utility Marker

    b. Berntsen International, Inc.

2.03 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the Contractor shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the system indicated herein.

2.04 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Valves and sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.

B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to the valves or short pipes.

C. Wording on valve tags shall describe the exact function of each valve (e.g., "HWR-BALANCING," "CLS THROTTLING", "RAS-PUMP SHUT-OFF," etc.) and include the valve number as indicated in the Contract Drawings. Wording on small pipes shall describe the contents of the pipe.

2.05 PIPE COATING:

A. Unless otherwise indicated, pipe coating shall be in conformance with Section 09 96 00 – High-Performance Coatings.

PART 3 -- EXECUTION

3.01 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.02 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.03 MARKER LOCATIONS

A. Each pipe shall be marked at:

1. Intervals of 20-feet in straight runs.

2. At least once in every room.

3. Within 2 feet of turns, elbows, and valves.

4. On the upstream side of tees, branches, and other distribution points.

5. On both sides of walls and floors through which the piping passes.

3.04 IDENTIFICATION COLORS

A. Conform to the following color codes.

Pipe Contents		Marker Color	Letter Color	Pipe Color
Symbol	**Service**			
D	Drain	green	white	
G	Grit	green	white	
NG	Natural Gas	yellow	black	
NPW	Non-Potable Water	green	white	
PA	Plant Air Containment	blue	white	
PI	Primary Influent	green	white	
RS	Raw Sewage	green	white	

Pipe Contents		Marker Color	Letter Color	Pipe Color
Symbol	**Service**			
RWL	Rainwater Leader	green	white	
RWO	Rainwater Leader Overflow	green	white	
SD	Sanitary Drain	green	white	
SEP	Septic	green	white	
SS	Sanitary Sewer	green	white	
WAS	Waste Activated Sludge	orange	black	
VT	Vent	blue	white	

END OF SECTION

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SECTION 40 05 06 – COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide pipe couplings indicated, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 01 - Piping General apply to the Work of this Section.

C. The provisions of this Section shall apply to piping in Divisions 33 and 40, and on the Drawings.

D. The couplings, adapters and joints shall be provided with restraining devices to restrict pipe axial movement. Where the restraining devices and/or details are not indicated on the Drawings, it is the Contractor's responsibility to provide the devices/details necessary to restraint the piping system.

E. The items specified in this section include the following:

1. Groove Couplings
2. Sleeve Couplings
3. Flanged Coupling Adapters
4. Dismantling Joints
5. Expansion Joints
6. Flexible Connectors
7. Transition Couplings.
8. Quick Disconnect Couplings
9. Tapping Sleeves
10. Miscellaneous Adapters

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Product submittals and shall be specifically identified with the applicable style or series designation, pressure rating and restraint system if applicable.
2. Couplings schedule or layout indicating where the couplings will be installed.

3. Expansion Joints: Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and guides, including information on materials, temperature, and pressure ratings.

4. Flexible Connectors: Submit pressure and thermal expansion calculations.

C. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the Contractor.

1.03 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping couplings, adapters and joints accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be replaced with new materials.

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
09 96 00	High-Performance Coatings
40 05 01	Piping General

B. Reference Standards

American Iron and Steel Institute (AISI)	
AISI 1012	Carbon Steel
ASTM A512	Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing
ASTM A513	Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 576	Steel Bars, Carbon, Hot Wrought, Special Quality
American Water Works Association (AWWA)	
AWWA C207	Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C219	Bolted Sleeve-Type Couplings for Plain-End Pipe
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe: A Guide for Design and Installation

PART 2 -- PRODUCTS

2.01 GENERAL

A. Extent of Work

1. Piping couplings, adapters, joints and accessories shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

2. The Contractor shall not be allowed to substitute any other type of coupling in lieu of the couplings as specified herein unless approved by the Engineer.

3. The Contractor shall assign the responsibility to the coupling manufacturer to review the piping connection to the equipment and submit any modifications to the Engineer for review.

B. Pressure Rating

1. Couplings, adapters, and joints shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

C. Seals

1. Seal elastomer materials shall be selected to be compatible with the fluid service, pressure, and temperature. They shall be composed of elastomeric-compound material that will not deteriorate from age under normal storage or use conditions.

D. Coating

1. Couplings shall be lined and coated at the factory, unless otherwise indicated.

2. Coating shall be in accordance with the Section 09 96 00 – High-Performance Coatings, unless otherwise indicated.

2.02 GROOVED TYPE COUPLINGS

A. General

1. Provide cast grooved type couplings where indicated, conforming to the requirements of AWWA C606 - Grooved and Shouldered Joints.

2. Grooved or banded piping shall conform to the coupling manufacturer's recommendations to suit the highest expected pressure.

a. If grooved connections are used, the remaining thickness of pipe material after grooving shall be adequate to carry the load imparted to the joint. Joints for thin wall pipes shall be banded or welded with a collared end to fit coupling.

b. Rolled pipe ends are not acceptable as a means of connection for metallic piping.

3. Equipment connections with mechanical-type couplings shall be provided with rigid grooved couplings or flexible type coupling with harness in sizes where rigid type couplings are not available, unless thrust restraint is provided by other means.

4. Couplings shall be electrically bonded.

5. For uniformity and compatibility of the piping components; grooving tools, grooved fittings, couplings, and valves shall be furnished by the same manufacturer as the coupling.

B. Grooved Type Couplings Manufacturer, or Equal

1. Grooved couplings for ductile iron piping shall be provided with flush seal gaskets.

a. Victaulic Company, Style 31 (flexible or rigid)

b. Gustin-Bacon (banded or grooved)

2. Grooved couplings for steel piping

a. Victaulic Company, Style 177 / 77 / W77 (grooved, flexible, or rigid)

b. Victaulic Company, Style 107H / 07 / W07 or HP-70 (grooved, rigid)

c. Gustin-Bacon (banded or grooved)

3. Grooved couplings for stainless steel piping

a. Victaulic Company, Style 489 (rigid)

b. Victaulic Company, Style 77S (flexible)

c. Gustin-Bacon (banded or grooved)

2.03 SLEEVE COUPLINGS

A. General

1. Provide sleeve couplings specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe.

2. Couplings shall be constructed without pipe stop.

3. The middle ring shall be at least the same wall thickness as the pipe to which the coupling is connected and not less than 1/4-inch thick.

4. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. For standard sleeve couplings, the coupling shall be either 5 or 7 inches long for pipe diameters up to and including 30-inch and 10 inches long for pipe diameters greater than 30-inch. For long sleeve couplings, the coupling shall be 16 inches long for all pipe diameters.

6. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling.

C. Insulating Sleeve Couplings

1. Where insulating couplings are required, both ends of the coupling shall be provided with a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of coupling metal parts from the pipe.

D. Sleeve-Type Couplings Manufacturer, or Equal

1. World Wide Metric, Inc. (Dresser), Style 38

2. Ford Meter Box Company, Inc., Style FC1 or FC3

3. Smith-Blair, Inc., Style 411

2.04 FLANGED COUPLING ADAPTERS

A. Provide flanged coupling adapters specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or ASTM A513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012 – Carbon Steel.

C. Flanged Couplings Adapter Manufacturer, or Equal

1. Smith-Blair, Inc., Model 913

2. Dresser®, Style 128-W

3. JCM Industries, Inc., Model 303

2.05 DISMANTLING JOINTS

A. Provide dismantling joints products specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A 512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012 – Carbon Stee.

C. Dismantling Joints Manufacturer, or Equal

1. Smith-Blair, Inc., Model 975

2. Dresser®, Style 131

3. JCM Industries, Inc., Model 309

2.06 EXPANSION JOINTS

A. Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures, accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints.

B. Expansion joints shall be provided with flanged ends and constructed of stainless steel, Monel, rubber, or other materials best suited for each individual service.

C. Where bellows-type expansion joints are mounted near the suction nozzle of the pump, a stainless-steel internal liner shall be provided to minimize turbulence as the flow passes through the arches of the bellows.

2.07 FLEXIBLE CONNECTORS

A. Low-Temperature

1. Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated.

2. Flexible connectors for service temperatures up to 180 degrees F shall be flanged-reinforced neoprene or butyl spools, rated for a working pressure of 40 to 150 psig, or reinforced flanged duck and rubber, as best suited for the application.

3. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for a minimum 150-psig working pressure, unless otherwise recommended by the equipment manufacturer.

4. The connectors shall be a minimum of 9 inches long and provided with face-to-face flanges, unless otherwise indicated.

5. The final material selection shall be approved by the manufacturer.

B. High-Temperature (temperature exceeding 250 degrees F (120 degree C))

1. Install flexible connectors in engine exhaust piping and where indicated.

2. Connectors shall be sufficient to compensate for thermal expansion and contraction and to isolate vibration between the engine and the exhaust piping system.

3. Connectors shall be stainless steel bellows-type, flanged, and rated for minimum 150 psig, 2000 degrees F.

2.08 TRANSITION COUPLINGS

A. Provide transition-coupling products specifically designed suitable for the fluid service and manufactured for the piping applications.

B. The transition couplings shall have function and design similar to the flexible couplings, joint and flanged coupling adapters for connecting piping having different outside diameters.

2.09 QUICK DISCONNECT COUPLINGS

A. Quick disconnect couplings shall be of the cam lock type (cam and groove type) consisting of a male adapter conforming to Specification MIL A-A-59326A. Male adapters shall be designed to receive a female coupler without requiring threading, bolting, or tools. Connections shall remain tight and leak proof up to full system pressures.

B. Each adapter shall be furnished with a dust cap complete with an 18-in long security chain of corrosion resistant material.

C. Unless otherwise indicated, the quick disconnect couplings shall be flanged connection to piping and materials shall be Type 316 stainless steel.

D. Quick connect couplings shall be as manufactured by **LMC-Couplings**; **Dover Corporation**; **Ever-Tite Coupling Products**; or equal.

2.10 TAPPING SLEEVES

A. Provide tapping sleeve products specifically designed suitable for the fluid service and manufactured for the piping applications.

B. Unless otherwise indicated, the tapping sleeves shall be of full circumference band with flanged outlet connection sized to ANSI class 150. Material of construction for the body and fastener shall be stainless steel.

C. Gasket material: Nitrile (Buna-N) or EPDM.

D. Tapping sleeves shall be as manufactured by **Smith-Blair Inc.**; **Romac Industries Inc.**; **Dresser®**, or equal.

2.11 MISCELLANEOUS ADAPTERS

A. A special pipe adapter may be required to provide proper connection between different type of pipes and/or fittings. The adapter may be indicated on the Drawing with the pipe type or equipment. However, it is the Contractor's responsibility to ensure proper connection between various type of pipes and pipe appurtenances. Provide adapters as required whether specifically indicated or not.

B. Provide piping adapter products specifically designed suitable for the fluid service and manufactured for the piping applications.

PART 3 -- EXECUTION

3.01 GENERAL

A. Installation, inspection, and field testing of the pipes shall in accordance with the requirements of Section 40 05 01 - Piping General.

B. The Contractor shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation.

C. The Contractor shall assign the responsibility to the couplings manufacturer to review the piping connection to the couplings and submit any modifications to the Engineer for review.

3.02 INSTALLATION

A. Where couplings are shown to connect piping to mechanical equipment such as pumps, compressors, and blowers, the piping shall be aligned with the equipment point of connection and shall be perpendicular to the axis of the flange or fitting for which the piping is to be connected.

B. The couplings or the piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment.

C. Restrained Joints on couplings, adapters, and joints

1. Couplings, adapters, and joints on pressure lines shall be harnessed unless thrust restraint is provided by other means.

2. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA M11, or as indicated.

3. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

4. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation in order to prevent misalignment of the pump imparted by the thrust within the piping system.

5. Other means of restraining the coupling such as set screws on piping will not be accepted.

END OF SECTION

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SECTION 40 05 07 – HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide pipe supports, hangers, guides, and anchors, complete and in place, as indicated in accordance with the Contract Documents.

B. Where pipe support systems are not indicated on the Drawings, the Contractor shall design and provide the supports in accordance with this Section. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing the pipe supports.

C. The provisions of this Section shall apply to piping in Divisions 33 and 40.

1. The Contractor shall provide supporting devices for supporting and restraining piping as indicated on the Drawings. Where pipe support devices and/or restraining details are not indicated on the Drawings, it is the Contractor's responsibility to develop the details necessary to support and restraint the piping for a complete and functional pipe support system.

D. Seismic and Wind Forces

1. Pipe support details indicated in the Contract Drawings are sized for gravity loads only, and not designed to resist seismic and wind forces. However, pipe support details indicating “SEISMIC COMPLIANCE” on drawings are designed to resist seismic and wind forces.

2. The Contractor shall arrange for the services of a registered professional engineer experienced in pipe support design to design such pipe supports to resist seismic and wind forces.

3. Piping support seismic and wind loads shall be sized in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit Shop Drawings which shall include the following information:

a. Drawings of pipe supports, hangers, anchors, and guides.

b. Pipe support schedule or layout indicating where the supports will be installed.

c. Calculations for special supports and anchors, stamped and signed by a registered professional engineer in the State of Utah.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
05 50 00	Miscellaneous Metalwork
09 96 00	High-Performance Coatings
40 05 01	Piping General

B. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B31.1	Power Piping
ASTM International (ASTM)	
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)	
ANSI/MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Code Compliance

1. Piping systems and pipe connections to equipment shall be properly anchored and supported in order to prevent undue deflection, vibration, and dislocation due to seismic events, line pressures, pipe weight, fluid weight, liquid movement, thermal changes, vibration, and probable forces applied during construction as well as stresses on piping, equipment, and structures.

2. Supports and parts thereof shall conform to the requirements of ASME B31.1 - Power Piping – Chapter II, Part 5 -Expansion, Flexibility, and Pipe Supporting Element and design the pipe supporting elements in accordance with the rules of MSS SP-58 -Pipe Hangers and Supports – Materials, Design and Manufacture, except as supplemented or modified in this Section.

3. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members

1. Wherever possible, pipes shall be supported from structural members.

2. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the Contractor.

3. Supplementary members shall be in accordance with the requirements of the Building Code and the American Institute of Steel Construction and shall be as acceptable to the Engineer.

C. Pipe Hangers

1. Pipe hangers shall be capable of supporting the pipe in operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment.

2. Hangers shall have a means of vertical adjustment after erection.

3. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe.

4. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves shall include hydraulic shock suppressors.

5. Hanger rods shall be subjected to vertical loading only.

D. Hangers Subject to Lateral or Axial Movement.

1. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement.

2. Where lateral or axial pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold-to-hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers

1. Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping.

2. Spring-type hangers shall be sized per the manufacturer's printed recommendations and for the loading conditions encountered.

3. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate the compression of the spring.

4. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

F. Thermal Expansion

1. Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or expansion joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely away from the anchored points.

2. Components shall be structurally suitable to withstand the imposed loads.

G. Heat Transmission

1. Supports, hangers, anchors, and guides shall be designed and insulated such that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports

1. Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping

1. Freestanding pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to support frames fabricated from angles, channels, or I-beams anchored to the structure.

2. Exterior, freestanding overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, or with horizontal, welded steel angles, and U-bolts or clamps securing the pipes.

J. Materials of Construction

1. Pipe support assemblies, including framing, hardware, and anchors, shall be of steel construction, galvanized after fabrication, unless otherwise indicated.

2. Submerged supports, as well as piping, conduits, and equipment in hydraulic structures located two feet above water level, shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel, unless otherwise indicated.

3. Piping in chemical and corrosive service areas shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

4. Corrosive service areas are indicated in Section 40 05 01 – Piping General, 1.2 Definitions - Corrosive Service.

K. Point Loads

1. Meters, valves, heavy equipment, and other point loads on PVC, FRP, or other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations, in order to avoid undue pipe stresses and failures.

2. In order to avoid point loads, the supports on PVC, FRP, or other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields for general service and Type 316 stainless steel shields for chemical or corrosive areas.

L. Concrete Anchors

1. Unless otherwise indicated, concrete anchors for pipe supports shall be according to the following table: consult the Engineer for any anchor applications not appearing on the table.

2. Anchor embedment shall be in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

Pipe Support Application	Type of Concrete Anchor

New Concrete	Use embedded concrete insert anchors on a grid pattern. Use **Grinnell (Anvil International), Tolco**, or equal.
Existing Concrete	Use non-shrink grouted anchors, expansion anchors, or epoxy anchors. Epoxy anchors are not permitted for vertical hanging applications or where sustained tension is exerted on the anchor. Exceptions: Expansion anchors and epoxy anchors are not permitted for pipe supports subject to vibrating loads. Epoxy anchors are not permitted where the concrete temperature is in excess of 100-degree F or higher than the limiting temperature recommended by the manufacturer.
Vibratory Loads and High-Temperature Conditions	Use non-shrink grouted anchors.

M. Noise Reduction

1. In order to reduce the transmission of noise in piping systems, copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar suitable material at each pipe support, bracket, clip, or hanger.

2.02 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads.

B. Where pipe spacing are indicated on the Drawings and are referenced to a Standard Detail, that requirement shall take preference over the general requirements of this section.

C. Pipe support spacing shall not exceed the maximum indicated spans. Piping with grooved joint couplings, flexible joints, and bend fittings shall be balanced supported by a minimum of two pipe supports per pipe length, one at near each joint/fitting.

D. For temperatures other than ambient temperatures or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations.

E. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of loading effects.

F. Steel Pipe

1. Where support spacing is not indicated on the Drawings, the Contractor shall use the spacing below.

2. Support spacing for standard wall or heavier welded steel, stainless steel or alloy steel pipe.

Nominal Pipe Diameter, Inches	Maximum Span, ft (Water Service)	Maximum Span, ft (Gas or Vacuum Service)
1/2	6	7
3/4 and 1	8	9
1-1/4 to 2	10	12
3	12	14
4	14	15
6	16	18
8 and 10	18	20
12 and 14	20	24
16 and 18	22	26
20 and greater	24	30

G. Ductile Iron Pipe

1. Install supports for ductile iron pipe in accordance with the recommendations of the Ductile Iron Pipe Research Association (DIPRA) Design of Ductile Iron Pipe on Supports.

2. As a minimum, where support spacing is not indicated on the Drawings, the Contractor shall use the spacing indicated in the following schedule:

Nominal Pipe Diameter, inches	Support Configuration
All diameters	two supports per pipe length, with one of the two supports located at a joint

H. Copper Tube

1. Where support spacing is not indicated on the Drawings, the Contractor shall use the spacing below:

Nominal Tube Size, inches	Support Spacing, feet	
	Water Service	Vapor Service
¾ and smaller	5	5
1	6	8
1-1/2 to 2-1/2	8	10
3	10	14
4	12	16
5	13	18
6	14	20

8	16	23

I. Schedule 80 PVC and CPVC Pipe

Nominal Pipe Size, inches	100 °F and below	101 to 120 °F	121 to 140 °F
1	5	3.5	3
1-1/2	5.5	3.5	3.5
2	6	4	3.5
3	7	4.5	4
4	7.5	5	4.5
6	9	6	5
8	9.5	6.5	5.5
10 and larger	10	7	6

J. Other Pipe Materials

1. Support spacing for pipe constructed of other materials shall be based on design temperature and in accordance with the pipe manufacturer's recommendations.

2.03 MANUFACTURED SUPPORTS

A. Stock Parts

1. Where not specifically indicated, designs that are generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.

2. Such parts shall be locally available, new, of best commercial quality, and designed and rated for the intended purpose.

B. Manufacturers, or Equal

1. Basic PSA, Inc.

2. Bergen-Paterson Pipe Supports Group

3. Grinnell

4. Power Piping Company

5. TOLCO (Eaton B-Line)

2.04 COATING

A. Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and shall receive protective coatings in accordance with the requirements of Section 09 96 00 – High-Performance Coatings.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Pipe supports, hangers, brackets, anchors, guides, and inserts shall be installed in accordance with the manufacturer's printed instructions and per ANSI/MSS SP-58 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

2. Embedded concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

B. Appearance

1. Pipe supports and hangers shall be positioned in order to produce an orderly, neat piping system.

2. Hanger rods shall be vertical, without offsets.

3. Hangers shall be adjusted to line up groups of pipes at the proper slope for drainage and venting, as close to ceilings or roofs as possible, and without interference with other Work.

3.02 FIELD FABRICATION

A. Quality Control

1. Field fabricated pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available.

2. Hangers and supports shall be neat in appearance without sharp corners, burrs, or edges.

END OF SECTION

SECTION 40 05 19 - DUCTILE IRON PROCESS PIPE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Description:

1. Section includes:

a. Ductile iron pipe, ductile iron fittings and gaskets for exposed process piping under the DI02 and DI03 piping designation.

b. Comply with all requirements of Section 40 05 01 - Piping General.

B. Related Sections:

1. This Section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

a. Section 01 33 00 – Submittal Procedures

b. Section 01 60 00 – Products, Materials, Equipment, and Substitutions

c. Section 01 75 00 – Equipment Testing and Plant Startup

d. Section 09 96 00 – High-Performance Coatings

e. Section 40 05 01 – Piping General

f. Section 40 05 06 – Couplings, Adapters, and Specials for Process Piping

g. Section 40 05 07 – Hangers and Supports for Process Piping

C. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe work.

2. Review existing ductile iron pipe materials and installation including actual pipe diameter, wall thickness, linings and appurtenances and coordinate with new piping, fittings and appurtenances to properly transition between the existing and new installations.

3. Review existing ductile iron and cast iron wall fittings and coordinate with new piping, fittings and appurtenances to properly transition between the steel pipe and ductile iron pipe installations.

1.2 REFERENCES

A. Reference Standards:

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references

under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ASTM A183	Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High-Temperature or High-Pressure Service and Other Special Purpose Applications
ASTM A194/A194M	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
ASTM A354	Standard Specification for Quenched and Tempered Alloy Steel Bolts, Stud and Other Externally Threaded Fasteners
ASTM A449	Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A716	Standard Specification for Ductile Iron Culvert Pipe
ASTM C150/C150M	Standard Specification for Portland Cement
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates
ASTM G14	Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)
ASTM G62	Standard Test Methods for Holiday Detection in Pipeline Coatings
AWWA C104 (ANSI A21.4)	Cement-Mortar Lining for Ductile- Iron Pipe and Fittings
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings
AWWA C111 (ANSI A21.11)	Rubber-Gasket Joints for Ductile- Iron Pressure Pipe and Fittings
AWWA C115 (ANSI A21.15)	Flanged Ductile-Iron or Gray-Iron Pipe With Threaded Flanges
AWWA C150 (ANSI A21.50)	Thickness Design of Ductile-Iron Pipe
AWWA C151 (ANSI A21.51)	Ductile-Iron Pipe, Centrifugally Cast
AWWA C153 (ANSI A21.53)	Ductile-Iron Compact Fittings
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Joints

Reference	Title
NACE RP0188	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NAPF 500	Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings
SSPC PA 2	Measurement of Dry Coating Thickness with Magnetic Gages
SSPC	Painting Manual, Volume 1, Paragraph XIV

1.3 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures and the following supplemental requirements.

B. Action Submittals

1. Procedures: Section 01 33 00 – Submittal Procedures.

2. Detailed Shop Drawings and data for pipe, fittings, gaskets, appurtenances, linings and coatings.

C. Informational Submittals

1. Procedures: Section 01 33 00 - Submittal Procedures.

2. Certifications specified in the following documents:

a. AWWA C110, certification of inspection and testing.

b. AWWA C111, record of specified tests.

c. AWWA C115, affidavit of compliance.

d. AWWA C151, Manufacturer’s statement and affidavit of compliance.

e. AWWA C153, Manufacturer’s statement and affidavit of compliance.

f. AWWA C606, affidavit of compliance.

3. Submit certificate signed by the applicator of the linings and coatings stating that product to be applied conforms to applicable referenced standards and that the applicator shall conform to the Contract Documents.

1.4 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of five (5) years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five (5) installations in satisfactory operation in the United States that are similar applications to the specified service.

B. Lining and coating products shall be manufactured by a firm with a minimum of five (5) years successful experience in protecting pipelines exposed to the specified service conditions and shall be able to show evidence of at least five (5) installations in satisfactory operation in the United States that are similar applications to the specified service.

C. Tests: Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

D. The Contractor shall perform said material tests as part of the Work. The Engineer shall have the right to witness testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

E. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished as a part of the Work.

F. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 Days prior to the start of any phase of the pipe manufacture.

G. During the manufacture of the pipe, the Engineer shall be given access to areas where manufacturing is in process and shall be permitted to make inspections necessary to confirm compliance with the Specifications.

H. Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	AWWA C151
Gravity service pipe	AWWA A716
Joints	
Gasket	AWWA C111
Threaded flange	AWWA C115
Fittings	AWWA C110
Cement mortar lining	AWWA C104

I. Supply and Compatibility:

1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe Manufacturer.

2. All grooved joint couplings, fittings and specialties shall be the product of a single Manufacturer.

3. All castings used for coupling housings, fittings, valve bodies, etc. shall be date stamped for quality assurance and traceability.

4. Ductile iron pipe Manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe Manufacturer's facility or at Manufacturer's suppliers' facilities.

1.5 DELIVERY, STORAGE AND HANDLING

A. Shipment, protection and storage shall conform to the requirements specified in Section 01 60 00 – Products, Materials, Equipment, and Substitutions and the Manufacturer's written recommendations.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

A. Provide products of:

1. **American Cast Iron Pipe Company**,

2. **Clow Water Systems Company**,

3. **U.S. Pipe and Foundry Company**,

4. Or Engineer approved equal.

2.2 MATERIALS

A. Pipe:

1. Flanged Pipe

a. Fabricate flanged pipe in accordance with AWWA C115.

b. Pipe barrel shall be manufactured in accordance with AWWA C151.

c. Unless otherwise specified, flanged ductile iron pipe shall be Special Thickness Class 53 for pipe sizes three (3) inch through 54 inch.

2. Non-Flanged Pipe

a. Manufacture pipe in accordance with AWWA C151.

b. Unless otherwise specified, grooved-end ductile iron pipe shall be Special Thickness Class 53 for pipe sizes three (3) inch through 54 inch.

c. Unless otherwise specified, push-on ductile iron pipe shall be Pressure Class 250 for pipe sizes three (3) inch through 64 inch.

B. Joints:

1. Unless otherwise specified, restrained joints are required for all exposed and buried piping. Restrained joints shall be flanged or grooved end for exposed service and restrained push-on or restrained mechanical joint for buried service.

2. Provide all joint systems capable of withstanding test pressures specified in Section 40 05 01 – Piping General and the Pipe Schedule.

3. Push-On Joints

   a. Unrestrained joints, where specified, shall be the rubber ring compression, push-on type joint suitable for buried service, by:

      1) Fastite Joint as manufactured by **American Cast Iron Pipe Company**,

      2) Tyton Joint as manufactured by **U.S. Pipe**,

      3) Or Engineer approved equal.

      This joint is not permitted on fittings or specials, unless otherwise specified. Unless otherwise specified, joints shall have an allowable deflection up to five (5) degrees at specified pressures. Joint assembly and field cut joints shall be made in strict conformance with AWWA C600 and Manufacturer's recommendations.

   b. Restrained push-on joints shall be as specified above, modified for restraint. Joints shall be:

      1) Flex-Ring or Lok-Ring Joint as manufactured by **American Cast Iron Pipe Company**,

      2) TR Flex Joint as manufactured by **US Pipe**,

      3) Or Engineer approved equal.

   c. Restrained joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and Manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the Owner.

   d. Gaskets: Unless otherwise specified in Section 40 05 01 - Piping General, for a given system, gaskets for push-on joints shall be Vulcanized SBR for liquid containing systems and EPDM for air containing systems, manufactured by the piping system Manufacturer. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.

4. Mechanical Joints

   a. Mechanical joints for above or below ground service shall meet the requirements of AWWA C110 and AWWA C111.

   b. Gland: Provide ductile iron

   c. Gaskets: Unless otherwise specified in Section 40 05 01 - Piping General, for a given system, gaskets for mechanical joints shall be plain tip, Vulcanized SBR for liquid containing systems and EPDM for air containing systems, manufactured by the piping system Manufacturer.

   d. Bolts and nuts: Provide high-strength low alloy steel.

e. Restrained joints: Provide restrained joints for mechanical joint systems. Restrained joints shall be by one (1) of the following systems:

1) Megalug Series 1100, by **EBAA Iron Sales, Inc.**,

2) MJ Coupled Joint, by **American Cast Iron Pipe Co.**,

3) MJ Field Lok, by **U.S. Pipe and Foundry Co.**,

4) Or Engineer approved equal.

5. Flanged Joints

a. Where flanged joints are indicated on the Contract Drawings or specified for pipe sizes four (4) inch through 16 inch, the Contractor may provide rigid grooved-end joints at no additional cost to the Owner with the approval of the Engineer.

b. Flanges shall be ductile iron and shall be threaded-on flanges conforming to AWWA C115 or cast-on flanges conforming to AWWA C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.

c. Gaskets: Unless otherwise specified, gaskets shall be 1/8 inch thick, ring or full face as required by the pipe Manufacturer, of synthetic rubber compound containing not less than 50 percent by volume nitrile or chloroprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets for air services shall meet the requirements above except shall be EPDM, suitable for exposure to temperatures up to 250°F. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe.

d. Bolts and Nuts: Comply with ANSI B18.2.1 and ANSI B18.2.2.

1) Exposed bolts shall conform to ASTM A307, Grade B

2) Exposed nuts shall conform to ASTM A563, Grade A, heavy hex.

3) Exposed bolts in hazardous locations, buried and submerged bolts shall conform to ASTM A193/A193M, Grade B8M, heavy hex, Type 316 stainless steel.

4) Exposed nuts in corrosive locations, buried and submerged nuts shall conform to ASTM A194/A194M, Grade B8M, heavy hex, Type 316 stainless steel.

6. Grooved-End Joints

a. Grooved-end joints shall comply with AWWA C606.

b. Unless otherwise specified, grooved-end joints shall be rigid type for exposed piping and flexible type for buried piping.

c. Gaskets: Unless otherwise specified, gaskets shall be flush seal type, specifically designed to conform to ductile iron pipe surfaces. Gaskets shall be of synthetic rubber compound containing not less than 50 percent by volume nitrile or chloroprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets for air services shall meet the requirements above except shall be EPDM, suitable for exposure to temperatures up to 250°F.

d. Bolts and Nuts: Conform to ASTM A449 and ASTM A183.

e. Grooved-end coupling shall be:

1) Style 31 by **Victaulic**,

2) Or Engineer approved equal.

C. Fittings:

1. Unless otherwise specified, fittings shall conform to AWWA C110.

2. Ends shall be flanged, restrained mechanical joint, restrained push-on, or grooved to suit the conditions specified.

3. Long-radius elbows shall be provided where shown on the Drawings or specified in Section 40 05 01 - Piping General.

4. Grooved end fittings shall be manufactured by the coupling Manufacturer as specified in Section 40 05 01 - Piping General.

5. Gaskets shall be as specified above for pipe joints.

D. Pipe Lining:

1. Ceramic Epoxy Lining:

a. General:

1) Ductile pipe and fittings designated DI02 shall be ceramic-epoxy lined. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment.

2) The lining shall be suitable for handling sewage, primary sludge, digested sludge, and scum.

3) All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

4) The lining shall be smooth, continuous, and suitable for prevention of grease and foam build-up.

5) The epoxy lining shall have the following properties:

a) A permeability rating of 0.00 when tested according to Method A of ASTM E-96 Procedure A with a test duration of 30 days.

b) An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: Section 7.8 Abrasion Resistance.

c) The following test must be run on coupons from factory lined ductile iron pipe:

(a) ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.

(b) ASTM G-95 Cathodic Disbondment 1.5 volts @ 77° F. Results to equal no more than 0.5 mm undercutting after 30 days.

(c) Immersion testing rated using ASTM D-714

(i) 20% Sulfuric acid—No effect after two years.

(ii) 140° F 25% Sodium Hydroxide—No effect after two years.

(iii) 160° F Distilled Water—No effect after two years.

(iv) 120° F Tap Water (scribed panel)—0.0 undercutting after two years with no effect

(v) ASTM G-22 Standard practice for determining resistance of Synthetic Polymeric materials to bacteria. The test should determine the resistance to growth of Acidithiobacillus Bacteria and should be conducted at 30 degrees centigrade for a period of 7 days on a minimum of 4 panels. The growth must be limited only to trace amounts of bacteria.

b. Application:

1) Applicator: The lining shall be applied by a certified firm with a successful history of applying linings to the interior of ductile iron pipe and fittings. All applicators must be independently inspected at least two times per year to ensure compliance with the requirements of this specification. This inspection must be coordinated and reviewed by the manufacturer of the lining material and any deviation from the application and/or quality requirements shall be corrected by the applicator. All inspections shall be in writing and a permanent record maintained.

2) Surface Preparation: Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance that can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the

surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be re-blasted.

3) Lining: After surface preparation and within 12 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40° F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

4) Coating of Bell Sockets and Spigot Ends: Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto 401 Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

5) Number of coats: The number of coats of lining material applied shall be as recommended by the lining Manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

6) Protecto 401 Joint Compound shall be used for touch-up or repair in accordance with Manufacturer's recommendations.

7) Finish shall be subject to the Engineer’s approval.

c. Inspection and Certification:

1) Inspection:

a) All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC PA-2 Film Thickness Rating.

b) The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500-volt test. Any defects found shall be repaired prior to shipment.

c) Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

2) Certification: The pipe or fitting Manufacturer must submit a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

d. Handling: Lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside

the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling. Care should be taken not to let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

e. Manufacturer, no equal

1) **Induron Protecto 401**, no equal

2. Glass Lining:

a. Where indicated in the Pipe Schedule (DI03) for the specific fluid service, ductile iron pipe and fittings shall be glassed lined. Pipe lining shall be as specified on the Contract Documents and per Section 40 05 01 – Piping General.

E. Taps:

1. Provide taps where shown or where required for small diameter piping or instrumentation connections.

2. Provide corporation stops where shown or required.

3. Where pipe wall thickness or tap diameter will not allow engagement of four (4) full threads, provide tapping saddle with outlet joints conforming to Section 40 05 06 – Couplings, Adapters, and Specials for Process Piping.

2.3 FINISHES

A. Coatings:

1. Unless otherwise specified, buried pipe and fittings shall be coated with asphaltic material as specified in AWWA C151, C115 and C110.

2. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 09 96 00 – High-Performance Coatings. Exposed ductile iron piping shall have surface prep and coating in accordance with Section 09 96 00 – High-Performance Coatings.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General:

1. Piping runs specified on the Drawings shall be followed as closely as possible. Proposed deviations shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

2. Buried pipe shall be installed in accordance with AWWA C600.

3. Piping shall be installed as specified in Section 40 05 01 - Piping General.

4. Pipe supports shall be provided as specified in Section 40 05 07 – Hangers and Supports for Process Piping.

3.2 FIELD CUTTING OF GROOVED PIPING

A. The Contractor shall stage an adjustable cut grooving tool on-site for field cutting and field fitting as required. The tool shall be staged for the duration of grooved piping system installation.

3.3 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is dielectric-coated, buried appurtenances shall be coated in kind. Where pipe is encased in polyethylene sleeves, buried appurtenances shall be encased in polyethylene.

B. Installation of Valves: Valves shall be handled in a manner to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust stem packing and operate each valve prior to installation to insure proper operation.

C. Valves shall be installed so that the valve stems are plumb and in the location indicated.

3.4 FIELD QUALITY CONTROL

A. Testing:

1. Testing shall conform to the requirements of Section 01 75 00 – Equipment Testing and Plant Startup and those specified in this Section.

2. Hydrostatic and pneumatic pressure tests shall be conducted in accordance with Section 40 05 01 - Piping General and the Pipe Schedule.

END OF SECTION

SECTION 40 05 31.13 – POLYVINYL CHLORIDE PROCESS PIPE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide polyvinyl chloride (PVC) pressure pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 01 - Piping General and Section 40 05 07 – Hangers and Supports for Process Piping apply to the Work of this Section.

C. This Section includes PVC pressure pipe with solvent-welded, flanged, or threaded joints.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

40 05 01	Piping General
40 05 02	Piping Identification
40 05 07	Hangers and Supports for Process Piping

B. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM International (ASTM)	
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe
ASTM D2467	Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings
ASTM D2564	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM F1498	Taper Pipe Threads 60 Degrees for Thermoplastic Pipe and Fittings
American Water Works Association (AWWA)	
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution

PART 2 -- PRODUCTS

2.01 PIPE MATERIAL

A. PVC pipe shall be made from new rigid unplasticized polyvinyl chloride and shall be normal impact Type 1, Grade 1, class 12454, Schedule 80, listed as compliant with NSF Standard 61, unless otherwise indicated, in accordance with ASTM D1785 –Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

2.02 PIPE JOINTS

A. Pipe joints shall be solvent-welded type with solvent cement and primer as recommended by the pipe manufacturer for the fluid in the pipe.

B. Threaded joints that are necessary to match up to threaded valves or fittings shall be made up with appropriate thread sealant, either paste or tape. Pipe threads shall conform to ASTM F1498 - Taper Pipe Threads 60 Degrees for Thermoplastic Pipe and Fittings and shall be full and cleanly cut with sharp dies or molded.

C. Flanged joints shall be made with solvent-welded PVC flanges, drilled to ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated.

2.03 FITTINGS

A. Solvent Welded and Threaded Fittings: Solvent-welded and threaded fittings shall be Schedule 80 PVC fittings in accordance with ASTM D2467 - Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

B. Flanged Fittings: Flanged fittings shall be Schedule 80 fabricated PVC fittings with Class 150 flanges in accordance with ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2.04 SOLVENT CEMENT

A. Solvent cement shall be in accordance with ASTM D2564 and certified by the manufacturer for the service of the pipe.

B. Potable Water Applications: Solvent cement listed by NSF for potable water applications.

C. Manufacturer: IPS® Corporation, or equal.

PART 3 -- EXECUTION

3.01 GENERAL

A. Installation, inspection, and field testing of the pipes shall in accordance with the requirements of Section 40 05 01 - Piping General.

END OF SECTION

SECTION 40 05 51 – COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 -- GENERAL

1.01 SUMMARY

A. Provide valves, actuators, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated.

C. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls, as indicated.

D. Unit Responsibility

1. The Contractor shall assign a single manufacturer to be responsible for the supply, coordination of design, assembly, testing, and furnishing of each valve; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve Section.

E. Single Manufacturer

1. Where 2 or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
05 50 00	Miscellaneous Metalwork
09 96 00	High-Performance Coatings
26 05 10	Electric Motors
40 05 01	Piping General
40 05 02	Piping Identification
40 05 57	Actuators for Process Valves and Gates

B. Reference Standards

American National Standards Institute (ANSI)	
American Water Works Association (AWWA)	
ASTM International (ASTM)	
ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 216	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

ASTM A 351	Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A 395	Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 515	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 536	Standard Specification for Ductile Iron Castings
ASTM B 62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 584	Standard Specification for Copper Alloy Sand Castings for General Applications
Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)	
MSS SP-25	Standard Marking Systems for Valves, Fittings, Flanges, and Unions
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Furnish the following information on Shop Drawings:

1. valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.

2. complete information on the valve actuator, hydraulic power units (HPU), pneumatic air supply system including size, manufacturer, model number, limit switches, and mounting.

3. cavitation limits for control valves.

4. assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. A valve-labeling schedule, listing the valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. Furnish a technical manual containing the required information for each valve, as indicated.

D. Furnish a spare parts list, containing the required information for each valve assembly, as indicated.

E. Factory Test Data

1. Where indicated, submit signed, dated, and certified factory test data for each valve requiring certification, before shipping the valve.

2. Furnish a certification of quality and test results for factory-applied coatings.

F. Field Test Data

1. Submit signed, dated, and certified field test data for each valve.

PART 2 -- PRODUCTS

2.01 PRODUCTS

A. General

1. Provide valves and gates of new and current manufacture.

2. Provide valves 6-inch and larger with actuators with position indicators.

3. Unless otherwise indicated, provide valve actuators in accordance with Section 40 05 57 – Actuators for Process Valves and Gates.

B. Protective Coating

1. Coat the exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 2-inch and larger in accordance with the requirements of Section 09 96 00 – High-Performance Coatings.

2. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with the indicated requirements.

3. Do not coat the machined flange faces of valves except where such flanges are not adjoining a mating flange as shown in the Contract Documents. Apply rust inhibitor coating on machined surfaces of the flange prior to shipment.

C. Valve Labeling

1. Except when such requirement is waived by the Engineer in writing, provide a label on shut-off valves and control valves except for hose bibbs.

2. Furnish a label composed of 1/16-inch plastic or stainless steel, a minimum of 2 inches by 4 inches in size, as indicated in Section 40 05 02 – Piping Identification, and permanently attached to the valve or on the wall adjacent to the valve as directed by the Engineer.

D. Valve Testing

1. As a minimum, unless otherwise indicated or recommended by the reference standards, test valves 3 inches in diameter and smaller in accordance with the manufacturer’s standard procedure.

2. Factory-test valves 4 inches in diameter and larger as follows:

a. Hydrostatic Testing

1) Subject valve bodies to an internal hydrostatic pressure equivalent to twice the water-rated pressure of the valve.

2) Metallic valves rating pressures shall be based at 100 degrees F.

3) Plastic valves rating pressures shall be based at 73 degrees F, or at a higher temperature according to material type.

4) During the hydrostatic test, there shall be no visible leakage through the valve body, end joints, or shaft seals, nor shall parts of the valve be permanently deformed.

5) Allow test duration of at least 10 minutes, in order to allow visual examination for leakage.

b. Seat Testing

1) Test the valves for leaks in the closed position, with the pressure differential across the seat equal to the water rated pressure of the valve.

2) Provide test duration of at least 10 minutes, in order to allow visual examination for leakage.

3) The leakage rate shall be the more stringent of the following:

a) As recommended by the reference standard for that type of valve; or

b) Leakage past the closed valve not to exceed one fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.

c. Performance Testing

1) Shop-operate the valves from the fully-closed to the fully-open position and reverse under no-flow conditions in order to demonstrate that the valve assembly operates properly.

E. Certification

1. Prior to shipment of valves with sizes larger than 12-inches in diameter, submit certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

F. Valve Markings

1. Permanently mark valve bodies in accordance with MSS SP-25 – Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.02 MATERIALS

A. General

1. Provide materials suitable for the intended application.

2. Provide materials in contact with potable water listed as compliant with NSF/ANSI 61.

3. Ensure that materials not indicated are of high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

4. Unless otherwise indicated, provide valve and actuator bodies conforming to the following requirements:

    a. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 – Gray Iron Castings, Class 30, or to ASTM A 126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings

    b. Ductile Iron: ASTM A 536 – Ductile Iron Castings, or to ASTM A 395 – Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

    c. Steel: ASTM A 216 – Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 – Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

    d. Bronze: ASTM B 62 – Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 – Copper Alloy Sand Castings for General Applications. Bronze materials in contact with potable water service shall be free of lead content meeting the Lead Reduction Act.

    e. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 – Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.

    f. PVC: Polyvinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454

    g. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447

    h. NSF/ANSI 61: Materials shall be listed for use in contact with potable water.

    i. Elastomeric materials used for seat, seals and O-rings shall be compatible with temperature, pressures, and fluid or gas service.

2.03 VALVE CONSTRUCTION

A. Bodies

1. Provide valve bodies that are cast, molded (in the case of plastic valves), forged, or welded, of the materials indicated, and with smooth interior passages.

2. Provide wall thicknesses uniform and in agreement with the applicable standards for each type of valve, without casting defects, pinholes, and other defects that could weaken the body.

3. Perform welds on welded bodies by certified welders and ground welds smooth.

4. Provide valve ends as indicated and rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections

1. Unless otherwise indicated, valves 2-1/2 inches in diameter and smaller may be provided with threaded end connections.

2. Unless otherwise indicated, provide valves 3 inches in diameter and larger with flanged end connections.

3. Flanges, bolts and gaskets shall be as specified in Section 40 05 01 – Piping General.

C. Bonnets

1. Connect valve bonnets to the body by clamping, screwing, or flanging.

2. Provide bonnets of the same material, temperature, and pressure rating as the body.

3. Make provisions for the stem seal with the necessary glands, packing nuts, and yokes.

D. Stems

1. Provide valve stems of the materials indicated, or, if not indicated, of the best commercially-available material for the specific service, with adjustable stem packing, O-rings, chevron V-type packing, or other suitable seal. Bronze materials in contact with potable water shall be NSF 61 approved and free of lead. Elastomeric materials shall be compatible with fluid service.

2. Where subject to dezincification, bronze valve stems shall conform to ASTM B 62.

3. Where dezincification is not a problem, bronze conforming to ASTM B 584 may be used, except that the zinc content shall not exceed 16 percent.

E. Stem Guides

1. Provide stem guides spaced with an L/R ratio not to exceed 200:1. Submit calculations for L/R ratios and guide spacing to the Engineer for review.

2. Stem guides shall have slotted holes and shall be adjustable in two directions.

3. Construct submerged stem guides from Type 316 stainless steel.

F. Internal Parts

1. Provide internal parts and valve trim as indicated for each individual valve.

2. Where not indicated, construct valve trim from Type 316 stainless steel or other material best-suited for the intended service.

G. Nuts and Bolts

1. Unless otherwise indicated, provide nuts and bolts on valve flanges and supports in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork and Section 40 05 01 – Piping General.

2.04 TORQUE TUBES

A. Submerged or buried valves with a remote gearbox and actuator shall be supplied with a torque tube to transfer torque from the actuator to the valve. Torque tubes shall be directly connected to the valve and the floor stand and gear actuator. Each torque tube and floor stand shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, torque tubes shall be made of schedule 40, steel pipe with epoxy coating suitable for the fluid service. Each submerged valve, torque tube, floor stand and actuator shall be pre-assembled and "matched marked" in the manufacturer's shop to ensure proper fit when assembled in field.

2.05 EXTENSION SHAFT STEM

A. Valves mounted in dry areas with gearbox attached to the valve and with remote actuator shall be supplied with an extension shaft stem with universal joint attached to the gear and actuator. All components shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, shaft stem and universal joints shall be made of carbon steel with epoxy coating suitable for the fluid service. Each valve, shaft stem, floor stand and actuator shall be pre-assembled and "matched marked" in the manufacturer's shop to ensure proper fit when assembled in field.

2.06 VALVE ACTUATORS

A. Valve actuators shall be as indicated and as specified in Section 40 05 57 – Actuators for Process Valves and Gates

2.07 VALVE ACCESSORIES

A. Provide valves complete with the accessories required to provide a functional system.

2.08 SPARE PARTS

A. Furnish the required spare parts, suitably packaged and labeled with the valve name, location, and identification number.

B. Furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve.

C. Spare parts are intended for use by the Owner, after expiration of the correction of defects period.

2.09 MANUFACTURERS

A. Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the indicated valves.

PART 3 -- EXECUTION

3.01 VALVE INSTALLATION AND TRIAL OPERATION

A. General

1. Install valves, actuating units, stem extensions, valve boxes, and accessories in accordance with the manufacturer's written instructions and as indicated.

2. Adequately brace gates in order to prevent warpage and bending under the intended use.

3. Firmly support valves in order to avoid undue stresses on the pipe.

B. Access

1. Install valves in a manner to provide easy access for actuation, removal, and maintenance, and to avoid interference between valve actuators and structural members, handrails, and other equipment.

C. Valve Accessories

1. Where combinations of valves, sensors, switches, and controls are indicated, properly assemble, and install such items such that systems are compatible and operating properly.

2. Clearly note the relationship between interrelated items on Shop Drawing submittals.

D. Trial Operation

1. After installation, schedule trial operation witnessed by the Engineer and the Owner representative.

2. All valves shall be cleaned thoroughly of all foreign materials and final adjustments made. The valves shall then be operated through one complete cycle from a fully closed position to a fully open position and back to a fully closed position to verify that the assembly is functional.

3. For control valves that operate in multiple operating scenarios, the Contractor shall simulate all operational scenarios including the hydraulic power units, pilot control system or pneumatic air supply system to demonstrate compliance to the specifications.

4. A field leakage test meeting the maximum allowable specified requirement shall be conducted.

5. Test certificate shall be signed by the valve manufacturer and the Contractor and shall be submitted to the Engineer.

END OF SECTION

SECTION 40 05 57 – ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Provide valve and gate actuators and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility

1. Make the valve or gate manufacturer responsible for the coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.

D. Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
05 50 00	Miscellaneous Metalwork
09 96 00	High-Performance Coatings
40 05 51	Common Requirements for Process Valves

B. Reference Standards

American National Standards Institute (ANSI)	
ANSI/ASME B 31.1	Power Piping
EN55011	Industrial, Scientific and Medical Equipment. Radio-Frequency Disturbance Characteristics
EN50082-2	Electromagnetic Compatibility - Generic Immunity Standard - Part 2 Industrial Environment
American Society of Mechanical Engineers (ASME)	
ASME BPVC SEC VIII	Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
American Water Works Association (AWWA)	
AWWA C 500	Metal-Seated Gate Valves for Water Supply Service
AWWA C541	Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
AWWA C 542	Electric Motor Actuators for Valves and Slide Gates
ASTM International (ASTM)	
ASTM A 105	Forging, Carbon Steel, for Piping Components

International Electrotechnical Commission (IEC)	
IEC 801.5	Surge Immunity Test
IEC 1000-4-5	Electromagnetic Compatibility Testing and Measurement Techniques – Surge Immunity Test
IEC 1000-4-8	Power Frequency Magnetic Field Immunity Test
National Fire Protection Association (NFPA)	
NPFA 70	National Electrical Code

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures and Section 40 05 51 – Common Requirements of Process Valves.

B. Submit Shop Drawing information for actuators with the valve and gate submittals as a complete package.

C. Submit calculations showing dynamic seating and unseating torques versus the output torque of the actuator.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, provide shut-off and throttling valves and externally actuated valves and gates with manual or power actuators.

B. Provide actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, hand wheels, levers, chains, and extensions, as applicable.

C. Provide actuators with torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering.

D. Manufacturers

1. Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer.

2. Where actuators are furnished by different manufacturers, coordinate the selection to result in the fewest number of manufacturers possible.

E. Materials

1. Provide actuators of current models, of the best commercial quality materials, and liberally sized for the required torque.

2. Provide materials suitable for the environment in which the valve or gate is to be installed.

F. Actuator Mounting and Position Indicators

1. Securely mount actuators by means of brackets or hardware specially designed and sized for this purpose and of ample strength.

2. Cast the word "OPEN" on each valve or actuator, with an arrow indicating the direction to open in the counter-clockwise direction.

3. Equip gear and power actuators with position indicators.

4. Where possible, locate manual actuators between 48 and 60 inches above the floor or the permanent working platform.

G. Standards

1. Unless otherwise indicated and where applicable, provide actuators in accordance with AWWA C 542 - Electric Motor Actuators for Valves and Slide Gates.

H. Provide fasteners in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

I. Provide coatings in accordance with the requirements of Section 09 96 00 – High-Performance Coatings.

2.02 MANUAL ACTUATORS

A. General

1. Unless otherwise indicated, provide valves and gates with manual actuators.

2. Provide valves in sizes up to and including 4 inches with direct-acting lever or hand wheel actuators of the manufacturer's best standard design.

3. Provide valves and gates larger than 4-inch with gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the hand wheel.

4. Provide buried and submerged gear-assisted valves, gates, gear-assisted valves for pressures higher than 250 psig, valves 30 inches in diameter and larger, and where indicated, with worm gear actuators, hermetically-sealed water-tight and grease-packed.

5. Valves 6-inch to 24-inch diameter may be provided with traveling-nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves

1. Unless otherwise indicated, provide buried valves with extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys.

2. Where indicated, provide buried valves in cast-iron, concrete, or similar valve boxes with covers of ample size in order to allow operation of the valve actuators.

3. Permanently label the valve box covers as required by the local Utility Company or the Engineer.

4. Provide wrench-nuts in compliance with AWWA C 500 - Metal-Seated Gate Valves for Water Supply Service.

C. Chain Actuator

1. Provide manually-activated valves with the stem located more than 7 feet above the floor or operating level with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains supplied by the valve manufacturer.

2. Construct the wheel and guide from ductile iron, cast iron, or steel.

3. Chains

a. Fabricate the chain from hot-dip galvanized steel or stainless steel, and extend to 5 feet, 6 inches above the operating floor level.

b. Provide an extra strong valve stem on chain-actuated valves in order to allow for the extra weight and chain pull.

c. Provide hooks for chain storage where chains interfere with pedestrian traffic.

D. Floor Boxes

1. Provide hot-dipped galvanized cast iron or steel floor boxes and covers to fit the slab thickness, for operating nuts in or below concrete slabs.

2. For operating nuts in the concrete slab, provide a bronze-bushed cover.

E. Tee Wrenches

1. Furnish buried valves with floor boxes with 2 operating keys or one key per 10 valves, whichever is greater.

2. Size the tee wrenches such that the tee handle will be 2 to 4 feet above ground, and to fit the operating nuts.

F. Manual Worm Gear Actuator

1. Provide an actuator consisting of a single- or double-reduction gear unit contained in a weatherproof cast iron or steel body with cover, and a minimum 12-inch diameter handwheel.

2. Provide the actuator to be capable of a 90-degree rotation and equip the actuator with travel stops capable of limiting the valve opening and closing.

3. Provide the actuator with spur or helical gears and worm gearing.

4. Provide a self-locking gear ratio in order to prevent "back-driving."

5. Construct the spur or helical gears of hardened alloy steel, and the worm gear of alloy bronze.

6. Construct the worm gear shaft and the hand wheel shaft from 17-4 PH or similar stainless steel.

7. Accurately cut gearing with hobbing machines.

8. Use ball or roller bearings throughout.

9. Provide the output shaft end with a spline in order to allow adjustable alignment.

10. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator.

11. Design gearing for a 100 percent overload.

12. The entire gear assembly shall be sealed weatherproof.

G. Design and rate buried gear actuators for buried service, provide with a stainless-steel input shaft, and double-seal on shaft and top cap.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Install valve and gate actuators and accessories in accordance with the requirements of Section 40 05 51 – Common Requirements for Process Valves.

B. Locate the actuators to be readily accessible for operation and maintenance without obstructing walkways.

C. Do not mount actuators where shock or vibrations will impair their operation, and do not attach the support systems to handrails, process piping, or mechanical equipment.

END OF SECTION

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SECTION 40 05 58 – SLUICE GATES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide hydraulic gates with appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all flap gates, slide gates, stop gates, sluice gates, and shear gates, except where otherwise indicated in the Contract Documents.

C. The requirements of Section 01 60 00 – Products, Materials, Equipment, and Substitutions Provisions apply to this Section.

D. The requirements of Section 40 05 57 – Actuators for Process Valves and Gates apply to this Section.

E. The Contractor shall assign to a single manufacturer responsibility for furnishing and functional operation of the hydraulic gates including operators and accessories. The designated single manufacturer, however, need not manufacture more than one part of the units but shall coordinate the design, assembly, testing, and installation of the units.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

AWWA C501	Cast Iron Sluice Gates
AWWA C 513	Open Channel Fabricated Metal Slide Gates
ASTM A 276	Stainless Steel Bars and Shapes
ASTM B 21	Naval Brass Rod, Bar, and Shapes
ASTM B 584	Copper Alloy Sand Castings for General Applications

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Furnish submittals in accordance with Section 40 05 57 – Actuators for Process Valves and Gates.

C. Shop Drawings: Shop Drawings for gates, frames, slides, and actuators, as well as design load calculations for deflection at the maximum expected head shall be submittal.

D. Technical Manuals: Complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary. A list of recommended spare parts for the Owner to store at the facility shall be included.

E. Certification: The Contractor shall obtain written certification from the designated single manufacturer, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Contract Documents, and that the designated single manufacturer accepts the Contractor's assignment of responsibility for coordination of gate equipment, including operators, controls, and services required for proper installation and operation. The Contractor shall submit all such certificates to the Engineer.

F. Field Procedures: Instructions for field procedures for installation, adjustments, inspection, and testing shall be provided prior to installation of the gates.

1.4 QUALITY ASSURANCE

A. Equipment Field Testing: The Contractor shall be responsible for the coordination of the tests of each hydraulic gate in the presence of the manufacturer's factory service representative. Excessive leaks shall be corrected and the equipment retested until found satisfactory by the Engineer.

B. Leakage criteria for field test:

1. Leakage: Gates shall be substantially watertight under the design head conditions. Under the design seating head, the leakage shall not exceed 0.01 gallons per minute per foot of seating perimeter. Under the design unseating head, leakage shall not exceed 0.05 US gallons per minute per foot of perimeter.

2. For unseating heads greater than 20-feet, the allowable leakage rate shall not exceed.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Installation and Startup Assistance: Service and testing assistance by the manufacturer's engineering representative for each gate and valve shall be furnished by the Contractor during installation and startup.

B. Instruction of Owner's Personnel: The Contractor shall arrange for the services of a factory service representative to instruct the Owner's personnel in the operation and maintenance of the equipment.

1.6 SPECIAL WARRANTY REQUIREMENT

A. The Contractor shall furnish the manufacturer's written guarantee that the hydraulic gates comply with these specifications. The Contractor shall also furnish the manufacturer's warranties as published in its literature.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Gates shall comply with AWWA C561 unless indicated otherwise.

B. All equipment provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products and which have had previous experience in such manufacture. The Contractor shall, upon request, furnish the names of not less than 5 successful

installations of the manufacturer's equipment of comparable nature to that offered under this contract.

C. All combinations of manufactured equipment which are provided under these Specifications shall be entirely compatible, and the Contractor and the manufacturer shall be responsible for the compatible and successful operation of the various components of the units. All necessary mountings and appurtenances shall be included.

D. Guide frames shall be extended 3-feet 6-inches above the walkway to match the height of the handrail. Where a gate is mounted in an opening between 2 sections of handrailing, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing. Horizontal members shall be arranged so that the railing will not interfere with operation of the actuator.

E. Gate actuators shall be seized, selected, and furnished by the gate manufacturer.

F. Manufacturers, or Equal:

1. Fontaine

2. Golden Harvest

3. Whipps

2.2 MATERIALS

A. Materials employed in the manufacture and installation of the hydraulic gates and operators shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

B. Construction: Unless otherwise indicated, materials of construction shall be in accordance with AWWA C561, suitable for the service. Material used in the fabrication of the slide gates shall conform to the requirements designated below:

1. The gate and frame shall be stainless steel ASTM A276, Type 316 and all anchors and hardware shall be Type 316 stainless steel. The gate slide shall be a flat plate, reinforced to limit deflection to 1/720 of the span at the design head. Frame shall bolt directly to an embedded Type 316 stainless steel wall; thimble.

2. The operating stem shall be minimum Type 316 stainless steel with a slenderness ratio of not less than 200. The stem design force shall not be less than 1.25 times the output thrust of the electric motor operator. Stem guides shall be Type 316 stainless steel with UHMWPE bushings. Stem cover shall be clear polycarbonate with clear mylar position indicating tape.

3. Lifting Devices: Lifting devices shall be provided complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, gear reducer, hand wheel, crank, electric or hydraulic cylinder where indicated. Lifting devices shall be weatherproof and shall be mounted on cast-iron or fabricated steel pedestals. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure. The centerline of the

manual actuator shall be approximately 3-feet above the base for pedestal mounted, and approximately 4-feet above the floor for frame-mounted actuators (self-contained gates, operator on a self-contained yoke). Power lifting devices shall be in accordance with Section 40 05 57 – Actuators for Process Valves and Gates. Slide gate hoist heads shall be cast iron. The operating nut shall be of solid bronze, ASTM B 584. Operating thrust shall be taken on roller or ball bearings. All parts shall be provided with an alternate lubrication system. The unit shall be designed for a maximum of 40 lb effort on the crank to operate the gate. Clockwise movement of the handwheel shall close the gate. The operating crank shall be easily removable to facilitate the use of a portable power operator.

4. The pedestal shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure. The centerline of the manual actuator shall be approximately 42" above the base. Alternatively, the pedestal may be constructed of heavy fabricated stainless steel at the gates manufacturer's option, and the specified coating system omitted.

5. Wall Thimble: Thimbles shall be furnished by the manufacturer of the gates and shall fit the bolt dimensions of the gates. All materials of construction shall be Type 316 stainless steel including studs and other hardware, except as required to avoid galling. All materials shall provide equivalent corrosion protection to Type 316 stainless steel. Thimble shall be of heavy construction, equal to gate and frame materials. Thimble shall be minimum 12 inches in length. See the drawings.

6. Guides and Seals: Guides, side and top seals shall be UHMWPE, self-adjusting with continuous compression cord. Efficient sealing shall be maintained in any position of the slide to allow flow only in the opened portion of the gate. Bottom seal shall be resilient neoprene set into the bottom member, and shall form a flush bottom.

2.3 HARDWARE

A. Bolts and nuts shall comply with Section 05 50 00 – Miscellaneous Metalwork.

2.4 PROTECTIVE COATING

A. Coat ferrous metal in accordance with Section 09 96 00 – High-Performance Coatings.

2.5 TOOLS AND SPARE PARTS

A. Tools: Furnish special tools necessary for maintenance and repair of the gates. Such tools shall be suitably stored in metal toolboxes and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts: Furnish the following spare parts in a box as described above for tools, for air or hydraulic actuated gates for each type and size of gate:

1. One set of directional valves, solenoid or pilot actuated

2. One set of cylinder actuator seals

3. One set of filters

4. One repair kit for the hydraulic pump, containing seals or packing, gaskets, and O-rings.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Sluice and shear gates shall be installed in strict accordance with the manufacturer's printed recommendations and the requirements herein. Operators shall be located to avoid interference with handrails and structural members.

B. Shortly before setting each gate, a 1/8-inch thick layer of mastic grade polysulfide elastomeric sealant shall be applied to the back of the gate frame. After setting the gate, the nuts shall be turned down on the anchor bolts just far enough to make them snug and to cause the rubber sealant to begin to ooze out, but not far enough to produce any significant stress to the frame. Excess sealant at the edges shall be removed. The sealant shall be allowed to cure for at least 7 days, after which the anchor bolt nuts shall be tightened to their final positions. If gaskets are being used, they shall be installed over the studs in one piece, or dovetailed and cemented with a liquid-type gasket material.

C. Following the completion of each gate installation, the gates shall be operated through at least two complete open/close cycles. If an electric or hydraulic operator is used, limit switches shall be adjusted following manufacturer’s instructions.

D. Damage to surface coatings incurred during shipment and/or installation shall be repaired to the satisfaction of the Engineer prior to installation.

E. Field modifications of or to gates or gate frames will not be permitted without prior written acceptance from the manufacturer.

END OF SECTION

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SECTION 40 05 62 – PLUG VALVES

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide plug valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves apply to this Section.

C. The requirements of Section 40 05 57 – Actuators for Process Valves and Gates apply to this Section.

D. Plug valves shall have undergone a proof-of-design test to demonstrate that the valve components operate at the service flow, pressure, temperature, and fluid conditions, free from binding, excessive noise, and premature failures. Proof-of-design test results shall be available to the Engineer on request. The proof-of-design test shall be conducted in accordance with the applicable provisions of AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

09 96 00	High-Performance Coatings
40 05 51	Common Requirements for Process Valves
40 05 57	Actuators for Process Valves and Gates

B. Reference Standards

American Water Works Association (AWWA)	
AWWA C517	Resilient-Seated Cast-Iron Eccentric Plug Valves
ASTM International (ASTM)	
ASTM A 126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 216	Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service
ASTM A 536	Ductile Iron Castings

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

PART 2 -- PRODUCTS

2.01 ECCENTRIC PLUG VALVES (1/2-INCH TO 72-INCHES)

A. Construction: Eccentric plug valves shall be of the non-lubricated, eccentric plug design with cast iron bodies conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with ANSI 125 lb. flanged ends for valves 3-inches and larger, and screwed or flanged ends for smaller sizes. The plugs and shafts shall be of cast iron or ductile iron conforming to ASTM A 536 - Ductile Iron Castings, and the plugs shall be lined with a resilient coating, best suited for the specific service. The body shall be lined with a suitable elastomer, where required for a special service, or it shall be epoxy-lined in accordance with Section 09 96 00 – High-Performance Coatings. The seats shall be of nickel or stainless steel welded to the body. Top and bottom shaft bearings shall be of permanently lubricated stainless steel or Teflon coated stainless steel. Grit seals of Teflon, Nylatron, or similar suitable material shall be at the top and bottom plug journals. Valves up to and including 20-inches in size shall have an unobstructed port area of not less than 80 percent of full pipe area, and not less than 70 percent for larger valves. Valves 24-inches and larger shall have an unobstructed port area of 100% of pipe area. Eccentric plug valves shall have a pressure rating of not less than 150 psi WOG, for bubble-tight shut-off in the standard flow direction, and 25 psi WOG in the reverse flow direction. When equipped with worm gear actuator, the pressure rating shall be 150 psi WOG in both directions. The stem seal shall consist of field adjustable packing, replaceable without removal of the actuator, or of self-adjusting U-cup packing.

B. Actuators: Unless otherwise indicated, eccentric plug valves 3-inches and smaller shall have operating levers; larger valves shall have worm-gear actuators. Valve actuators shall be in accordance with Section 40 05 57 – Actuators for Process Valves and Gates.

C. Manufacturers, or Equal

1. DeZurik Corporation
2. Clow Valve Company
3. Pratt Valve
4. Victaulic

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Plug valves shall be installed in strict accordance with the manufacturer's published recommendations and the applicable provisions of Section 40 05 51 – Common Requirements for Process Valves.

B. Eccentric Plug Valves: Unless otherwise directed, the following rules shall be observed for the installation of eccentric plug valves on sewage, sludge, or other liquid systems containing solids, silt, or fine sand:

1. The valves shall be positioned with the stem in the horizontal direction.

2. In horizontal pipelines, the plug shall swing upwards when opening, to permit flushing out of solids.

3. The orientation of the valve shall prevent the valve body from filling up with solids when closed; however, where the pressure differential through the valve exceeds 25 psi, the higher pressure for valves without worm gear, electric, or air operators shall be through the valve to force the plug against the seat.

4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines) and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), shall be equipped with worm gear operators for the full range of sizes.

5. For special applications or when in doubt, consult with the manufacturer prior to installation.

END OF SECTION

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SECTION 40 05 63 – BALL VALVES

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves apply to this Section.

C. The requirements of Section 40 05 57 – Actuators for Process Valves and Gates apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

40 05 51	Common Requirements for Process Valves
40 05 57	Actuators for Process Valves and Gates

B. Reference Standards

American Petroleum Institute (API)	
API 6D	Specification for Pipeline Valves (resilient seated)
API 607	Fire Test for Soft-Seated Valves (resilient seated)
American National Standards Institute (ANSI)	
ANSI B 16.5	Pipe Flanges and Flanged Fittings
American Water Works Association (AWWA)	
AWWA C507	Standard for Ball Valves 6-inches through 48-inches (resilient seated)

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

PART 2 -- PRODUCTS

2.01 METAL BALL VALVES (4-INCHES AND SMALLER)

A. General: Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have actuators in accordance with Section 40 05 57 – Actuators for Process Valves and Gates.

B. Body: Ball valves up to and including 1-1/2 inches in size shall have bronze or carbon steel 2- or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 4-inches in size shall have bronze or carbon steel 2- or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.

C. Balls: The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

D. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced teflon seal.

E. Seats: The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.

F. Manufacturers, or Equal

1. Conbraco Industries, Inc. (Apollo)

2. ITT Engineered Valves

3. Neles-Jamesbury, Inc.

4. Watts Regulator

5. Worcester Controls

2.02 PLASTIC BALL VALVES

A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the specific application. Valves shall have manual actuators in accordance with Section 40 05 57 – Actuators for Process Valves and Gates, unless otherwise indicated.

B. Construction: Plastic ball valves shall have union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges for easy removal. The balls shall have full size ports and teflon seats. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.

C. Manufacturers, or Equal

1. ASAHI-America

2. George Fischer, Inc.

3. NIBCO Inc., (Chemtrol)

4. Plast-O-Matic Valves, Inc.

5. Spears Mfg. Co.

6. Watts Regulator

PART 3 -- EXECUTION

3.01 GENERAL

A. Valves shall be installed in accordance with Section 40 05 51 – Common Requirements for Process Valves. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

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SECTION 40 05 65.10 – CHECK VALVES

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

40 05 51	Common Requirements for Process Valves

B. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B1.20.1	Pipe Threads, General Purpose (inch)
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.5	Pipe Flanges and Flanged Fittings
American Water Works Association (AWWA)	
AWWA C508	Swing-Check Valves for Waterworks Service
ASTM International (ASTM)	
ASTM A48	Gray Iron Castings
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B16	Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines
ASTM B148	Aluminum-Bronze Castings
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM B763	Copper Alloy Sand Castings for Valve Application

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

PART 2 -- PRODUCTS

2.01 SWING CHECK VALVES (3-INCHES AND LARGER)

A. General: Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with AWWA C508 - Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. Units shall have a flanged cover piece to provide access to the disc. Where indicated, swing check valves shall be provided with position indicators.

B. Body: The valve body and cover shall be of cast iron conforming to ASTM A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or be mechanical joint ends, as indicated.

C. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B584 - Copper Alloy Sand Castings for General Applications.

D. Seat and Rings: The valve seat and rings shall be of bronze conforming to ASTM B584 or ASTM B148 - Aluminum-Bronze Castings or of Buna-N.

E. Hinge Pin: The hinge pin shall be of bronze or stainless steel.

F. Manufacturers, or Equal

1. DeZurik/APCO

2. Kennedy Valve

3. Mueller Company

4. Stockham Valves and Fittings

5. GA Industries

PART 3 -- EXECUTION

3.01 GENERAL

A. Valves shall be installed in accordance with provisions of Section 40 05 51 – Common Requirements for Process Valves.

END OF SECTION

SECTION 40 90 10 - CONTROL STRATEGIES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The System Integrator, under contract to the Owner, shall provide all PLC-Based Control System (PBCS) application programming required to implement the control strategies described in this section, the functions shown on the Drawings and I/O schedules complete and operable in accordance with the Contract Documents.

B. The control strategies in this section are intended to describe the general operation of the systems and processes and address systems that are required to be installed or modified as part of this project and to describe the general operation of the systems and processes. The control strategies are not intended to be all-inclusive operational procedures for the operation of the complete facility. The System Integrator shall make refinements, modifications, and additions to these strategies as needed.

C. The requirements in this section includes modifications to the programming of new and existing PLC, RTU, SCADA, and all other PBCS interfaces including network and communication devices.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The requirements of Section 40 91 00 – Process Control and Instrumentation Systems, and Section 40 95 10 – PLC-Based Control System Hardware.

1.3 ACTION SUBMITTALS/ INFORMATIONAL SUBMITTALS

A. The PLC submittal shall be provided in accordance with the requirements specified in Section 40 91 00 - Process Control and Instrumentation Systems.

B. Contractor must be aware that the system software submittal in Section 40 91 00 - Process Control and Instrumentation Systems, requires a functional design report of the implemented control functions using as a reference the strategies specified in this section.

1.4 FUNCTIONS AND CONTROL MODES

A. The term Plant Control System (PCS) is used as a generic representation of any type of control system, independent of the technology used to control a facility. The control system can be either a DCS or a PLC based system.

B. Functions

1. LOCAL: The term “LOCAL” means “in the field” i.e., at the physical location of the equipment. Local control means at the equipment or control from the MCC starter. Local control is from the equipment starters or equipment in the field via either pushbuttons or HOA selector switch where HAND allows operation local in the field.

2. REMOTE: The term “REMOTE” means away from the equipment. Remote control means ability to control the equipment at the pump station HMI or from the SCADA system via telemetry.

3. Local Control Panel (LCP): refers to the presence of a field-situated panel, which serves as a control location. LCPs may contain a PLC.

4. Local Display: This function refers to the display of equipment status or process variable at a location in the field, local to the equipment.

5. Local Interlock: This function refers to the presence of field-situated control logic in which the status of other equipment directly effects the operation and control of the equipment being controlled.

6. Control System Alarms and Status: Variable or status data to be alarmed in the Control Room.

7. Local Alarms: Alarms that are announced in the field.

8. Setpoints: Values which are adjustable at the engineer (supervisor) level displays without requiring any software configuration. Some of these values may be adjustable by the operator from the display station depending on permissions level. Whenever a LOCAL/REMOTE setpoint selection is provided, in LOCAL, the setpoint shall be adjustable from the equipment. In REMOTE, the setpoint shall be adjustable from a REMOTE setpoint input. Final setpoint values shall be determined at commissioning.

C. Control Modes

1. Local Manual Control Mode: This mode enables manual control near the equipment. The equipment is then manually controlled (e.g., START, STOP, OPEN-STOP-CLOSE, etc.) by a local selector switch station by switching it to “HAND” or “OFF”, or “OPEN-STOP-CLOSE”. The control logic and setpoints in the plant control system PLC are bypassed and do not affect the operation of the equipment. All the controls from the HMI are disabled.

2. Local Automatic Control Mode: This mode enables automatic control that is provided and performed external to the main PLC. In some cases, the equipment in the plant is pre-packaged with a Local Control Panel complete with its own automation logic.

3. Remote Manual Control Mode: This mode allows control from the HMI. To enable Remote Manual mode, the operator switches the field LOCAL/REMOTE switch (LOR) to REMOTE and the AUTO/MANUAL” switch at the HMI to “MANUAL”. In this mode the operator can “START”, “STOP”, “OPEN”, CLOSE” etc. the equipment, or manually change the control output to the equipment. Consequently, in this mode the automatic control logic and setpoints in the PICS are overridden.

4. Remote Automatic Control Mode or SCADA Mode: This mode allows control of the equipment from the automatic PLC logic. The operator at the control room switches the “AUTO/MANUAL” switch at the HMI to “AUTO” position to enable PCIS automatic operation. In this mode the equipment is controlled automatically by the control logic and setpoints residing in the PLC. Personnel with the elevated security credentials can change operational parameters through the HMI by entering new setpoints. The PLC shall monitor equipment local control mode status i.e., (LOCAL/ REMOTE) field switches, and disable Remote Auto mode when any affected equipment LOR is changed to LOCAL.

D. General Control and Mode Switch Terms

1. “LOCAL-OFF-REMOTE” Switch: The LOR switch is located at the equipment in the field or at the MCC.

a. LOCAL Position: In this position equipment automation and control from the control panel/PLC are bypassed. The control is being delegated away from the PLC. Control from the HMI is also disabled.

b. OFF Position: In this position all equipment control functions are off and disabled.

c. REMOTE Position: In this position equipment automation and control are available from the control panel/PLC. An AUTO-MANUAL and a START-OFF-STOP switch (or OPEN-OFF-CLOSE) shall be provided at the operator HMI workstation from which remote manual control is performed.

2. "HAND-OFF-AUTO" Switch: This switch is located usually at the LCP. Control through this switch is performed from the LCP only if the LOCAL-OFF-REMOTE switch in the field or at the MCC is in LOCAL position as discussed above. All the control functions are performed locally and external to the PLC.

a. HAND Position: in this position the equipment is started manually.

b. OFF Position: The equipment is off.

c. AUTO: In this position the equipment is automatically controlled locally and external to the PLC by local control hardware.

3. HMI Switches:

a. For equipment that is controllable from the PLC in either a MANUAL or AUTOMATIC mode, the operator shall be provided with a software "AUTO-MANUAL" selector switch at the operator HMI workstation. This switch is functional only when LOCAL-OFF-REMOTE switch in the field is in REMOTE position. The following are the AUTO- MANUAL functions:

1) AUTO – In this position the operator delegates and enables the automation and control functions of the equipment to be performed at the PLC/control panel in the field. The operator is unable to manually control the equipment from the HMI.

2) MANUAL – In this position the operator is able to override the control functions in the PLC and remotely control the field equipment manually from the HMI.

b. A second software switch such as "START-OFF-STOP" or OPEN-STOP-CLOSE", etc. or as required by the application, shall be provided in the HMI to control the equipment in the field manually from the HMI. Variations of these types of control switches shall be provided for the equipment based on its control application. These switches shall be functional only when the above "AUTO-MANUAL" switch is in "MANUAL" mode.

1.5 CONTROL STRATEGY CONTENTS

A. Control Strategy General Description: The control strategy general description provides a narrative of the process, its related equipment, as well as the function, the philosophy and methodology of the process control. It provides guidelines for programming the control functions. The general description together with detailed functional description and other section of the strategy comprise the design criteria of the process control.

B. Common Functions

1. The following list of Common Control Features shall be implemented on all equipment and as stated in the individual control strategies listed within these specifications.

   a. The “Soft I/O” signals described in this document are provided for the Contractor’s convenience and represent the minimum signals to be derived for the monitoring and control of the equipment. The Contractor shall provide all necessary additional software-derived signals to meet the control strategies at no additional cost to the Owner.

   b. Analog instrumentation failure feature:

      1) Out of Range Alarm: All analog inputs shall have a unique instrument failure alarm when the input is below 0 percent or above 100%. This alarm shall be displayed on the HMI as an Out-of-Range alarm.

      2) If an analog signal is used to control the operation of the equipment from the PLC, the equipment shall remain running at its last valid setpoint until the analog instrumentation is stable for a tunable time setting.

   c. Unless otherwise stated or shown, all discrete outputs shall be maintained outputs. For START/STOP PLC functions, the PLC shall issue a maintained START command until a FAIL state is detected or when a STOP command is issued. When a momentary command is required, the PLC shall issue the command for 2 seconds, and then remove the signal.

   d. Pump Control and Status Discrepancies Programming:

      1) In general, for equipment that the PLC is allowed to control, the PLC shall provide a FAIL alarm if the equipment fails to comply with a PLC command signal (START, STOP, OPEN, CLOSE) that has been present for more than a tunable time period. In this event, the command shall be removed after the expiration of the tunable time period.

      2) A discrepancy/fail alarm shall be generated for any pump or final control element if a discrepancy exists between a system or operator command and the device status. For example, the system commands to start ("CALL") and the pump fails to start ("RUN" status report back) within a programmable time delay, then a discrepancy ("FAIL") alarm shall be generated.

      3) Likewise, involuntary change in the device's status shall also generate an alarm. For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.

      4) A "FAIL" alarm shall not be generated even if the pump is intentionally started or stopped by an operator switching the HMI control switch to "START" or "OFF" position. However, if the operator turns the switch to “START” position and the pump has not started, a failure alarm shall be announced at the Reuse Building OIT and the plant HMI. Furthermore, if the operator turns off a pump and the pump has not stopped, an alarm shall also be announced. All fail alarms shall be delayed by an adjustable time delay ranging from 0-90 seconds. If a process requires a longer delay time, the System Supplier shall request Engineer approval.

e. Wherever 2 or more pieces of equipment are provided for the same functions, for example secondary reuse pumps, the SCADA system shall alternate the equipment after each use.

f. Where alarms are specified in the control strategy descriptions, alarms shall be initiated from the applicable inputs. If discrete inputs are not available, the specified alarms shall be initiated from the applicable analog input; alarm setpoints shall be operator adjustable.

g. Additional common control and monitoring functions are provided in the "EXECUTION" part of Section 40 95 20 – PLC-Based Control System Software.

h. Historical Data – All analog values shall be collected and trended.

i. Controller Setpoint Handling – Operator entered setpoints shall be constrained to match PLC programmed setpoint ranges. If a value lower than the setpoint range is entered, the PLC program defaults to the lowest allowable value. If a value higher than the setpoint range is entered, the PLC program defaults to the highest allowable value. The PLC shall prohibit entry of setpoints beyond the operational range of a system or process. If a PLC reboot occurs, the setpoints shall be automatically restored with the last entries.

1.6 QUALITY ASSURANCE

A. The control strategies shall be tested as part of the factory and field acceptance tests and in accordance with the requirements specified in Section 40 91 00 – Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS – NONE

PART 3 -- EXECUTION

3.1 01-CS-1 – INFLUENT PUMP STATION

A. Background -

B. Reference Drawing: 1I-101

C. Description:

D. Local Manual Control: Local Manual mode is intended to be used for commissioning and maintenance only and should be used with extreme caution. The reuse pumps are intended to operate normally in Remote Auto mode.

1. The operator places the individual pump HAND/OFF/REMOTE (HOR) selector switch at the VFD in the HAND position to start the pump and into the OFF position to stop the pump. Operation from SCADA is disabled when the HOR is in HAND or OFF.

2. Speed adjustments are made directly on the VFD Human Interface Module (HIM).

E. Local Automatic Control: None required

F. Remote Manual Control: Remote Manual mode is intended to be used for commissioning and maintenance only and should be used with extreme caution. The reuse pumps are intended to operate normally in Remote Auto mode.

1. The operator places the individual pump HOR selector switch at the VFD in the REMOTE position to enable REMOTE control. When REMOTE control is enabled, the SCADA system receives an IN REMOTE status input from the VFD for indication at the operator workstation and local control from the VFD is disabled.

2. The operator selects REMOTE MANUAL for the pump at the HMI. REMOTE MANUAL mode and pump run command OFF shall be the default mode any time the VFD HOR is moved from OFF to REMOTE.

3. In this mode the operator may START/STOP and control the speed of the pump from the HMI.

4. A MINIMUM speed setpoint shall be provided at the HMI. Default value shall be determined at commissioning and coordinated with the pump and VFD suppliers to match the VFD minimum speed setting. Setpoint shall be configured such that operators cannot enter any value below the default minimum speed at the HMI.

G. Remote Automatic Control: Remote Auto control shall be used for normal operations. The System Integrator shall adjust the control strategy as required by the Engineer to achieve smooth operation of the pump station, without excessive pump cycling.

1. Prior to entering Remote Auto mode, the operator shall ensure the following adjustable setpoints are entered at the HMI. Tags for setpoints are shown below using [TAG].[SETPOINT] syntax for explanatory purposes only. System Integrator may choose the same or a similar syntax provided that the tag name clearly defines the setpoint. Default setpoints listed are for initial use only. Values shall be tested and adjusted at commissioning as needed to provide a safe, smoothly operating system:

   Note: System Integrator shall add PID parameter setpoints as needed and provide restricted access to the setpoints on an HMI controller faceplate. Mean Sea Level (msl) in the table below shall be converted to feet above wet well floor at commissioning and adjusted in coordination with pump installation.

Setpoint	Tag	Default	Units

Setpoint	Tag	Default	Units

2. The operator places the individual pump HOR selector switch at the VFD in the REMOTE position to enable REMOTE control. When REMOTE control is enabled, the SCADA system receives an IN REMOTE status input from the VFD for indication at the operator workstation and local control from the VFD is disabled. Unless a pump is out of service, all pumps shall be placed in Remote Auto mode for proper Remote Auto operation.

3. The operator selects REMOTE AUTO for the pumps at the HMI. If any large pump is placed in remote auto mode, the jockey pump shall be disabled. If the jockey pump is placed in remote auto mode, large pump remote auto mode shall be disabled.

H. Hardwired Interlocks:

1. Software Interlocks:

I. Alarms: The following alarms shall be provided:

3.2 02-CS-1 – GRIT WASHING SYSTEM

A. Background -

B. Reference Drawing: 2I-102

C. Description:

1. Grit Washing System

D. Local Manual Control: Local Manual mode is intended to be used for commissioning and maintenance only and should be used with extreme caution. The effluent pumps are intended to operate normally in Remote Auto mode.

1. The operator places the individual pump HAND/OFF/REMOTE (HOR) selector switch at the VFD in the HAND position to start the pump and into the OFF position to stop the pump. Operation from SCADA is disabled when the HOR is in HAND or OFF.

2. Speed adjustments are made directly on the VFD Human Interface Module (HIM) using the momentary push buttons.

E. Local Automatic Control: None required

F. Remote Manual Control: Remote Manual mode is intended to be used for commissioning and maintenance only and should be used with extreme caution. The effluent pumps are intended to operate normally in Remote Auto mode.

1. The operator places the individual pump HOR selector switch at the VFD in the REMOTE position to enable REMOTE control. When REMOTE control is enabled, the SCADA system receives an IN REMOTE status input from the VFD for indication at the operator workstation and local control from the VFD is disabled.

2. The operator selects REMOTE MANUAL for the pump at the HMI. REMOTE MANUAL mode and pump run command OFF shall be the default mode any time the VFD HOR is moved from OFF to REMOTE.

3. In this mode the operator may START/STOP and control the speed of the pump from the HMI.

4. A MINIMUM speed setpoint shall be provided at the HMI. Default value shall be determined at commissioning and coordinated with the pump and VFD suppliers to match the VFD minimum speed setting. Setpoint shall be configured such that operators cannot enter any value below the default minimum speed at the HMI.

G. Remote Automatic Control – Flow Mode: Remote Auto flow control mode shall be used for normal operations. Level control mode shall be used when reuse pumps are not in use.

1. Prior to entering Remote Auto mode, the operator shall ensure the following adjustable setpoints are entered at the HMI. Tags for setpoints shown below using [TAG].[SETPOINT] syntax are for explanatory purposes only. System Integrator may choose the same or a similar syntax provided that the tag name clearly defines the setpoint. Default setpoints listed are for initial use only. Values shall be tested and adjusted at commissioning as needed to provide a safe, smoothly operating system:

   Note: System Integrator shall add PID parameter setpoints as needed and provide restricted access to the setpoints on an HMI controller faceplate. Mean Sea Level (msl) in the table below shall be converted to feet above wet well floor at commissioning and adjusted in coordination with pump installation.

Setpoint	Tag	Default	Units

Setpoint	Tag	Default	Units

2. The operator places the individual pump HOR selector switch at the VFD in the REMOTE position to enable REMOTE control. When REMOTE control is enabled, the SCADA system receives an IN REMOTE status input from the VFD for indication at the operator workstation and local control from the VFD is disabled. Unless a pump is out of service, all pumps shall be placed in Remote Auto mode for proper Remote Auto operation.

3. The operator selects REMOTE AUTO for the pumps at the HMI.

4. Remote Automatic Control –

Setpoint	Tag	Default	Units

5. The operator places the individual pump HOR selector switch at the VFD in the REMOTE position to enable REMOTE control. When REMOTE control is enabled, the SCADA system receives an IN REMOTE status input from the VFD for indication at the operator workstation and local control from the VFD is disabled. Unless a pump is out of service, all pumps shall be placed in Remote Auto mode for proper Remote Auto operation.

6. The operator selects REMOTE AUTO for the pumps at the HMI.

7. The operator selects pump 1, 2 or 3 as the Lead pump and one of the other two pumps as Lag. The third pump automatically takes the standby position. The System Integrator shall coordinate with the Owner to establish the method used for initial pump position selection; however, the selected algorithm shall keep pump runtimes evenly distributed.

8. The operator manually enables pump operation from the HMI.

H. Hardwired Interlocks:

1. Software Interlocks:

I. Alarms: The following alarms shall be provided:

3.3 03-CS-1 – INTERMEDIATE PUMPS

A. Reference Drawings: 3I-102

B. Background –

C. Reference Drawings: I-15, I-18, GI-04

D. Description:

E. Local Manual Control:

F. Local Automatic Control: None

G. Remote Manual Control:

H. Remote Auto Control:

1. Prior to entering Remote Auto mode, the operator shall ensure the following adjustable setpoints are entered at the HMI. Tags for setpoints are shown below using [TAG].[SETPOINT] syntax for explanatory purposes only. System Integrator may choose the same or a similar syntax provided that the tag name clearly defines the setpoint. Default setpoints listed are for initial use only. Values shall be tested and adjusted at commissioning as needed to provide a safe, smoothly operating system:

   Note: System Integrator shall add PID parameter setpoints as needed and provide restricted access to the setpoints on an HMI controller faceplate.

2.

Setpoint	Tag	Default	Units

I. Hardwired Interlocks:

J. Software Interlocks:

K. Alarms: In addition to the setpoint comparison alarms shown above, the following alarms shall be provided:

END OF SECTION

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SECTION 40 91 00 - PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

The Contractor, using a Systems Supplier, shall provide/modify the existing Process Control and Instrumentation Systems (PCIS) complete and operable, in accordance with the Contract Documents. For this Contract, PCIS is synonymous and interchangeable with supervisory control and data acquisition (SCADA), where applicable. The requirements of this Section apply to every component of the PCIS unless indicated otherwise.

A. Responsibilities

1. The Contractor, using a single prequalified Systems Supplier, and qualified electrical and mechanical installers, shall be responsible to the Owner for the implementation/modifications of the PCIS and the integration of the PCIS with other required instrumentation and control devices.

2. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these specifications that the Systems Supplier will be responsible to the Contractor for the integration of the PCIS with existing devices and devices provided under this and other Divisions with the objective of providing a completely integrated control system free of signal incompatibilities.

3. The Contractor shall request the Owner to demonstrate that all existing equipment that is to be reused or interfaced with in this project works properly for the intended function. In the event the existing equipment does not work, the issue should be brought up in the preconstruction/ pre-submittal meeting(s).

4. As a minimum, the implementation of the PCIS by the Systems Supplier shall include the following Work:

   a. Modify the existing PCIS for the new influent pumps and grit system and other process modifications provided under this and other Divisions

   b. Prepare the required PCIS submittals

   c. Design and develop project-wide loop diagrams including those associated with equipment provided under other Divisions and Owner-furnished and existing equipment

   d. Design and develop control panel drawings, if applicable

   e. Field verify existing conditions

   f. Prepare factory and field test submittals

   g. Prepare training plan

   h. Prepare spare parts submittal

i. Procure hardware and software, if applicable

j. Configure and factory test the PCIS

k. Bench calibrate instruments and verify calibration after installation

l. Terminate signals inside control and network panels; terminate communication and network devices and nodes

m. Supervise and coordinate installation and termination of field signals, power, and utilities associated with the PCIS. Resolve signal, power, or functional incompatibilities between the PCIS and new and existing interfacing devices.

n. Loop test in accordance with the loop diagrams. Validate and certify loops

o. Oversee, document, and certify system commissioning

p. Conduct system performance test

q. Prepare technical manuals

r. Conduct training classes

s. Prepare PCIS as-built final construction drawings

5. Any Systems Supplier responsibilities in addition to the list above are at the discretion of the Contractor and the Systems Supplier. Additional requirements in this Section and throughout Division 40 that are stated to be the Contractor's responsibility may be performed by the prequalified Systems Supplier if the Contractor and Systems Supplier so agree.

B. RELATED WORK AND REQUIREMENTS SPECIFIED ELSEWHERE

1. All electrical work required under this section shall conform to the requirements of this Section and the applicable requirements of the Sections in Division 01 and Division 26.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all Work specified herein shall conform to or exceed the applicable requirements of the referenced documents to the extent that the requirements therein are not in conflict with the provisions of this Section; provided, that where such documents have been adopted as a code or ordinance by the public agency having jurisdiction, such code or ordinance shall take precedence.

B. Definitions

1. Systems Supplier**:** The Systems Supplier shall be a single firm, corporation, or other entity assuming full responsibility through the Owner to perform all engineering and to select, furnish, program, configure, integrate, supervise the installation and connections, test, calibrate, and place into operation all instrumentation, controls,

communication hardware and software. The Systems Supplier shall specialize and have an experienced engineering and technical staff in the design, integration, and supply of systems like the one in these Contract Documents. The term " Systems Supplier " shall mean the same as "SCADA System Supplier" or "PCIS Supplier.

C. The PCIS Work shall conform to or exceed the applicable regulations, standards, specifications, and codes which are referenced in Section 01 42 19 - Reference Standards, and current as of the date of the final inspection for this Contract, including, but not limited to, those which are established by the following sources:

1. The International Society of Automation (ISA)
2. National Electrical Code (NEC)
3. National Fire Protection Association (NFPA)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. Occupational Safety and Health Administration (OSHA)
6. American National Standards Institute (ANSI)
7. National Electrical Manufacturers Association (NEA)
8. Insulated Cable Engineers Association (ICEA)
9. Local Power and Telephone Companies
10. Local Authorities having jurisdiction over the work
11. Federal Communication Commission (FCC)
12. Underwriter Laboratory (UL)

D. Where the requirements set forth in these Specifications or on the Drawings are greater or more rigid than the mandatory requirements referenced above, the applicable Specifications or Drawings shall govern.

E. In the case of conflict between any mandatory requirements and Specifications or Drawings, the mandatory requirement shall be followed in each case, but only after submitting such proposed changes to the Engineer for approval.

F. Nothing contained in these Specifications or shown on the Drawings will be so construed to conflict with any national, state, municipal, or local laws or regulations governing the installation of work specified herein, and all such acts, ordinances, and regulations, including the National Electrical Code, are hereby incorporated and made a part of these Specifications. All such requirements will be satisfied by the Contractor at no additional expense to the Owner.

G. The Drawings and Specifications are complementary to each other; what is called for by one shall be as binding as if called for by both. If a conflict between Drawings and Specifications is discovered, this shall be referred to the Engineer as soon as possible for

resolution. Should a conflict exist between the Drawings, Specifications, and/or mandatory requirements (i.e., codes, ordinances, etc.), it will be assumed that the more expensive method has been estimated, unless such alternate has been agreed to prior to submission of bids.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Presubmittal Conference

1. The Contractor shall arrange and conduct a Pre-submittal Conference within 30 Days after award of the Contract. The purpose of the Pre-submittal Conference is to review and approve the manner in which the Contractor intends to carry out its responsibilities for Shop Drawing submittal on the Work to be provided under this Section. The Systems Supplier and the Engineer shall attend. Both the Contractor and the Engineer may invite additional parties at their discretion.

2. Before preparing the submittals, the Contractor shall meet with the Owner and visit the project site(s) to obtain information and inventory regarding the existing conditions. Interface to existing equipment, control and monitoring circuits shall also be reviewed. During the inventory the Contractor shall determine the location of the new equipment that is part of this contract. Any major conflicts with the contract documents shall be brought to the Engineer’s attention at the pre-submittal conference The Contractor shall also review the available as built drawings.

3. The Contractor shall allot 2 hours for the pre-submittal conference.

4. The Contractor shall present the following for discussion at the pre-submittal conference:

   a. A list of equipment and materials required for the PCIS and the manufacturer's name and model number for each proposed item.

   b. A list of requests for clarifications (RFC) or information (RFI) to the contract documents along with a brief explanation of each. Resolution shall be subject to a separate formal submittal and review by the Engineer.

   c. An exact one-to-one sample of each type of submittal herein.

   d. A bar-chart type schedule for system-related activities from the Pre-submittal Conference through start-up and training. Dates of submittals, design, fabrication, programming, factory testing, deliveries, installation, field testing, and training shall be shown. The schedule shall be subdivided to show activities relative to each major item or group of items when everything in a given group is on the same schedule.

5. The Contractor shall take minutes of the pre-submittal conference, including events, questions, and resolutions. Prior to adjournment, attendees must concur with the accuracy of the minutes and sign accordingly.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. The Contractor shall provide submittals in accordance with Section 01 33 00 – Submittal Procedures and the additional submittal requirements specified in this Section, in Division 40, and the following:

1. The Contractor shall coordinate the PCIS part of the Work so that a complete instrumentation and control system will be provided and will be supported by accurate Shop Drawings and as-built drawings.

2. The submittals and their schedules shall be in accordance with the requirements listed below: Any incomplete submittal will be rejected and returned without comments.

3. Interface between instruments, VFDs, flowmeters and other equipment related to the PCIS shall be included in the shop drawing submittal. Interface between existing equipment, instruments and control panels shall also be included,

4. Exchange of Technical Information: During the period of preparation of these submittals, the Contractor shall authorize a direct, informal liaison with the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as indicated may be authorized informally by the Engineer but will not alter the scope of Work or cause increase or decrease in the Contract Price. During this informal exchange, no oral statement by the Engineer shall be construed to give approval of any component or method, nor shall any statement be construed to grant exception to or variation from these Contract Documents.

5. Symbols and Nomenclature: In these Contract Documents, systems, meters, instruments, and other elements are represented schematically, and are designated by symbols as derived from Instrument Society of America Standard ISA S5.1 - Instrumentation Symbols and Identification. The nomenclature and numbers designated herein and, on the Drawings, shall be employed exclusively throughout Shop Drawings, and similar materials. No other symbols, designations, or nomenclature unique to the manufacturer's standard methods shall replace those prescribed above, used herein, or on the Drawings.

B. Shop Drawings Submittal Organization

1. Shop Drawings shall include the letter head or title block of the Systems Supplier. The title block shall include, as a minimum, the Systems Supplier’s registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing.

2. Organization of the Shop Drawing submittals shall be compatible with eventual submittals for later inclusion in the Technical Manual. Submittals not so organized will not be accepted.

3. For a project with multiple sites the Contractor shall provide a separate and unique set of drawings for each site.

4. Drawings that require more than one sheet due to space limitation or continuation in the subject of the drawings (e.g. loop diagrams, etc.) shall be given the same drawing number but with different sheet number (e.g. sheet 1 of x, sheet 2 of x, etc.).

5. Each submittal shall include a complete index appearing in the front of each bound submittal volume. Drawings and/or system groups shall be separated by labeled tags. The organization of the initial shop drawing submittal required above shall be compatible to eventual inclusion with the Technical Manuals submittal and shall include final alterations reflecting as-built conditions.

6. Interfaces between new and existing instruments, motor starters, variable speed drives, flow meters, chemical feeders, panels, and other equipment related to the PCIS shall be included in the Shop Drawing submittal.

C. Field Instrument Submittal

1. Submittal Schedule: The Contractor shall submit for approval a complete field and process instrument submittal, all at one time, within 60 calendar days after the date of Notice to Proceed is given to the Contractor.

2. Submittal Contents: The submittal shall include a complete index which lists each device by tag number, type, and manufacturer in accordance with the specified data sheets provided in this CONTRACT. A separate manufacturer technical brochure or catalog sheet shall be included with each specified instrument data sheet. If, within a single system or loop, a single instrument is employed more than once, one manufacturer brochure or catalog sheet may cover multiple identical uses of that instrument in that system. Each manufacturer brochure or catalog sheet shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags. Special options and features which are furnished shall be identified.

D. System Hardware Submittal:

1. Submittal Schedule: The Contractor shall submit for approval a complete system hardware submittal, all at one time, within 90 calendar days after the date of Notice to Proceed is given to the Contractor. This submittal shall be submitted together with the submittal for the System Architecture, and Communication Diagrams submittal and the Project-Wide Wiring Diagrams and Panel Drawings submittal specified below.

2. Submittal Contents:

   a. The submittal shall be for the hardware specified under Sections 40 95 10 – PLC -Based Control System Hardware and 40 92 00 - Control Panels.

   b. The submittal shall include a complete index which lists each device by type, and manufacturer in accordance with the contract documents. A separate manufacturer technical data sheet or brochure shall be included for each hardware component. If, within a single system a single component is employed more than once, one manufacturer technical data sheet or brochure may cover multiple identical uses of that component in that system. Special options and features which are furnished shall be identified.

c. The submittal shall include load calculations and size of the various UPS systems to demonstrate that the UPS is able to accommodate present and future load requirements, as well as overload capacity requirements.

d. Spare Parts and Tools List: A list of spare parts and tools shall be submitted, covering items which are specified and furnished under this Contract. The list shall include the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts. The list shall also include recommended spare parts and tools, quantities and prices from which the Owner will select the "Additional Recommended Spare Parts and Tools".

E. System Software Submittal

1. Submittal Schedule: The Contractor shall submit for approval a complete system hardware submittal, all at one time, within 90 calendar days after the date of Notice to Proceed

2. Submittal Contents:

a. The submittal shall be for the software specified under Section 40 95 20 – PLC-Based Control System Software. This submittal shall be provided in a singular all inclusive submittal and be made separately from other PCIS submittals.

b. The software submittal shall include but not be limited to:

1) Vendor documentation that supports that the specific functional requirements of the contract documents Section 40 95 20 – PLC-Based Control System Software are met. Details shall include complete description of the standard (baseline) application Human Machine Interface (HMI) software programs, operating system and utility programs to be furnished, including modifications and explanation of how the specific functional requirement will be met. A cross reference between the specification and the software submittal shall be provided in order to provide the Engineer the ability to identify how each specified section or function is being met by the Contractor.

2) A functional design report of the implemented control functions using as a reference the strategies specified in Section 40 90 10 – Control Strategies. The report shall include:

a) Control narratives and their implementation, which describe all monitoring and control functions (e.g., commands, mission, anticipated action, etc.) on a loop by loop or site by site basis in the PLC. It shall also describe special control functions in the server(s), including peer-to-peer communication. These narratives will be used for the operating instructions and inclusion in the Operations and Maintenance Manuals.

b) Control narratives shall enumerate the signal point name, signal description, associated PLC number, associated graphic displays, system functions activated by the signal (i.e., interlocks, alarms, logs, etc.)

c) A complete set of all available software algorithms with annotation of:

1) Individual coil register and variable description

2) Program, group of program, subroutine, and complete rung detail comments

3) Memory, coil, register, and variable usage mapping

d) Description of how the HMI software will be configured to meet the requirements specified in Section 40 95 20 – PLC-Based Control System Software.

e) Electronic copies of the configured PLC control software shall be provided.

F. Input and Output (I/O) Data List:

1. Submittal Schedule: The Contractor shall submit for approval a complete I/O list(s), all at one time, within 90 calendar days after the date of Notice to Proceed is given to the Contractor.

2. Submittal Contents:

a. The submittal shall include a complete listing of the PCIS I/O data base listing for each data point relevant parameters such as range, active state, contact orientation, limits, incremental limits, and I/O hardware address. The list shall be divided and grouped on a site by site basis and PLC assignment, and divided into type of I/O's (card type). The I/Os shall be identified by the location of the card (slot no.) and input/output point number. The I/O list shall be formatted in MS Excel.

b. In addition to the active I/O's, the list shall also include the implemented spare I/O's and the available I/O's remaining on the I/O board.

G. System Architecture and Communication Diagrams

1. Submittal Schedule: The Contractor shall submit for approval a complete set of system architecture and communication diagrams all at one time within 90 calendar days after the date of Notice to Proceed is given to the Contractor. This submittal shall be submitted together with the System Hardware submittal and the Project-Wide Wiring Diagrams and Panel Drawings submittal specified herein.

2. Submittal Contents: System Architecture and Communication System Diagrams: The Contractor shall develop and submit project-wide system architecture and communication diagrams, which present the system architecture, the network(s), and radio communication as applicable. The submittal shall include a set of drawings that presents the following as applicable:

a. System architecture and network (copper and fiber optic) physical topology schematic, including applicable servers, workstations, hardware nodes, network hardware such as routers, cabling converters, etc., and connections.

b. Radio communication, cabling and connections included within panels and the antenna.

H. Project-Wide Wiring Diagrams and Panel Drawings Submittal:

1. Submittal Schedule: The Contractor shall submit for approval a complete set of project-wide wiring diagrams (PWWD) and panel drawings, all at one time within 120 calendar days after the date of Notice to Proceed is given to the Contractor. The panel drawings shall be a singular complete hard copy bound package and accompanied with a PDF on a CD. This submittal shall be submitted together with the System Hardware submittal and the System Architecture and Communication Diagrams submittal specified herein.

2. Submittal Contents: The PWWD and panel drawings shall be submitted as a single and comprehensive set of drawings. The submittal shall include a complete index in the front of each part of the submittal. The drawings shall be indexed by systems, sites, or process areas. Diagrams shall be tagged in a manner consistent with the Contract Documents and shall include the following:

a. Project-Wide Wiring Diagrams: The PWWD shall define and document the contents of each analog and discrete monitoring, alarming, hardware interlock, and control functions associated with equipment provided under Division 40 sections. The PWWD shall also cover equipment provided under sections in other Divisions, existing, and Owner-furnished equipment. The PWWD shall also include both field and panel wiring diagrams.

1) Drawings showing definitive diagram for every analog and discrete instrumentation loop system. These diagrams shall show and identify each component in each loop or system using legend and symbols from the standards in the Contract Documents. The wiring diagrams shall be presented on an 11"x17" drawing with no more than 10 loops per drawing.

2) In general, loops shall be grouped and organized by PLC (if used) and the I/O cards within the PLC. Each I/O card shall be presented on a separate sheet(s) and on the right side of the drawing. The type of card, part number and its slot location shall be identified. Each I/O shall be identified as well as its location on the card and its address. Existing, spare, and future I/Os shall also be shown. Power supply wiring to the card/loops, wire colors, and terminal numbers shall be shown on the wiring diagrams. The I/O cards, the loops and any device in the loop shall be shown together. Each loop shall be complete, including the source/destination within new or existing panels, device(s) in the loop, field connection panels or field junction boxes, field and PLC interface terminal blocks and wire numbers.

3) In addition, wiring diagrams shall show the following details

a) Functional name of each loop

b) Reference name, drawing, and loop diagram numbers for any signal continuing off the wiring diagram sheet.

c) Lighting panel, circuit, and breaker numbers for power feeds to the loops and instrumentation.

d) Wiring type, size, and color

e) Designation, and if applicable, terminal assignments associated with every manhole, pull box, junction box, conduit in which wiring is to be located, and panel through which the loop circuits pass.

f) Vendor panel, instrument panel, conduit, junction boxes, equipment and PLC terminations, termination identification wire numbers and colors, power circuits, and ground identifications.

4) Wiring diagrams shall be developed for loops in equipment vendor-supplied packages, equipment provided under Division 40, and Owner-furnished equipment.

b. Panel Wiring Diagrams: Panel wiring and/or piping diagrams shall be prepared in concert with the PWWD and shall include the following information:

1) Name of panel

2) Power distribution schematic diagrams associated with each panel or system (120VAC, 24VDC and other DC systems, control circuits). The schematic diagram shall show source of power for the panel (circuit breaker panel and breaker) and fuses. All power backup system distribution shall also be shown.

3) Schematic diagrams for control circuits in accordance with ANSI standards. The diagrams shall show complete details on the circuit interrelationship of all devices within and outside each Control Panel. Including primary measurement and control devices.

4) Communication diagram(s) for the equipment inside the panel.

5) Interfaces with existing control and monitoring systems. The Contractor shall furnish all necessary diagrams that depict any and all modifications made to existing measurement and control circuits, equipment and wiring. It is the responsibility of the Systems Supplier to ascertain actual field conditions of the existing circuits, equipment and wiring. The Contractor may request copies of as built drawings and data that the Owner can provide that show such existing conditions. Lack of such drawings shall not alleviate the contractual responsibility to ascertain and implement interfaces and modifications to existing measurement and control circuits, equipment and wiring.

6) Surge protection and signal and safety grounding circuits

7) Wiring type and piping size and material

8) Terminal block numbers and wire numbers

c. Panel Drawings: Panel drawings, including console, and cabinet layout drawings, shall be prepared and submitted for each panel and shall include the following information: These drawings shall include enough other details to define exactly the style, the contents, and overall appearance of the panel assembly.

1) Name of Panel.

2) Panel Dimensions; front, side, and plan views and layout to scale.

3) Arrangement of internally and externally mounted instruments and equipment to scale. Note: Control panel layouts shown on the Contract Drawings are diagrammatic.

4) Location of terminal blocks, electrical devices, and conduit entry location(s).

5) Tag number or item number and functional name of items mounted in and on panel, console, or cabinet.

6) Nameplate legend which includes text, letter size, and colors to be used.

7) Complete and detailed Bills of Materials shall include all items within a panel and shall be presented on the panel layout drawing. The bill of material list shall include quantity, description, manufacturer, and part number.

8) Panel mounting information, including conduit entrance location.

9) Communication hardware installation, such as radio, mast, and antenna.

10) Assembly and construction drawings. These drawings shall include dimensions, identification of all components, construction material and gauge, surface preparation and finish data, panel door locks and hinge mechanism, nameplates, and the like.

I. Display and Report Submittals:

1. Submittal Schedule:

a. After all Software Submittals have been approved by the Engineer, but 30 calendar days prior to the requisite Graphics and Report Meetings, the Systems Supplier shall submit a PDF set of the graphic displays, trend displays, and periodic reports for review by the Engineer and Owner.

b. Required periodic reports for effluent or reuse shall be provided in coordination with the Owner.

c. This submittal shall be prepared and submitted 30 calendar days after the requisite Graphics and Report Meetings specified in Section 40 95 20 – PLC-Based Control System Software.

2. Submittal Contents:

    a. The Contractor shall refer to the specified Graphic meetings No.1 and 2 in Section 40 95 20 - PLC-Based Control System Software.

    b. Displays: All workstation displays (graphics and trends) submittals shall be in full color as they will appear on the monitor. Locations for process data shall be clearly identified either using simulated data or by showing variables on the displays and providing a reference list describing those variables. All dynamic points shall be identified by tag number as a minimum and their operation shall be described on separate sheets (color change, symbol change, etc.).

    c. Reports: Sample reports of each type shall be submitted in the format established in the Graphics Meeting. The reports shall use simulated data.

J. Fiber Field Test Results and Report Submittal

1. Submittal Schedule: The Systems Supplier shall submit for approval fiber test results and report complete within 14 calendar days after receipt of the approved communication test procedure.

2. Submittal Contents: The report shall present the results of the fiber test and the completed forms.

K. Factory Test Procedure Submittal:

1. The FAT shall be witnessed to verify modifications to the existing programming for the influent pump station and grit system are in accordance with these specifications.

2. Submittal Schedule: The Systems Supplier shall submit for approval a comprehensive factory acceptance test (FAT) procedure complete within 180 calendar days after the date of Notice to Proceed is given to the Systems Supplier, but not later than 60 calendar days prior to the Factory Acceptance Test date.

3. Submittal Contents:

    a. The Systems Supplier shall develop and submit factory test procedures to show that the integrated system hardware and software is fully operational and in compliance with the requirements of the Contract Documents. (Also see “Quality Assurance” paragraph in this Section and Section 40 95 20 – PLC-Based Control System Software.

    b. The FAT procedures shall include the following tests to be conducted:

        1) Hardware review and inventory

        2) Panel computer system(s) start-up

        3) Panel Computer Security

        4) Navigation and operator’s commands

5) Database definition and configuration

6) Graphic displays and editing function

7) Monitoring and alarm features and functions

8) Trending functions

9) Reports and report system functions

10) Network Communication and access from all the network nodes

11) PLC functionality – I/O processing

12) Process PLC and HMI operation including pump control

c. Procedure Format: The test procedure shall have a table of contents and each procedure shall be provided on a separate sheet or sheets. The following shall be provided for each procedure:

1) Test number

2) The purpose of the test

3) The procedure

4) The expected result

5) Space to indicate “Pass” and “Fail” and explanation

6) Space for sign-off Signature for the Contractor, the Engineer, the Owner, and DATE

7) Space to provide comments and punch list items

L. Startup and Commissioning Submittals

1. Submittal Schedule: The Contractor shall submit for approval a proposed procedure to be followed during startup and commissioning of the PCIS and its components no later than 60 calendar days prior to the Factory Acceptance Test date.

2. Preliminary Submittal: Outlines of the specific procedures and examples of proposed forms and checklists.

3. Detailed Submittal: After approval of the Preliminary Submittal, the Contractor shall submit the proposed detailed procedures, forms, and checklists. This submittal shall include a statement of objectives with the test procedures.

M. Training Plan and Training Manual Submittals:

1. Submittal Schedule: The Contractor shall submit for approval a training plan and a training manual submittal no later than 30 calendar days prior to start of the first training session.

2. Submittal Contents: The Training submittal shall consist of two parts:

   a. Training Plan, which shall include:

      1) Schedule of training courses including dates, durations, and locations of each class. Number of times each class will be offered, if applicable and the number of people expected in each class.

      2) List of courses and lessons and who will conduct them

      3) Resumes of the instructors who will conduct the training classes. The Contractor shall identify in the submittal the courses and lessons that will be performed by the equipment manufacturer.

      4) List of material used for the training, which shall include the Technical Manuals for the PCIS.

   b. Training Manual

      1) Training subjects' syllabus and associated lesson plans. The training subjects are listed in Part 3 "Execution "of this Section. If, in the opinion of the Systems Supplier, additional subjects that are not listed and are pertinent to the training and will benefit the Owner's staff, these subjects shall also be included in the training manuals and taught in the class.

1.5 CLOSEOUT SUBMITTALS

A. Technical Manuals Submittal

1. Submittal Schedule:

   a. The Contractor shall submit for approval Technical Manuals for the PCIS: Initial set shall be submitted at least 60 days prior to the starts of the Owner's training.

   b. Each set shall consist of one (1) or more volumes and provided in PDF. In addition, a hard copy of the technical manual shall be provided in bound standard size, 3-ring, loose-leaf, vinyl plastic hard cover binders, suitable for bookshelf storage. Binder ring size shall not exceed 3 inches.

2. Submittal Contents:

   a. Information in the Technical Manual shall be based upon the approved Shop Drawing submittals as modified for conditions encountered in the field during the Work. The Technical Manuals shall therefore contain the as-built drawings and information.

   b. The Technical Manuals shall include installation, connection, operating, calibration, set points (e.g., pressure, pump control, time delays, etc.)

adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.

c. The Manuals shall have the following material organized in volumes and divided by subject and tabs The Technical Manual shall have the following organization for each process (the number and the enumeration of the sections shall be project specific):

1) Section A – Process and Instrumentation Diagrams (as built copy)

2) Section B – System Architecture and Diagram

3) Section C – Wiring Diagrams. A separate set of drawings shall be provided for each site. Each set shall be arranged in a separate tab (drawings shall also be provided in PDF).

4) Section D – Functional design report. It shall include a copy of the site graphic display(s) and description how the site is controlled and any special control strategies. Special control functions in the existing server that apply to this project shall also be included. Calibration, set points (e.g., pressure, pump control, time delays, etc.) shall also be included.

5) Section E – Instrument Data Sheets and corresponding manufacturer's data sheet/catalog cuts/brochure that was used in the hardware submittal and the operation and maintenance/user manual.

6) Section F – Calibration Documentation

7) Section G – Communication survey and test results

8) Section H – Loop, Commissioning and Performance Test Results

d. System User Manual: Its purpose is to provide an operator a manual how to use the SCADA system hardware and software and the HMI. The user manual shall be a separate binder and, as a minimum, shall include, but not limited to:

1) System Architecture Diagram with names and locations of major components

2) System access assignment procedures and security level assignment and their privileges and limitations

3) Navigation Bar/Buttons instructions (alarms, navigation buttons, maps, username, login procedure, site summary, communication, etc.)

4) Menus

5) Description of Graphic Standards Used (colors, symbols, etc.)

6) List of display screens, trends, and reports, with display name and description.

7) Procedures during system start-up, fail-over, and recovery

8) A list of the control screens with the display names and description. It shall also provide a summary of possible commands and operator inputs to these screens including set points. All control actions shall be included

9) Alarms: screen, maintenance, historical, messages, operator commands, etc.

10) Report data format and scheduling; procedures to change formats and scheduling. Instructions for manually printing screens or reports, both real time and historical as applicable.

11) Procedure to manually backup HMI software application and data files.

e. Software Manual(if applicable): This manual shall be devoted exclusively to the control system software and the PLC programming. In addition to the requirements specified in Section entitled Contractor Submittal, this manual shall contain complete documentation of the software programs provided, including listings, database, communication protocol(s), annotated PLC programs, and all as necessary to maintain, troubleshoot, modify, or update the all the software systems such as application software and PLCs. It shall also include:

1) All program manuals and electronic media supplied by the manufacturers with the standard software packages the source code of all high-level program language which is specifically created by the Contractor for this project.

2) All PLC program and panel mount computer configuration program files stored on electronic media. The PLC program and computer configuration files on electronic media shall also be updated as required if any changes or corrections are required in this programming prior to project completion.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. The Contractor shall provide the specified spare parts and tools. In addition, the Engineer and the Owner will select from the priced list of “Additional Recommended Spare Parts” in the Hardware Equipment Submittal. The Contractor shall furnish these parts and will be paid for them from the corresponding allowance item in the Bid. The total price will not exceed the amount of the allowance item.

B. The Contractor shall furnish a priced list of special tools required to calibrate and maintain the instrumentation provided from which the Engineer or the Owner will select the needed tools. After approval the Contractor shall furnish tools on that list. The cost of these tools will be included in the allowance.

1.7 QUALITY ASSURANCE

A. Factory Acceptance Tests (FAT):

1. Prior to shipment, the PCIS including all panels, integrated SCADA system, PLCs, peripherals, communications equipment, etc. provided under this Division, shall be

assembled, connected, and all software loaded for a full functional factory acceptance test (FAT) of the integrated system. Existing equipment is not required to be included in this test.

2. In preparation for the FAT, the Contractor shall check, troubleshoot, debug and test the PCIS prior to arrival of the Engineer in order for the PCIS to be ready for the FAT, minimize testing time, and minimize re-testing during the visit. Similar testing shall be performed even if the Engineer chooses not to witness the FAT.

3. The Contractor shall allow the Engineer and Owner to inspect the PCIS and witness the functional testing of the system at the site of assembly and integration of the system.

4. A minimum of 21 Days notification shall be given to the Engineer prior to testing. No shipments shall be made without the Engineer's approval. A successful completion of the test is a prerequisite to the shipment of the system.

5. The factory test will be witnessed by the Engineer (1 person) and the Owner (up to 3 people). The Systems Supplier shall pay and provide for travel, food, and lodging for all the test witnesses.

6. The factory acceptance test shall be conducted at the place where the system was engineered, fabricated, assembled, and programmed.

7. It is considered reasonable that once scheduled, the system will be ready for the test and the test will be successfully completed in one session. If during the test, at the opinion of the Engineer and in accordance with the test procedure, the system is not ready for the test or has failed, and the Engineer and the Owner must extend their stay or leave and arrive at another date, the Owner reserves the right to withhold monies due to the Systems Supplier to cover additional costs of the Engineer’s time, travel, food, and lodging and associated project cost.

8. During the factory acceptance test, the Systems Supplier’s Project Manager and software engineers (HMI application software and PLC programming) who worked on the PCIS shall be available on the premises where the test is being conducted for explanation, demonstration or corrections.

9. After the successful completion of the test, the Engineer will generate a punch list. The list may include items that must be corrected or addressed prior to the shipment of the system, and/or items that must be corrected later in the field during installation and startup.

10. PLCs shown in the network architecture diagram shall be included in the factory test as representatives of the system. Vendor PLCs may be simulated.

B. Field Tests: The Contractor's attention is directed to the Article "EXECUTION" of this Section which delineates all the tests that are required to be performed in the field in order to demonstrate compliance with the Contract Documents.

C. The Contractor shall provide and assign to the Owner all user software and hardware licenses. Computer and software system shall be purchased on behalf of the Owner who shall also be designated as the licensee. Each software package shall be provided with

a “Site License” or with as many licenses as a “Site License” includes (site is defined as the name of the Owner). The Contractor shall include in the bid price all license fees.

D. The Contractor shall provide the proper number of software licenses for any additional computers and/or software required to provide concurrent and simultaneous user operation.

E. Prior to final acceptance of the PCIS System and related equipment, the Contractor shall propose and present in writing to the Owner a one-year maintenance contract and quotation which will become effective upon the expiration of the warranty. The maintenance contract is an option that the Owner may purchase from the Systems Supplier. The contract shall offer different maintenance, site visit and help-desk with options each with its respective cost.

1.8 FIELD SITE CONDITIONS

A. The PCIS shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions of a wastewater treatment facility.

B. Site Equipment:

1. Ambient temperature range: -18° through 60° C

2. Thermal shock: 1.0° (1.8° F) per minute maximum

3. Relative humidity: 95 percent maximum non-condensing

1.9 WARRANTY

A. All parts, material labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period shall be borne by the Contractor under the guarantee specified in Division 1. Equipment, software, and materials that do not achieve their intended purpose shall be replaced by the Contractor to attain compliance, at no additional cost to the Owner.

B. Extended Period for Correction of Defects: The Contractor shall correct defects in the PCIS upon notification from the Owner within 2 years from the date of Substantial Completion. Corrections shall be completed within 5 Days after notification.

C. The performance of the control panel monitor, and panel mount PC hardware shall be guaranteed (repair of parts and labor at the owner's site including travel expenses) for a period of three (3) years following the date of completion and formal acceptance of the work (next business day on-site service).

D. Software Upgrades: During the warrantee period, the Contractor shall furnish and install at no additional cost to the Owner any application software upgrades published applicable to Owner’s applications and compatible with Owner’s hardware and operating system.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Standard and Current Technology: All PCIS hardware, software, materials, and equipment furnished under this contract shall be new, free from defects, and shall be standard products and technology produced by manufacturers regularly engaged in the manufacturer of these products. Meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

The Contractor shall submit a Substitute Item Request Form in case of discontinued or upgraded product or other cases where changing technology requires changes in equipment or software.

B. Adverse Environmental Impact: No component of an instrumentation system shall contain liquid mercury.

C. Hardware Commonality and Modularity: Instruments which utilize a common measurement principle shall be furnished by a single manufacturer. Panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer. All equipment shall be of modular design to facilitate interchangeability of parts to assure ease of servicing and expandability.

D. Instrument and Loop Power: Power requirements and input/output connections for components shall be verified. Power for transmitted signals shall, in general, originate in and be supplied by the control panel devices. The use of "2 wire" transmitters is preferred, and use of "4 wire" transmitters shall be minimized. Individual loop or redundant power supplies shall be provided as specified and/or as required by the manufacturer's instrument load characteristics to ensure sufficient power to each loop component. Power supplies shall be mounted within control panels or in the field at the point of application.

E. Loop Isolators and Converters: The Contractor is responsible to resolve any signal level incompatibilities where required.

F. Signal Levels: Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable. Electrical signals outside control panels shall be 4 to 20 milliamperes DC except as indicated. Signals within enclosures may be 1 to 5 volts DC. Electric signals shall be electrically or optically isolated from other signals. Pneumatic signals shall be 3 to 15 psig with 3 psig equal to 0 percent and 15 psig equal to 100 percent.

G. Alternative Equipment and Methods: Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the Engineer through the "or equal" process of Section 01 60 00 - Products, Materials, Equipment, and Substitutions. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage, and maintenance enhancement over the equipment or method indicated, or shall include evidence that an indicated component is not available.

H. Lightning and Surge Arrestors

1. A lightning and surge arrestor (LSA) shall be provided to protect the electronic instrumentation system from induced surges propagating along the analog and discrete signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation but shall be lower than the instrument surge withstand level and be maintenance-free and self-restoring. The LSA shall be housed in a suitable metallic case, properly grounded. Ground wires for all surge protectors shall be connected to a good earth ground and where practical, each ground wire run individually and insulated from each other.

2. Protection of field analog, discrete, digital, and telemetered signal lines shall be provided as required. LSA devices shall be installed as close to the instrument being protected as possible.

3. Where signal lines enter or leave control rooms, buildings, etc., through an interface cabinet, the protection devices shall be mounted in the interface cabinet. Protection shall be with the combined use of gas tube surge arrestor and Zener diode protectors, MOV's and capacitors. The LSA shall be modular and plug-in type with an indicator to show LSA status. The LSA shall be compatible with the terminal blocks. The terminal block surge arrestors shall be as manufactured by Emerson (EDCO), WAGO, Phoenix Contact or equal

2.2 SPARE PARTS AND SPECIAL TOOLS

A. Additional spare parts and special tools as recommended by the Contractor.

B. All furnished special tools and spare parts shall be submitted before startup commences, suitably wrapped and identified.

2.3 FACTORY TESTING

A. The Contractor shall arrange to allow the Engineer and Owner to inspect and witness the testing of the supplied equipment at the site of fabrication. Equipment shall include equipment skid, the control cabinets (including Master PLC control cabinet if applicable), remote input/output (RIO) cabinets, control system network communication systems, special control systems, and other pertinent systems and devices. Reference Section 40 95 10 – PLC-Based Control Systems Hardware for factory test scheduling, setup, execution, and documentation requirements. A minimum 30 days notification shall be provided to the Engineer and Owner prior to testing. No shipments to the Work site shall be made prior to the Factory Test without the Engineer's written approval.

2.4 INSTRUMENT AND PANEL LIST

A. A complete instrument schedule is attached to this specification as Appendix A.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Shipping: After completion of shop assembly, factory test, and approval, the tested PCIS equipment, cabinets, panels, and computer hardware shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.

B. Special Instructions: Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. Tagging: A permanent stainless steel or other non-corrosive material tag marked with the instrument or equipment tag number shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package.

D. Storage: It is the Contractor's responsibility to assure proper handling and on-site storage of instrumentation and control equipment in accordance with the Systems Supplier’s recommendations. All equipment and materials delivered to the jobsite shall be stored in a location which will not interfere with the operations of other contractors or the Owner. Equipment shall not be stored outdoors. Storage and handling will be performed in manners which will afford maximum protection to the equipment and materials.

E. Equipment shall be stored in dry shelters, including in-line equipment, and shall be adequately protected against mechanical damage. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 INSTALLATION

A. General

1. All systems and instrumentation, including instrumentation furnished under other Divisions, shall be installed, connected calibrated, tested, started, and placed into operation in accordance with CONTRACT documents under Division 40 and the manufacturers' instructions. The installation shall be coordinated with the Engineer and the Owner. This shall include final integration in concert with equipment specified and provided by others.

2. The Contractor shall employ installers who are skilled and experienced in the installation and connection of all PCIS equipment.

3. The Contractor shall furnish the services of an on-site engineer to supervise and coordinate installation, adjustment, testing, and start-up of the PCIS. The engineer shall be present during the total period required to affect a complete operating system.

A team of engineering personnel shall be at the site for 40 hours to check equipment, perform the tests indicated in this Section, and furnish startup services.

4. Equipment Locations: The monitoring and control system configurations indicated in the contract documents are diagrammatic. The locations of equipment are approximate unless dimensioned. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Contractor shall make such changes without additional cost to the Owner.

5. The Contractor shall review the existing site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

6. The Contract Documents identify conduits and instruments required to make a complete PCIS. The Contractor shall be responsible for providing any reasonable additional or different type connections as required by parts of the PCIS' specific installation requirements, or as practical.

B. Conduit, Cables, and Field Wiring

1. Conduits, process equipment control wiring, 4 to 20 mA signal circuits, signal wiring to field instruments and to control panels, PLC input and output wiring, and other field wiring and cables shall be provided under Division 26 and without delay to the Work of Division 40.

2. PLC equipment cables and communication network cables shall be provided under Division 40, but the installation in the field shall be under Division 26.

3. Terminations and wire identification inside PCIS equipment and panels furnished under this or any other Division shall be provided under Division 40.

4. The Contractor shall supervise, and coordinate installation and termination and identification of field signals, power, and utilities associated with the PCIS. Resolve signal, power, or functional incompatibilities between the PCIS and new and existing interfacing devices.

C. Installation and Connections:

1. Instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements applicable to the Site. Appropriate mounting stands and bracket materials and workmanship shall be provided and shall comply with requirements of the Contract Documents.

2. Existing Instruments that are to be removed and reinstalled shall be cleaned, reconditioned, and recalibrated by an authorized service facility of the instrument manufacturer. The Contractor shall provide certification of this Work prior to reinstallation of each instrument.

3. The Contract Documents show necessary conduit and instruments required to make a complete instrumentation. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that Work. Such changes shall not be a basis of claims for extra Work or delay.

4. Field Connection Panels and Interface Terminal Blocks: In cases where field I/O wiring has to be extended to a control panel or from enclosures or devices that are removed, the Contractor shall provide separate enclosures or junction boxes with interface terminal blocks that will serve as a field connection panel (FCP). The FCP and the terminal block shall be shown on the project-wide wiring diagrams.

5. Conduits and/or raceways in building interior locations shall be surface mounted on walls or ceilings wherever possible and run perpendicular and parallel to building lines. Conduits shall not be routed on floors in areas subject to foot traffic. In exterior locations conduit shall be routed below grade.

6. Wires and cables shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the Engineer. Wiring shall be protected from sharp edges and corners.

7. Signal and low voltage wiring shall be run in a separate conduit from power and 120-volt control wiring.

8. Field wiring shall terminate at terminal blocks in the control panel. Field wiring shall not be wired directly to equipment in the control panel except communication and specialty cables that must be wired directly to their respective equipment.

9. Power and signal wires shall be terminated with crimped type lugs.

10. Wires shall be marked clearly with an identification wire number labels that are of a permanent nature. Computer system equipment cables shall be identified and marked for their location at each end of the cable. Computers and peripheral equipment connections/ports shall also be identified as to what cable is connected to its port location.

11. Connectors shall be, as a minimum, watertight.

12. Sensing Lines and Tubing:

    a. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3-feet of rigid tubing.

    b. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at panels requiring pipe or tubing entries.

13. Flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.

14. Differential pressure elements shall have 3 valve manifolds.

15. The Contractor shall verify the correctness of each installation, including polarity of electric power and signal connections. The Contractor shall certify in writing all discrepancies have been corrected for each loop or system checked out. In addition, the Contractor shall make sure process connections are free of leaks.

D. Removal of Abandoned Equipment: Unless otherwise specified, all existing equipment in each facility that is no longer required after the new system has been put in service shall be removed and delivered by the Contractor to the Owner.

3.3 FIELD QUALITY CONTROL

A. General:

1. Devices provided under Division 40 shall be initially calibrated by the manufacturer at the manufacturer’s facility prior to shipment. Following installation, the devices shall be field calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements. The Contractor shall also field calibrate existing instruments if it is part of a modified loop.

2. Each instrument shall be field tested, inspected, and adjusted to the indicated performance requirement in accordance its manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirement, or, in the absence of a contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer.

B. Calibration Points: During bench and field calibration each instrument shall be calibrated at least at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs and outputs. The test instruments shall have accuracies traceable to National Institute of Standards and Testing.

C. Bench Calibration: Instruments that have been bench-calibrated by the manufacturer shall be verified in the field after installation to determine whether any of the calibrations are in need of adjustment.

D. Field Calibration: Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Analyzer Calibration: Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.

F. Calibration Sheets: Each instrument calibration sheet shall provide the following information and a space for sign-off on individual items and on the completed unit:

1. Project name

2. Loop number and site or process name and number

3. Tag number

4. Manufacturer

5. Model number

6. Serial number

7. Calibration range

8. Calibration data: Input, output, and error at 0 percent, 50 percent, and 100 percent of span

9. Switch setting, contact action, and dead band for discrete elements

10. Space for comments

11. Space for sign-off by Systems Supplier and when applicable by the manufacturer and date

12. Test equipment used and associated serial numbers

G. Calibration Tags: A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The Contractor shall sign the calibration sheet when calibration is complete. The Engineer will sign the calibration sheet when the calibration and testing has been accepted.

H. Loop Testing: The Contractor shall test newly installed and modified existing loops for continuity and functionality. The up-to-date wiring diagrams shall be used as reference. The Engineer and/or the Owner shall witness the loop testing.

I. The Contractor shall notify the Engineer of scheduled tests minimum of 30 calendar days prior to the estimated completion date of installation and wiring of the PCIS. After the Engineer's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop testing shall be witnessed by the Engineer and/or the Owner.

J. Control Valve Tests: Control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to ensure that no changes have occurred since the bench calibration.

K. Interlocks: Hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers, and packaged equipment controls shall be checked to the maximum extent possible.

L. Loop Validation:

1. Control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the HMI displays associated with the PLC. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested.

2. Accuracy tolerances for each analog network are defined as the root-mean-square (RMS) summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by contract requirements or by published manufacturer accuracy specifications, whenever contract accuracy requirements are not indicated. Each analog loop shall be tested by applying simulated analog or discrete inputs to the first element of an analog loop. For loops which incorporate analog elements, simulated sensor inputs corresponding to 0, 25, 50, 75, and 100 percent of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated RMS summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. Analog loop test data, including calculated RMS summation system accuracy tolerance, shall be documented by the Contractor on the loop validation sheets. The validation sheets shall be included in the O&M Manuals.

M. Loop Validation and Certification Sheets:

1. Loop Validation: The Contractor shall prepare loop validation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop validation sheets shall form the basis for operational tests and documentation. Each loop validation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop by the Systems Supplier:

   a. Project name

   b. Loop number

   c. Tag number, description, manufacturer, and model number for each element

   d. Installation bulletin number

   e. Specification sheet number

   f. Loop description number

   g. Adjustment check

   h. Space for comments

   i. Space for loop sign-off by the System Supplier and date

   j. Space for Engineer witness signature and date

2. Loop Certification**:** A certified copy of each loop test validation sheet signed by the Systems Supplier, the Engineer or the Engineer's representative as a witness, with test data entered, shall be submitted to the Engineer together with a clear and unequivocal statement that the loops have been tested and the instrumentation in the loop has been successfully calibrated, inspected, and tested.

N. Manufacturer’s Services

1. The Contractor shall provide jobsite visits and services of a manufacturer’s technical field representative for supervision of the following:

   a. Oversee installation: Supervise installation and connection of all instruments, elements, and components of every system, including connection of instrument signals to primary measurement elements and to final control elements such as VFD, pumps, valves, and chemical systems.

   b. Verify that installed instrument and software meet manufacturer’s recommendations

   c. Certify installation and reconfirm manufacturer's accuracy statement

   d. Oversee loop testing, prepare loop validation sheets, and certify loop testing

   e. Certify when testing is completed.

   f. Training the Owner's personnel

2. Manufacturer's services shall be furnished for the following equipment:

   a. Autosampler

   b. Process Analyzers

3.4 PRE-COMMISSIONING

A. General:

1. Pre-commissioning, which is defined in Section 01 75 00 – Equipment Testing and Plant Startup, is basically the demonstration of proper operation of every part in the PCIS with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible. All systems shall be exercised through field operational tests, as a complete PCIS in accordance with the approved test procedures and in the presence of the Engineer and/or the Owner.

2. Pre-commissioning shall commence after completion and acceptance of continuity tests, calibration tests and loop tests, and inspections have demonstrated that the instrumentation and control system complies with contract requirements.

3. Pre-commissioning Procedures and Documentation: Pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance

limits for each step. Completion of system pre-commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system pre-commissioning and test requirements have been satisfied. The result of the testing shall also include a punch list developed by the Engineer.

4. The burden of proof of conformance of the system to specified functions and performance is on the Contractor. Tests that fail to demonstrate the required operation shall be repeated in their entirety or continued after corrective action has been completed at the discretion of the Engineer.

5. The Contractor shall supply necessary test equipment and technical personnel if called upon to prove accuracy and/or performance, at no separate additional cost to the Owner, wherever the Owner or Engineer has reasonable doubt or evidence of malfunction or poor performance appears.

6. The Contractor shall coordinate the scheduling of tests among all parties involved so that the tests may proceed without delays or disruption by uncompleted work. Field operational and functional testing must be successfully completed prior to the start of the 30-day final acceptance test.

B. Operational Validation:

1. Where feasible, system pre-commissioning activities shall include the use of the actual process to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, PLCs, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational.

2. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of process controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

3. Pre-commissioning shall also include the testing of remote sites to verify compliance with all functional requirements and communication specified. The testing shall include manual and automatic control modes, fail-safe and backup control modes, and PLC interlocks and control strategies provided by the Systems Supplier.

C. Loop and Equipment Tuning: Controllers incorporating proportional, integral and/or derivative control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings

shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

D. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on test forms as follows:

1. The validation form, which shall include:

a. Project name

b. Loop number

c. Loop and function description

d. Tag number, description, manufacturer, and data sheet number for each component.

e. Pre-Commissioning Certification - A statement certifying that the contract requirements have been met. It shall also include a listing of instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system testing must be provided in writing by the Engineer before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the General Conditions.

f. Space for sign-off and date by the Contractor and the Engineer.

3.5 COMMISSIONING

A. Commissioning is the verification that the complete Work functions on an extended basis are in full conformance with the Contract requirements.

B. As part of the commissioning, the entire PCIS shall operate continuously without failure for 30 consecutive days without failure (see test details below), thus extending its operation test longer than the commissioning period specified in Section 01 75 00.

3.6 STARTUP OPERATION

A. General: Startup is defined as testing, demonstrations, and other activities as required to achieve Substantial Completion. Pre-commissioning and commissioning activities, manufacturer’s services, certifications of readiness for testing, and troubleshooting, checkout, and shakedown activities must be completed before startup activities begin.

B. When all equipment and systems have been assessed by the Contractor to have been successfully carried through complete operational and functional tests with not less than a minimum of simulation, and the Engineer concurs in this assessment, system startup by the Owner's operating personnel can follow.

C. Each facility, process, or site startup shall be performed in accordance with the approved test procedures.

D. Scheduling of startup shall be coordinated by the Contractor among all parties involved so that the tests may proceed without delays or disruption by uncompleted work. System startup and training and instruction of the Owner's personnel must be completed a minimum of seven (7) days prior to the final acceptance test.

1. Troubleshooting and Corrections

a. The Contractor shall participate in all start-up activities. If problems occur, the Contractor and the Systems Supplier shall jointly participate in the diagnosis wiring, control interface, hardware and software problems and correct deficiencies. The Contractor shall be responsible and bear all expenses to diagnose and correct all the deficiencies for work and equipment furnished under this Contract.

b. Existing Instruments, Wiring, and Interface: As specified above, prior to start of the Work the Contractor shall request the Owner to demonstrate that all existing equipment and software that is to be reused or interfaced with in this project works properly for the intended function. Consequently, if during the calibration, testing, or start up, the Contractor and/or the Contractor encounters problems with existing instruments, hardware, wiring, or software that have been demonstrated to work, the Contractor shall notify the Engineer and the Owner. In this case, the Contractor and the Owner’s representative shall jointly participate in the diagnosis of the problem. The course of action how to correct the deficiency shall be determined jointly by the Owner, the Engineer, and the Contractor. The Contractor shall be compensated for correcting the deficiencies or replacing the equipment.

c. If a problem is found to be a result of the Contractor’s workmanship or equipment and work furnished under this Contract, the Contractor shall be responsible and bear the expenses for correcting the deficiencies.

3.7 FINAL ACCEPTANCE TEST (COMMISSIONING)

A. After the pre-commissioning, functional tests, and startup have been completed, the Contractor shall submit a report/letter stating that the CONTRACT requirements have been met and the PCIS is ready for the Final Acceptance Test.

B. The entire PCIS shall go through a final 30-day acceptance test. For the purpose of this Contract, the terms “Final Acceptance Test” and “Final Performance Test” are synonymous and are used interchangeably. The 30-day test must be successfully completed prior to the date of and as a condition to substantial completion of the entire project Work. During the testing period, all system functions shall be exercised, and any system interruption and accompanying component, subsystem, software, or program failure shall be logged for cause of failure, as well as time of occurrence and duration of each failure.

C. The Contractor shall furnish support staff as required to operate the system and to satisfy the repair or replacement requirements. The Contractor shall also provide a competently programmer on call during all normal working days and hours from the start of the acceptance test until final acceptance of the system. The on-call programmers shall be ready to respond within two hours of the notification of the problem.

D. Testing: The entire PCIS shall be tested and shall include, but not limited to, the field instrumentation, control and PLC panels and PLC programs, application SCADA software, graphics and trends, reports, and the control and monitoring functions. Each system function, e.g., status report-backs, alarms, logs, and displays shall be exercised several times at a minimum, and in a manner which approximates "normal" system operation. At least two displays and reports shall be generated during the test.

E. Failure During Testing: Failure of the system during the testing shall be considered as indicating that part of the PCIS does meet the requirements of the specifications and corrective action shall be required before restarting the acceptance test.

Failures shall be classified as either major or minor as follows, and it is at the discretion of the Engineer how to classify the failure:

1. Minor Failure: A minor failure would be a small and non-critical component failure which can be corrected by the Owner's operators. This occurrence shall be logged but shall not be reason enough for stopping the test and shall not be grounds for non-acceptance or restart, provided that the function(s) can be provided by backup equipment and repairs can be made and equipment returned to service within one (1) working day.

   However, should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance and termination of the test.

2. Major Failure: A major failure shall be considered to have occurred when a major component of the PCIS, subsystem, communication, or program fault causes a halt in operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system. A major failure shall cause termination of the acceptance test. When the causes of a major failure have been corrected, a new acceptance test shall be started.

F. Technician Report: Each time a technician is required to respond to a malfunction in the PCIS he/she must complete a report which shall include details concerning the nature of the complaint or malfunction and the resulting repair action required and taken. If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report shall be required (logged as specified above). Each report shall be submitted within 24 hours to the Engineer or its representative, and the Owner.

3.8 CLOSEOUT ACTIVITIES

A. Training:

1. The Contractor shall train the Owner’s personnel on the PCIS operation, maintenance, calibration, and repair of equipment provided under this Contract. The training shall be by qualified instructors. The training courses shall be given on-site to a minimum four (4) Owner’s personnel. All instruction, tools and training material shall be provided by the Contractor.

2. These courses shall be designed to provide the operations, maintenance, and supervisory personnel with training in routine and preventive maintenance of all the PCIS including instrumentation, communication, PLCs software, and HMI. The

training course shall include instruction on the use of all maintenance equipment and special tools provided under the contract.

3. Instructions: The training shall be performed by qualified instructors. The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

4. Training Manuals and Material: The Contractor shall use the approved Training syllabus and Training Manuals to develop training material. The training material shall be designed to provide the operations, maintenance, and supervisory personnel with training in routine operation procedures, and preventive maintenance and troubleshooting of the PCIS, PLCs and the computer monitoring and control systems.

5. Schedule: Training shall be performed on-site during the calibration, loop and functional testing of the PCIS prior to the 30-day Final Acceptance Test. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The Engineer will review the course outline for suitability and provide comments that shall be incorporated. Due to availability and scheduling of the Owner's staff, the Contractor shall coordinate with the Owner the schedule of the classes. The Owner reserves the right to videotape the training sessions for later use. Due to possible limited availability of the Owner's staff, the Contractor shall provide the number of identical courses/sessions of each of the following training courses as indicated, each up to four (4) people of the Owner's staff.

6. Training Subjects, Duration, and Agenda**:** The training shall include operation and maintenance procedures, troubleshooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment. During the course, hands-on experience with the system equipment shall be provided. Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects of the PCIS and the PLCs. Operator classes shall stress operational theory and use of the PCIS and the PLCs.

    a. Field Instruments

        1) Duration – an average of one (1) hour per each type of instrument, unless otherwise noted

        2) Subjects - installation, setup, configuration, maintenance, calibration, and troubleshooting:

            a) Pressure transmitter

            b) Level transmitter

            c) Flow measuring device and transmitter

            d) Analyzer – chlorine and turbidity (2 hours)

            e) Autosampler (2 hours)

            f) Panel devices

g) OIT and PLC

h) Uninterruptible power supply (UPS)

7. PLC: The training of the following subject shall be performed by the Contractor and the PLC manufacturer as noted: Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects of the PLC. Operator classes shall stress operational theory and use of the PLCs.

   a. Duration – 2 instruction hours or a minimum of 2-hours per class of PLC training.

   b. Subjects:

      1) Project specific operation and communication – by the Contractor

      2) Project specific PLC program troubleshooting – by the Contractor

8. HMI Operation

   a. Duration

      1) 4 hours for Operations

   b. Subjects

      1) Report and trend generation

      2) Operator training for Reuse Building processes

      3) HMI graphics with emphasis on making changes and additions to reports and displays method to be used for scheduling and changing the scheduling of reports.

      4) Historical backup and maintenance.

      5) Diagnostics, troubleshooting, and related procedures

9. Communication System and Network

   a. Duration – 1 hour

   b. Subjects –

      1) Communication types and communication equipment – radio to reservoir

      2) PLC communication hardware

      3) Network equipment and maintenance

      4) Communication protocols

      5) Wireless communication

6) Communication failure diagnosis/troubleshooting and repair

3.9 CRITERIA FOR SUBSTANTIAL COMPLETION

A. For this Section and all Division 40, the following conditions shall be fulfilled before the Work is considered substantially complete:

1. Submittals have been completed and approved.

2. The PCIS has been calibrated; loop tested, pre-commissioned, commissioned, and the startup completed.

3. The Owner's training has been performed.

4. Spare parts and expendable supplies and test equipment have been delivered to the Owner.

5. The Final Acceptance Test has been successfully completed.

6. Major punch-list items have been corrected.

7. As built drawings in both hard copy and electronic format have been submitted. The as built drawings shall also include annotation of the PLC ladder logic program by providing a descriptive label for all relays and function blocks and functional description of each rung.

8. Revisions to the Technical Manuals that may have resulted from the field tests have been made and reviewed.

9. Debris associated with installation of instrumentation has been removed.

10. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

END OF SECTION

APPENDIX A

Drawing Number	Instrument Tag	Instrument Type	Service Description	Location	Signal Detail	Req. Power Supply	Instrument Range	Instrument Setpoint	Isolation Ball Valve Required	Installation Details Ref.	Area Classification	Comments
1I-101	FE-101	Flow Element (Ultrasonic)	Sampling and Flow Monitoring SS Manhole Flow	Influent Pump Station	N/A					I-101	Class 1, Division 1	
1I-101	FIT-101	Flow Indicating Transmitter	Sampling and Flow Monitoring SS Manhole Flow	Influent Pump Station	4-20 mA					I-101	NA	
1I-101	FE-102	Flow Element (Ultrasonic)	Sampling and Flow Monitoring SS Manhole Flow	Influent Pump Station	N/A					I-101	Class 1, Division 1	
1I-101	FIT-102	Flow Indicating Transmitter	Sampling and Flow Monitoring SS Manhole Flow	Influent Pump Station	4-20 mA					I-101	NA	
1I-101	XS-110B	Centrifugal Switch	Grease Pump No 1 Motor Centrifugal Switch	Influent Pump Station	24VDC					By Vendor	NA	
1I-101	XS-120B	Centrifugal Switch	Grease Pump No 2 Motor Centrifugal Switch	Influent Pump Station	24VDC					By Vendor	NA	
1I-101	XS-130B	Centrifugal Switch	Grease Pump No 3 Motor Centrifugal Switch	Influent Pump Station	24VDC					By Vendor	NA	
1I-101	FE-103	Magnetic Flow Element	Meter Vault Flow	Influent Pump Station	N/A					I-101	Class 1, Division 1	
1I-101	FIT-103	Magnetic Flow Indicating Transmitter	Meter Vault Flow	Influent Pump Station	4-20 mA					I-101	NA	
1I-101	LE-101	Radar Level Element	Influent Wet Well Common Level	Influent Pump Station	N/A					I-202	Class 1, Division 1	
1I-101	LIT-101	Radar Level Indicating Transmitter	Influent Wet Well Common Level	Influent Pump Station	4-20 mA					I-202	NA	
1I-101	LSHH-100	Vibronic Fork Level Detection Switch	Meter Vault	Influent Pump Station	24VDC					I-254	NA	
2I-101	PI-210	Pressure Gaugue	Grit Washer Skid No 1 Suction Pressure	Grit Washing Facility	NA					I-301	NA	
2I-101	PI-220	Pressure Gaugue	Grit Washer Skid No 2 Suction Pressure	Grit Washing Facility	NA					I-301	NA	
2I-101	FI-210	Rotameter	Grit Washer Skid No 1 Non-Potable Water Flow	Grit Washing Facility	NA					By Vendor	NA	
2I-101	FI-220	Rotameter	Grit Washer Skid No 2 Non-Potable Water Flow	Grit Washing Facility	NA					By Vendor	NA	
2I-101	LIT-210	Level Indicating Transmitter	Grit Washer Skid No 1 Washer Level	Grit Washing Facility	4-20 mA					By Vendor	NA	
2I-101	LIT-220	Level Indicating Transmitter	Grit Washer Skid No 2 Washer Level	Grit Washing Facility	4-20 mA					By Vendor	NA	
2I-101	SSL-210	Speed Switch Low	Grit Washer Skid No 1 Motor Speed Switch Low	Grit Washing Facility	24VDC					By Vendor	NA	
2I-101	SSL-220	Speed Switch Low	Grit Washer Skid No 2 Motor Speed Switch Low	Grit Washing Facility	24VDC					By Vendor	NA	
2I-101	TSH-210	Temperature Switch High	Grit Washer Skid No 1 Motor Temperature Switch	Headworks Facility	24VDC					[per motor supplier]	NA	
2I-101	TSH-220	Temperature Switch High	Grit Washer Skid No 2 Motor Temperature Switch	Headworks Facility	24VDC					[per motor supplier]	NA	
3I-102	PI-300	Pressure Gaugue	Intermediate Pump Station Common Header Pressure	Headworks Facility	NA					I-301	NA	
3I-102	TSH-304	Temperature Switch High	Intermediate Pump No 4 Motor Temp Switch High	Headworks Facility	24VDC					[per motor supplier]	NA	
3I-102	XS-304	Leak Switch	Intermediate Pump No 4 Motor Leak Switch	Headworks Facility	24VDC					[per motor supplier]	NA	
3I-102	TSH-305	Temperature Switch High	Intermediate Pump No 5 Motor Temp Switch High	Headworks Facility	24VDC					[per motor supplier]	NA	
3I-102	XS-305	Leak Switch	Intermediate Pump No 5 Motor Leak Switch	Headworks Facility	24VDC					[per motor supplier]	NA	
3I-103	TSH-310A	Temperature Switch High	Grit Mixer No 1 Motor Temperature Switch	Headworks Facility	24VDC					[per motor supplier]	NA	
3I-103	TSH-310B	Temperature Switch High	Grit Pump No 1 Motor Temperature Switch	Headworks Facility	24VDC					[per motor supplier]	NA	
3I-103	TSH-320A	Temperature Switch High	Grit Mixer No 2 Motor Temperature Switch	Headworks Facility	24VDC					[per motor supplier]	NA	
3I-103	TSH-320B	Temperature Switch High	Grit Pump No 2 Motor Temperature Switch	Headworks Facility	24VDC					[per motor supplier]	NA	

SECTION 40 91 02 - IN-LINE LIQUID FLOW MEASURING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The Contractor shall provide in-line liquid flow measuring systems, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Section 40 91 00 - Process Control and Instrumentation Systems.

B. Applicable Sections in Division 40 and 43 – Instrumentation and Control for Process Systems.

C. Division 26 – Electrical.

D. Section 09 96 00 – High-Performance Coatings

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Submittals shall be provided in accordance with the requirements specified in Section 40 91 00 – Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.1 MAGNETIC FLOW MEASURING SYSTEMS

A. Manufacturers: The Magnetic flow meter manufacturer and model flow meters shall be as follows and or equal:

1. **Rosemount model 8705 Sensor & 8732E/8712E Transmitter or 8707 Sensor (High Signal)/8712H Transmitter**

2. **Endress+Hauser Proline Promag W 400**

3. **ABB**

4. **Siemens**

5. **Or Equal**

B. Description: Magnetic flowmeter systems shall be the low frequency electromagnetic induction type that produces a DC pulsed signal directly proportional to and linear with the liquid flow rate. .

C. Performance / Design Criteria: Magnetic flowmeter system shall be suitable for the intended service and shall be based on the conductivity properties and solid content of the process fluid, in accordance with the manufacturer’s recommendations.

1. Magnetic flowmeter system shall be capable of measuring fluid velocities in the range of 0.04 and 39 ft. /sec. in both forward and reverse flow in all sensor sizes.

2. Accuracy: The flow metering system shall be installed in accordance with the manufacturer's recommendations to provide at least 0.5 percent of flow rate from 10 to 100 percent full scale for velocities over 3 feet per second.

3. Repeatability: 0.1 percent of reading.

4. Power consumption shall be as indicated in the data sheet.

5. Power input requirements shall be as indicated in the data sheet.

D. Materials / Components: The magnetic flow metering system shall include a metering tube, transmitter, and signal cable and flowmeter grounding rings.

1. Metering Sensor/Tube:

a. The metering sensor shall employ a pulsed DC technique to drive flux-producing coils. Sensors using high pulsed DC signals shall be used in accordance with the manufacturer's recommendations for the required service application and as indicated in the data sheet.

b. The metering tube sizes shall be available from at least 1-inch to 36-inch line size. It shall be sized in accordance with the installation application and the intended service and as recommended by the manufacturer, and as indicated in the data sheet. If fractional size or larger size meters are required, the manufacturer shall be consulted for availability.

c. Metering Sensor/Tube

1) Flanged Connections: The flanges' size, style, type and construction material shall be in accordance with the required installation and the intended service application and as recommended by the manufacturer, and as indicated in the data sheet. Pressure ratings shall be as indicated in the data sheet and in accordance with the requirements of Section 40 05 01 – Piping General as recommended by the manufacturer for the intended service.

2) A minimum of two (2) electrodes shall be provided. The electrodes' material shall be suitable for the required service as recommended by the manufacturer, and as indicated in the data sheet. A reference electrode shall be provided as recommended by the manufacturer for the required installation application.

3) Lining material shall be in accordance with the manufacturer's recommendation for the intended service, and as indicated in the data sheet.

4) Meter housing shall be rated for NEMA 6P (IP68) (limited depth) and shall be offered with certified ratings for different hazardous locations as specified in the data sheet. It shall be able to operate between -20 to 140 Degrees F (-29 to 60 degrees C).

5) Meter tube shall have epoxy protective coating.

6) Grounding rings shall be provided and designed to protect and shield the liner's edge interface from abrasion at the meter end. Grounding rings shall

conform to the manufacturer's bore and material recommendation for the intended service Grounding shall conform to the manufacturer's recommendations.

2. Transmitter/Converter

a. The transmitter/converter shall be capable of being mounted integral to the metering tube or remotely as indicated in the data sheet. Mounting hardware shall be provided.

b. The transmitter/converter shall be rated for NEMA 4X (IP67). Certified ratings for different hazardous locations shall be offered as an option as specified in the data sheet. It shall be able to operate in ambient temperatures of -20 to 140 degrees F (-29 to 60 degrees C).

c. The transmitter shall convert the DC pulse signal from the metering tube to a linear 4 to 20 mA DC signal into a minimum of 700 ohms. The 4-20 mADC signal shall comply with HART protocol. Output signal shall be continuously adjustable over the full scale. Other digital output options shall be available.

d. The transmitter shall have an LCD displays for flow rate, percent of span, totalization, operator configuration interface, and diagnostic information.

e. The transmitter shall have an adjustable integral low flow cutoff and zero return.

f. The transmitter shall perform self-diagnostics and automatic data checking and activate a switch closure output when a transmitter fault is detected.

3. Cables

a. Remote transmitter configuration shall be provided with the required lengths and types of electrodes and coil drive cables as recommended by the manufacturer for the required installation application. Maximum distance of transmitter from the metering tube shall be as recommended by the manufacturer.

E. Calibration: Each flow metering system shall be hydraulically calibrated at a facility that is traceable to the National Institute of Standards and Technologies. The calibration procedure shall conform to the requirements of ANS/ISO/IEC 17025:2005 and ANSI/NCSL Z540.3-2006. A real-time computer generated printout of the actual calibration data shall be submitted to the Engineer at least 30 Days prior to shipment to the site.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. In-line liquid flow measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 - Process Control and Instrumentation Systems. Manufacturer's service, supervision, and training shall also be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

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SECTION 40 91 06 - LEVEL MEASURING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The Contractor shall provide level measuring systems, complete and operable in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Section 40 91 00 - Process Control and Instrumentation Systems.

B. Applicable Sections in Division 40 – Instrumentation and Control for Process Systems.

C. Division 26 – Electrical.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Submittals shall be provided in accordance with the requirements specified in Section 40 91 00 – Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.1 NON-CONTACTING RADAR TYPE LEVEL MEASUREMENT

A. Manufacturers: Non-contact radar type level measuring systems shall be **Rosemount 5408, Vega model VEGAPULS 6X**, or equal.

B. Description: Radar type level measuring systems shall employ time domain reflectometry (TDR) , utilizing impulses of electromagnetic energy transmitted from the antenna at the tank top down to the liquid level. When the pulse reaches the liquid surface, which has a higher dielectric constant than air, part of the energy is reflected back to the transmitter. The time difference between the transmitted and reflected pulse is proportional to the distance to the liquid surface, from which liquid level and/or volume is calculated.

C. Performance / Design Criteria:

1. Transmitter:

a. Power input to the transmitter shall be as noted in the data sheet. The transmitter shall provide an isolated, 4 - 20 mADC output signal, linearly proportional to level and shall be compatible with digital HART protocol. The unit shall have a local LCD display for configuration and monitoring. Transmitter operating temperature shall be -40 to 175 degrees F.

b. Measuring range shall be as indicated in the data sheet and with a resolution ofplus or minus 0.04-inch.

D. Materials / Components:

1. Transmitter:

a. Transmitter housing material shall be as recommended by the manufacturer for the intended service and as indicated in the data sheet.

2. Antenna and Cone shape material shall be as recommended by the manufacturer for the intended service and as indicated in the data sheet.

3. Transmitter and antenna shall be provided with all the mounting hardware. Mounting type and material shall be as recommended by the manufacturer for the intended service and as indicated in the data sheet and coordinated with the Contractor.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. Level measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 - Process Control and Instrumentation Systems. Manufacturer's service, supervision, and training shall also be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 91 07 - LEVEL DETECTION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The Contractor shall provide level detection switches, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Section 40 91 00 - Process Control and Instrumentation Systems.

B. Applicable Sections in Division 40 – Instrumentation and Control for Process Systems.

C. Division 26 – Electrical.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Submittals shall be provided in accordance with the requirements specified in Section 40 91 00 – Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.1 TIPPING FLOAT TYPE LEVEL SWITCHES

A. Manufacturers: Tipping float type level switch manufacturers shall be **MAGNETROL T10, FLYGT ENM-10, KARI**, **SIEMENS,** or equal.

B. Description: Tipping float level switch shall consist of a switch, a moving float, and a connecting cable that is anchored at the midpoint of a differential band. As the level rises and falls the float rights itself or inverts causing switching actions. The cable anchoring point shall be protected by strain relief.

C. Performance / Design Criteria: The hermetically sealed switches shall have a SPDT output with a minimum rating of 10 Amps at 120 VAC.

D. Materials / Components: The float switch shall be mercury-free. Float material shall be in accordance with the manufacturer’s recommendations for the intended service and installation application and as indicated in the data sheet.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL:

A. Level detection switches shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 - Process Control and Instrumentation Systems. Manufacturer’s service, supervision, and training shall also be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

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SECTION 40 91 08 - PRESSURE MEASURING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The Contractor shall provide pressure measuring systems, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Section 40 91 00 - Process Control and Instrumentation Systems.

B. Applicable Sections in Division 40 – Instrumentation and Control for Process Systems.

C. Division 26 – Electrical.

1.3 ACTION SUBMITTALS / INFORMATIVE SUBMITTALS

A. Submittals shall be provided in accordance with the requirements specified in Section 40 91 00 – Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers: Shall be Ashcroft 1279, Ametek Solfrunt Series 1900, or Equal.

B. Performance / Design Criteria: Gauge Protection: Gauges shall be protected with the appropriate components as indicated in the data sheet.

C. Materials / Components:

1. Pressure gauges shall be 4-1/2 inches, with white laminated dials and black graduations, and have either a shatterproof glass or acrylic window as indicated in the data sheet. The gauges' bottom connection size shall be as indicated in the data sheet.

2. Sensing element shall be bourdon tube with welded, stress-relieved joints. Sensing element material shall be as recommended by the manufacturer and as indicated in the data sheet. Gauges shall have an accuracy of plus and minus 1/2-percent of full scale.

3. Body material shall be as recommended by the manufacture and as indicated in the data sheet.

4. Gauge shall be either dry or liquid filled as indicated in the data sheet.

5. Gauges shall be provided with a 316 stainless steel pulsation dampener (snubber), unless otherwise noted in the data sheet. The pulsating dampener shall absorb system pressure pulses.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. Pressure measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 - Process Control and Instrumentation Systems. Manufacturer's service, supervision, and training shall also be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 92 00 - CONTROL PANELS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The Contractor shall provide control panels, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 - Process Control and Instrumentation Systems apply to this Section.

C. The provisions of this Section apply to Section 40 92 01 - Control Panel Instrumentation except where indicated otherwise.

D. The provisions of this Section apply to local panels provided in equipment systems specified in other sections unless indicated otherwise in those sections.

E. The requirements of Division 26 specifications shall apply to this section.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be furnished in accordance with Section 01 33 00 – Submittal Procedures.

B. **Control Panel Engineering Submittal:** The Contractor shall submit a control panel engineering submittal (CPES) for each control panel furnished. The CPES shall completely define and document the construction, finish, layout, power circuits, signal and safety grounding circuits, fuses, circuit breakers, signal circuits, internally mounted instrumentation and SCADA system components, face plate mounted instrumentation components, internal panel arrangements, and external panel arrangements. All panel drawings shall, as a minimum, be "B" size with all data sheets and manufacturer specification sheets being "A" size. The submittal shall be in conformance with ISA-S20 - Standard Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves, shall be submitted as a singular complete bound volume or multi-volume package within 120 calendar days after Notice to Proceed, and shall have the following contents:

1. A complete index shall appear in the front of each bound volume. Drawings and data sheets associated with a panel shall be grouped together with the panels being indexed by systems or process areas. Panel tagging and nameplate nomenclature shall be consistent with the requirements of the contract requirements.

2. Scale construction drawings which define and quantify the type and gauge of steel to be used for panel fabrication, the ASTM grade to be used for structural shapes and straps, panel door locks and hinge mechanisms, type of bolts and bolt locations for section joining and anchoring, details and proposed locations for "UNISTRUT" members, stiffener materials and locations, electrical terminal box and outlet locations, electrical access locations, print pocket locations, writing board locations, and lifting lug material and locations.

3. Scaled physical arrangement drawings drawn to scale which define and quantify the physical groupings comprising control panel sections, auxiliary panels, subpanels, and racks. Cutout locations with nameplate identifications shall be shown.

4. Front of panel layouts for all control panels.

5. Schematic/elementary diagrams shall depict all control devices and circuits and their functions.

6. Wiring/connection diagrams shall locate and identify electrical devices, terminals, and interconnecting wiring. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.

7. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment. These diagrams shall show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.

8. Control sequence diagrams to portray the contact positions or connections required to be made for each successive step of the control action. Written descriptions explaining the control sequence diagrams and system operation shall be furnished.

9. Completed ISA S20 data sheets for all instrumentation devices associated with each control panel supplemented with manufacturer specification sheets which verify conformance to the requirements of the Contract Documents

10. A bill of materials which enumerates all devices associated with the control panel.

11. A priced listing of analog spare parts in conformance with Section 40 91 00 - Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Environmental Suitability:** Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated by the Contractor. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation devices 20 percent within the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide all power wiring for these devices. Enclosures suitable for the environment shall be provided. Instrumentation in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

B. Control panel power shall be 120 VAC. Where the electrical power supply to the control panel is 240 VAC single phase or 480 VAC 3-phase, the control panel shall be provided with a control panel transformer. Control conductors shall be provided in accordance with the indicated requirements.

C. The control panel shall be the source of power for any 120 VAC solenoid valves interconnected with the control panel. Equipment associated with the control panel shall be ready for service after connection of conductors to equipment, controls, and control panel.

D. The main feeder disconnect shall have a door-mounted handle unless otherwise indicated.

E. Unless indicated otherwise, control panels shall be housed in NEMA rated enclosures. Control panels shall be either freestanding, pedestal-mounted or equipment skid-mounted, as indicated. Internal control components shall be mounted on an internal back-panel or side-panel as required.

F. Each source of foreign voltage shall be isolated by providing disconnecting or pull-apart terminal blocks or a disconnect operable from the control panel front. Each control panel shall be provided with identified terminal strips for the connection of all external conductors. The Contractor shall provide sufficient terminal blocks to connect 25 percent additional conductors for future use.

G. Motor starters, where required, shall be furnished, installed, and configured by others (reference Section 40 90 10 for Contractor system communication requirements). Each motor starter shall be provided with contact closures for motor overload, local indication, and remote alarm. Electrical components shall be of standard American manufacture.

H. Discrete inputs to the control panel shall be 24Vdc. Discrete outputs from the control panel shall be provided by electrically isolated contacts rated for 5 amps at 120 VAC. Analog inputs and outputs shall be isolated 4-20 mA, 2-wire signals with power supply.

I. Control panel mounted devices shall be mounted a minimum of 42-inches above finished floor elevation.

J. Panels shall be assembled in accordance with published UL-508 standards and shall prominently bear the UL-508 label as well as the applicable NEMA rating label after final assembly.

2.2 CONTROL PANELS

A. Materials

1. Panel section faces shall be No. 10 gauge minimum thickness for free standing panels and No. 14 gauge minimum thickness for wall mounted or pedestal mounted panels. Materials shall be selected for levelness and smoothness.

2. Relay rack high density type panels shall utilize standard relay racks with No. 14 gauge steel frame and supports.

3. Structural shapes and strap steel shall comply with ASTM A 283 - Low and Intermediate Tensile Strength Carbon Steel Plates, Grade C.

a. Bolting Material: Commercial quality carbon steel bolts, nuts, and washers shall be 1/2-inch diameter with UNC threads. Carriage bolts shall be used for attaching end plates. All other bolts shall be hex end machine bolts. Nuts shall be hot pressed hex, American Standard, heavy. Standard wrought washers shall be used for foundation bolts and attachments to building structures. Other bolted joints shall have SAE standard lock washers.

4. Construction: Dimensions shall be in accordance with vendor's requirements. Elevations and horizontal spacing shall be subject to Engineer's approval.

B. Fabrication

1. End plates, top plates, and top closure panels (to hung ceiling) shall be provided when required by the material requisition. End plates, top plates, and top closure panels

shall be removable with countersunk bolts to match panels. Top closure panels shall be furnished in lengths which match the widths of standard panels, except that one top closure panel may extend across two 4-foot 6-inch wide or five 2-foot-wide standard panels. The vertical joints of these panels shall align with the vertical joints of the standard panels.

2. End closure or rear closure doors shall be provided where required. Such doors shall be flush fitting, gasketed, and be of the hinged lift-off type with lockable door handles. A common key shall be provided for all doors on one panel assembly. Removable access panels shall be provided with dished handle fasteners. Screw driver 1/4 turn or Dzus type fasteners are not acceptable.

    a. The flanged edges of all panels shall be straight and smooth. Corners shall be welded and ground smooth.

    b. The face of the panel shall be true and level after flanging.

    c. All panel cutouts and holes may be cut or drilled by any standard method that does not cause deformation. Burrs shall be ground smooth.

    d. Adjacent panels shall assemble with faces flush. Gaps or cracks shall not be visible from the front of the assembled instrument board.

    e. Stiffeners shall be welded to the back of panels, as required to prevent panel deformation due to the weight of face mounted instruments.

    f. Panels shall be self-supporting as defined below.

C. Framework and Supports

1. The rear of each panel section shall have a steel framework assembled to it for supporting conduit, wireways, switches, piping, and instrument accessory items such as relay or terminal enclosures, transducers, pressure switches, valves, and air relays. The main framework shall be constructed of standard structural shapes. Special shapes such as "**Unistrut**" may be used for secondary supports. Framework must neither interfere with instrument connections nor interfere with access needed for maintenance or adjustments.

2. Steel framework shall extend 2-feet 4-inches back from the panel face or as indicated in the material requisition. Where indicated, individual adjustable leg supports shall be provided at the back of the framework so that the entire panel is self-supporting.

D. Preparation of Panel Surface

1. The following requirements apply to the front and rear face of the panel, both sides and the edges of all flanges, and the periphery of all holes or cutouts.

    a. High spots, burrs, and rough spots shall be ground smooth.

    b. The surfaces shall be sanded or sandblasted to a smooth, clean, bright finish.

    c. All traces of oil shall be removed with a solvent.

    d. The first coat of primer shall be applied immediately.

E. Panel Finishing

1. A Thin coat primer surface shall be applied over the entire panel surface.

2. Wet sand, dry, then quick glaze spot putty on the front of the panel only. Dry, then wet sand again and dry

3. A primer surface shall be applied on the front of the panel only.

4. Wet sand to smooth clear finish, then dry.

5. At least 2 coats of air-dry, satin finish lacquer enamel shall be applied over the entire surface. Color to be as approved by Engineer.

6. Contractor shall supply 2 one-pint containers of air drying, matching paint for field touch-up of the panel face.

F. **Instrument Finishing:** The final coats applied to painted surface of instrument cases, doors, or bezels which are visible from the front of panels shall be manufacturer's standard unless otherwise indicated. Black japan or "crinkle" finishes on instrument cases are not acceptable.

G. Mounting of Instruments

1. The panel vendor shall provide cutouts and shall mount all instrument items indicated to be panel mounted, including any instruments indicated to be furnished by other vendors but installed in the panel.

2. The panel vendor shall also mount behind the panels other instrument accessory items as required for functionality as indicated.

3. Equipment mounted at the rear of panel shall be installed to allow for commissioning adjustments, servicing requirements, and cover removal.

4. Spare space shall be kept clear of wiring, etc., to give maximum space for future additions.

H. Electrical Requirements

1. The Contractor shall provide conduit, wireways, switches, wire, and electrical fittings for 120-volt circuits to instruments and other electrical devices as required for a complete and operable installation.

2. Conduit, wireways, junction boxes and fittings shall be provided for signal wire, thermocouple, or resistance thermometer lead wire. Conduit or wireway runs shall include those required between temperature sensors and temperature transmitters and between the thermocouple wireway or junction box and instruments.

3. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. Wiring shall be identified with stamped tubular wire end markers.

4. Freestanding panels shall be provided with switched 100-watt incandescent back-of-panel lights. One light shall be provided for every 4-feet of panel width and shall be mounted inside and in the top of the back-of-panel area.

5. Freestanding panels shall be provided with a 15-amp, 120 volt, service outlet circuit within the back-of-panel area. The circuit shall be provided with 3 wire, 120 volt, 15 ampere, duplex receptacles, one for every 4-feet of panel width (one minimum per panel), spaced evenly along the back-of-panel area.

6. Wall mounted or pedestal mounted panels shall be so sized as to adequately dissipate heat generated by equipment mounted in or on the panel.

7. Wall mounted or pedestal mounted panels mounted outside or in unshaded areas shall be provided with thermostatically controlled heaters that maintain inside temperature above 40 degrees F.

8. Provide a hand switch controlled 100-watt incandescent light and a breaker protected 120 volt, 15 amp duplex receptacle within each wall mounted or pedestal mounted panel larger than 4 cubic feet volume.

9. Wiring Methods: Wiring methods and materials for all panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise indicated.

10. Signal and Control Circuit Wiring

    a. Wire type and sizes: Conductor shall be flexible stranded copper machine tool wire, UL listed Type MTW, and shall be rated 600 volts. Wires for instrument signal circuits and alarm input circuits shall be No. 14 AWG. All other wires, including shielded cables, shall be No. 16 AWG minimum.

    b. Wire Insulation Colors: Conductors supplying 120 VAC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor. Grounded circuit conductors shall have white insulation. Insulation for ungrounded 120V AC control circuit conductors shall be red. Wires energized by a voltage source external to the control panel shall have yellow insulation. Insulation for DC conductors shall be blue.

    c. Wire Marking: Wire numbers shall be marked using white numbered wire markers made from plastic-coated cloth, **Brady Type B-500** or equal, or shall be heat shrink plastic.

    d. Flexible conduit is not acceptable except when specifically approved by the Engineer in writing.

    e. Conduit fittings shall be **Crouse Hinds** cast fittings or equal.

    f. For case grounding, panels shall be provided with a 1/4-inch by 1-inch copper ground bus complete with solderless connector for one No. 4 AWG bare stranded copper cable. The copper cable shall be provided by the Contractor and shall be connected to a system ground loop.

11. Communication Cables

    a. All Ethernet cables shall be CAT 6 minimum.

12. Electrical Locations

a. When the Contract Documents call for thermocouple actuated instruments, the thermocouple lead wire shall be installed without junction by the Contractor. The panel vendor shall provide dedicated empty conduits or wireways running from the instrument(s) to the top or bottom of the panel as called for in the material specifications or as otherwise required. Sizing of the conduit or wireway shall be in accordance with the capacity of the instrument(s).

b. Single case (no remote logic) annunciator units shall be installed at the top of panel and may be considered as a terminal box when top of panel wire entry is indicated. If bottom of panel entry is indicated, a terminal box shall be provided at the bottom of the panel and be wired to the annunciator unit. Terminals shall be identified with plastic marker strips.

c. Terminal boxes for incoming and outgoing signal leads shall be located at the top or bottom of the panel as indicated in the material specification, or as otherwise required.

13. Power Supply Wiring

a. Unless otherwise indicated, instruments, alarm systems, and motor controls shall operate on 120-volt, 60 Hz circuits.

b. At a location near the top of the panel (or bottom), the panel fabricator shall provide terminal box connections for the main power supply entry.

c. Power supply switches for alarm units shall be 3 pole type, arranged to open both power circuits and alarm circuits. Each annunciator unit shall be equipped with a separate switch.

d. Instruments located on the same panel section and serving the same process unit may be connected to a common branch circuit from the power supply. The number of circuits depends on the circuit load as noted herein. A 15 amp, 2 pole circuit breaker shall be provided in each branch circuit. The circuit load shall not exceed 10 amp. Different panel sections or different process units must not use common branch circuits. When instruments do not come equipped with integral fuses, provide fuses as required for the protection of individual instruments against fault currents. Fuses shall be dinrail-mounted on the panel backplane in a fuse terminal block with each fuse identified by a service name tag. Fuses shall be as manufactured by **Weidmuller SAK Series KDKS** or equal.

e. Each potentiometer type instrument, electronic transducer, controller, or analyzer shall have an individual disconnect switch. Disconnect switches shall have metal or plastic tags indicating instrument tag numbers. Individual plug and cord set power supply connections may be used without switches when indicated in the material specification.

f. Where alarm units are single unit types, one switch may be used to disconnect not more than 6 alarm units located on the same or adjacent panels.

14. Alarm Wiring: The panel vendor shall install and wire alarms including light cabinets, audible signal units, test and acknowledge switches, and remote logic units as indicated. Interconnecting wiring to panel mounted initiating devices shall also be wired by the panel vendor. The wiring from external initiating devices shall be provided by the Contractor. Where plug and cord sets are provided for component interconnection, the panel vendor shall harness and support the cables in neat and

orderly fashion. Where separate wire is required, panel vendor shall install No. 16 AWG with THWN or THHN insulation between all components.

15. Signal Wiring

    a. Signal Wire - Non-Computer Use

        1) Signal wire shall be twisted pair or triads in conduit or troughs. Cable shall be constructed of No. 16 AWG copper signal wires with THWN or THHN insulation.

        2) Color code for instrument signal wiring shall be as follows:

            Positive (+) – Black
            Negative (-) - White

        3) Multiconductor cables where indicated shall consist of No. 16 AWG copper signal wires twisted in pairs, with 90-C, 600 V fault insulation. A copper drain wire shall be provided for the bundle with a wrap of aluminum polyester shield. The overall bundle jacket shall be PVC.

    b. Signal Wire - Computer Use

        1) Signal wires shall be similar to those for non-computer use but each pair shall be triplexed with a copper drain wire and aluminum polyester tape shall be applied over the triplexed group. Cable shields, including thermocouple extension leads shall be terminated in the central control room at the computer system grounding bus. Continuity of the shield shall be maintained throughout the cable runs.

    c. Multi-conductor cables, wireways and conduit shall be sized to allow for 10 percent spare signal wire.

I. **Labor and Workmanship:** Panels shall be fabricated, piped, and wired by fully qualified workers who are properly trained, experienced, and supervised.

2.3 SCADA SYSTEM ENCLOSURES

A. Each SCADA system PLC and remote I/O system and corresponding housing, I/O modules, power supply modules, communication interface devices, and peripheral equipment shall be mounted inside a steel NEMA 12 enclosure (for indoor installation within controlled environments), complete with 3-point latch and interior lighting kit. Process area or sheltered outdoor panels shall be 316 stainless steel NEMA 4X panels with 3-point latching handle (Hoffman Powerglide), heating strip, interior lighting kit, corrosion inhibitor and recirculation fans (strategically located to cool critical components). Outdoor exposed mounted panels shall be similarly configured with the addition of 316 stainless steel sunshields on all sides.

B. All PLC and remote IO cabinets shall also include the following components, wired to the panel I/O for control system monitoring:

    1. 24Vdc primary and secondary power supply status monitoring (as shown on the I/O list).

    2. Controller webpage monitoring (as applicable)

C. For all panels, I/O wiring from the field to the remote I/O system shall be terminated on terminal blocks in the lower portion of the enclosure. Sufficient terminal blocks shall be provided to accommodate the full I/O compliment of the furnished I/O racks. A nameplate shall be mounted on the outside of the door of the enclosure and be engraved with "XX-PLC-XXXX" or "XX-RIO-XXXX" where "X" is the number or description as shown on the contract drawings. (Nameplates shall be as detailed in Specification 26 00 00.)

D. Dimensions shown on the contract panel elevation drawings are provided as reference only. Final enclosure dimensions shall be as established by the Contractor to accommodate all components required plus spare. Enclosures shall be as manufactured by **Hoffman**, or equal.

E. All panels furnished shall adhere to the requirements of NEC article 409 (SCCR).

2.4 SPARE PARTS AND SPECIAL TOOLS

A. In Control panel spare parts selected by the Engineer and special tools shall be furnished in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Preparation for Shipment and Shipping

1. Panels shall be crated for shipment using a heavy framework and skids. Panel sections shall be cushioned to protect the finish of the instruments and panel during shipment. Instruments which are shipped with the panel shall further have suitable shipping stops and cushioning material installed to protect parts which could be damaged due to mechanical shock. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.

2. Shipments shall be by air ride van unless otherwise indicated.

3. Control panel testing and inspection shall be performed prior to shipping.

4. Control panels shall be installed in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

3.2 CONTROL PANEL SIGNAL AND CONTROL CIRCUIT WIRING

A. **Wiring Installation:** Wires shall be run in plastic wireways except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing out panel to components on a part of the fixed structure, and (4) wiring to panel mounted components. Wiring run from components on a swing out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals.

B. Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.

C. Wiring to rear terminals on panel-mount instruments shall be in plastic wireways secured to horizontal brackets above or below the instruments in about the same plane as the rear of the instruments.

D. Shop Drawings shall show conformance to the above wiring installation requirements.

E. **Wire Marking:** Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on Shop Drawings. These numbers shall be marked on conductors at every terminal. Wire labels shall be generated by a portable label printer with self-adhesive labels. Label printer shall be as manufactured by **Brady, BMP41 Model** or equal.

3.3 CALIBRATION, TESTING, AND INSTRUCTION

A. **General:** Calibration, testing, and instruction shall be performed in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 92 01 - CONTROL PANEL INSTRUMENTATION

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. **General:** The Contractor shall provide control panel instrumentation, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 - Process Control and Instrumentation Systems apply to the Work of this Section.

C. The requirements of Section 40 92 00 - Control Panels apply to the Work of this Section.

1.2 CONTRACTOR SUBMITTALS

A. General: Submittals shall be included within the submittals of Section 40 92 00 - Control Panels.

PART 2 -- PRODUCTS

2.1 GENERAL

A. **Power Supplies:** Power supplies shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

2.2 INDICATORS (NOT USED)

A. RECORDERS (NOT USED)

2.3 CONTROLLERS AND CONTROL STATIONS (NOT USED)

2.4 INTEGRATORS AND TOTALIZERS (NOT USED)

2.5 FUNCTION MODULES

A. **Signal Splitters**: (NOT USED)

2.6 CONVERTERS

A. **Current-to-current converter/isolators**: (NOT USED)

2.7 TRANSMITTERS

A. **Current Transmitters:** Not used

2.8 ADDITIONAL PANEL COMPONENTS

A. Panel-mounted devices, conductors, and other panel electrical components shall be furnished in accordance with Division 26 specifications. Panel-mounted devices shall be mounted a minimum of 40-inches above finished floor elevation.

B. If used, pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30 mm. Miniature style devices are not acceptable. Devices shall be as manufactured by **General Electric, Eaton Electrical,** or equal.

1. Lens colors shall be consistent with the Owner's current standard.

2. Pilot lights shall be low voltage, transformer, push-to-test type.

3. Provide hazardous location type pilot devices in classified locations.

4. Lever-type switches shall be furnished as indicated on the P&ID panel elevation drawings.

C. Relays shall be 3 PDT with 10-amp contacts, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips. Relays shall be as manufactured by **Square D, Idec** or equal.

D. Terminal strips shall be provided for all panels and shall be the flanged fork or ring lug type suitable for No. 12 AWG stranded wire minimum. Provide 25 percent spare terminals in each panel.

E. Time delay relays shall be combination on delay and off delay (selectable) with adjustable timing ranges. Provide socket with screw terminal connections and retaining strap. Time delay relays shall be as manufactured by **ATC, Phoenix Contact** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Control panel instrumentation shall be executed in accordance with Section 40 91 00 – Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 95 10 - PLC BASED CONTROL SYSTEMS HARDWARE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. Herein, the term Contractor shall be used to represent the party responsible to the General Contractor for the Work of this division.

B. The Contractor shall furnish, supervise installation, assemble, and configure, program, and place into service the Magna WRF Grit Washing Building PLC-based Control System (PLCS), herein referred to as the Plant PLCS and specified under this Section, Specification Section 40 90 10 – Control Strategies and in Specification Section 40 95 20 - PLC-Based Control Systems Software. All work shall be executed in accordance with the requirements of the Contract Documents. The Contractor shall reference the I/O list in Appendix A.

C. Plant System Integrator: The Contractor shall be singularly responsible for selecting, configuring, and verifying correct operation of compatible hardware and software to provide a functional Plant PLCS SYSTEM. The Contractor shall be the integrator of all hardware and all database, data acquisition, control, display, and all other system software. Additionally, the Contractor shall be responsible for the application programming of the PLCs and GUI software per Section 40 90 10 – Control Strategies and other sections of the contract specifications.

D. Vendor Package Supplier**:** It is the intent of these specifications to have the Vendor Package Supplier of the filter package systems to be singularly responsible for selecting, configuring, and verifying correct operation of compatible hardware and software to provide a functional Vendor PLCS. To preserve this focused responsibility, the Vendor Package Supplier shall be the integrator of the furnished vendor hardware, database, data acquisition systems, control functions, operator displays and all other system software. Additionally, the Vendor Package Supplier shall be responsible for the application programming of the furnished VPLCS and GUI software per the Vendor submitted / Engineer approved Control Strategies, applicable general and process specific sections of Section 40 90 10 and other sections of the contract specifications.

E. Plant/Vendor PLCS Configuration: The PLCS and Vendor PLCS shall consist of PLC's and all required equipment and peripherals as shown on the Network Block Diagrams and as described in these specifications, and as required to meet the functional intent of the specifications. Substitutions for Engineer approved and/or specified functions are not permitted

F. The PLCS and VPLCS shall be in conformance with the following key system criteria:

   a. Both PLCS and Vendor PLCS shall be of the same manufacturer

   b. Unless noted otherwise, peer to peer networks shall conform to IEEE 802.3 Ethernet protocols to preserve a nonproprietary system infrastructure.

   c. All database structures shall strictly adhere to SQL and promote an open interface with third party software applications

G. **Scope of Work**:

a. The Contractor shall furnish and install the Plant PLCS as specified within the Contract Documents. The Contractor shall be responsible for all equipment selection and supply, hardware and software submittal preparation, system integration, programming, graphics generation, supervision of installation, testing, training, start-up, and other implementation activities for the Plant PLCS as detailed in the contract documents. The PLC hardware and software shall be standardized to utilize off-the-shelf, commercially available configurations of hardware and software modules.

b. The Contractor shall install and field test each vendor PLCS under supervision of the Vendor Package Supplier as specified within the Contract Documents. For each vendor package, the Vendor shall be responsible for all equipment selection and supply, hardware and software submittal preparation, system integration, programming, graphics generation, supervision of installation and field testing, training, start-up, and other implementation activities as detailed in the contract documents. The PLC hardware and software shall be standardized to utilize off-the-shelf, commercially available configurations of hardware and software modules.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS.

A. PLC-based control systems-hardware reference specifications, codes, and standards shall be provided in accordance with Specification Section 40 91 00 - Process Control and Instrumentation Systems.

1.3 SUBMITTALS

A. General**:** Unless specifically noted otherwise, submittal requirements of sub-section 1.3 apply to both Plant PLCS submittals and the individual Vendor package PLCS submittals and shall be in accordance with section 01 33 20 – Submittal Procedures.

B. Shop Drawings: Vendor PLCS submittals shall be in accordance with the applicable requirements of Specification Section 40 91 00 - Process Control and Instrumentation Systems. Vendor PLCS submittals shall, however, shall be made separately from other process control and instrumentation system submittals. Both PLCS and Vendor PLCS software submittals shall be provided in accordance with the requirements of Specification Section 40 95 20 - PLC-Based Control Systems-Software

C. Hardware Submittals**:** The PLCS hardware submittal shall be a singular all-inclusive submittal which shall include but not be limited to:

1. A complete index appearing in the front of each bound submittal volume. System groups shall be separated by labeled tags.

2. Complete grounding requirements for the entire PLCS including any requirements for PLCS communication networks and control room equipment.

3. Requirements for physical separation between PLCS components and 120-volt, 480-volt power sources.

4. Data sheets shall be included for each PLCS component together with a technical product brochure or bulletin. These data sheets shall show the component name as

used within the Contract Documents, the manufacturer's model number or other identifying product designation, the project tag number, the project system of which it is a part, the project site to which it applies, the input and output characteristics, the requirements for electric power, the ambient operating condition requirements, and details on materials of construction.

5. Complete and detailed bills of materials: A bill of material list, including quantity, description, manufacturer, and part number, shall be submitted for each component of the VPLCS system. Bills of material shall include all items within an enclosure.

6. Site-specific (and Vendor skid) arrangement and construction drawings for all equipment cabinets, and/or consoles including dimensions, identification of all components, preparation and finish data, nameplates, and the like. Drawings shall be scaled and show the position of the equipment at its intended installation location. Drawings must show a scaled representation of the placement of all equipment and its spatial relationship to all other equipment located in the abutting and adjoining areas. All required access and clearances associated with the equipment must be shown with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.

4. Complete PLC System calculations to include, but not be limited to:

   a. PLC memory calculations to demonstrate that the specified processor and memory allocation provides 150% of memory requirements.

   b. PLC card calculations to demonstrate that the specified number of installed I/O cards meets present and 20% spare requirements.

   c. PLC I/O chassis sizing and quantity to accommodate I/O and communication cards for present, future and 20% spare requirements.

   d. PLC power supply requirements for each PLC.

5. Calibration, adjustment, and test details for all PLCS and Vendor PLCS components.

D. Owner’s Manuals: General requirements for Owner’s Manuals are as described in Specification Section 40 91 00 – Process Control and Instrumentation Systems. The following items shall also be included in the software manual:

1. A documented PLC program listing including the I/O list and housing configuration for each PLC, a memory usage report for each PLC, and a register layout list for each PLC.

2. A documented configuration listing for each Ethernet switch, the Panel PC, and any changes to existing server.

3. Operation and maintenance manuals for the PLCS, Vendor PLCS, Ethernet switches, Panel PC and all other hardware specified herein and shown on the contract drawings.

E. PLCS and Vendor PLCS Test Procedures

1. Procedures shall be prepared for the Reuse Building PLCS by the Contractor and Vendor Package Supplier, separately. The procedures shall be in narrative form and

shall describe sequentially the operational steps to be followed in verifying the correct operation of the system including all features described in the Engineer approved control strategies and any additional control requirement described in Specification Section 40 90 10. All PLC, OIT, or Panel PC equipment that functions together to form a complete package system shall be tested together.

F. Factory Test Procedure:

1. The Contractor and Filter Vendor Package Supplier shall prepare and submit a factory test procedure which incorporates test sequences, test forms, samples of database lists, a testing block diagram, and an estimated test duration which comply with the requirements of the factory test specified herein. The PLCS and Vendor PLCS shall be tested separately.

1.4 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Refer to Specification Section 40 91 00 for additional Manufacturer’s services required.

1.5 STORAGE AND HANDLING

A. All equipment and materials delivered to the job site shall be stored in a location which shall not interfere with the operations of the plant’s personnel or interfere with construction. Storage and handling shall be performed in a manner which shall afford maximum protection to the equipment and materials. It is the Contractor responsibility to assure proper handling and on-site storage.

1.6 SPECIAL WARRANTY REQUIREMENTS

A. Special warranty requirements shall be in accordance with the applicable requirements of Specification Section 40 91 00 and shall be coordinated by the Contractor. The following additional warranty requirements apply to the entire VPLCS (inclusive of the VPLCS of all Vendor packages listed in Section 40 91 00):

B. Equipment, software, and materials which do not achieve design requirements after installation shall be replaced or modified by the Contractor to attain compliance. All associated costs shall be the responsibility of the Contractor. Following replacement or modification, the Contractor shall retest the system and perform any additional procedures needed to place the complete VPLCS in satisfactory operation and attain design compliance approval from the Engineer.

C. The Contractor warrants the materials and workmanship used for the VPLCS control system and further guarantees the materials and workmanship used for any equipment and materials produced and furnished hereunder as a part of the Work to be as herein specified and agreed upon, free from injurious defects, and in all respects satisfactory for the service required.

D. The Contractor warrants/guarantees the satisfactory performance of the equipment and materials under operating conditions for a period of two years after the date of acceptance of certificate of completion (i.e., completion of all contractual items including a successful system performance test as specified in Part 3 of this section). In the event that tests and inspections disclose latent defects or failure to meet the specified requirements, the Contractor upon notification by the Engineer shall proceed at once to correct or repair any such defects or non-conformance or to furnish, at the delivery point named in the Contract Documents, such new equipment or parts as may be necessary for conformity to the

specified requirements, and shall receive no additional compensation therefore. In the case of any required repairs or other corrective or remedial work covered under warranty, the warranties on all such corrections, repairs, new equipment, or parts shall be extended for an additional 24 months from the date of final acceptance or 12 months from the date of completion of any such corrections, repairs, new equipment, or parts, whichever date is later. The Contractor shall reimburse the Buyer for all costs incurred in the removal of the defective material and installation of the replacement.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The requirements of Specification Section 40 91 00 apply to this Section.

B. All materials and all VPLCS equipment furnished under this Contract shall be new, free from defects, of first quality, and produced by manufacturers regularly engaged in the manufacture of these products.

C. Hardware Commonality: Where there is more than one item of similar equipment being furnished all such similar equipment shall be the product of a singular manufacturer.

D. PLCS Growth Provisions:

1. In addition to satisfying the functional requirements of these specifications, all PLCS equipment and resources including PLC memory requirements GUI software, etc., shall be provided to accommodate a 20 percent expansion in the number of I/O points shown on the drawings and/or listed in the appendix.

2. All equipment and resources, including PLC I/O cards and implementation services, shall be provided such that at least 20 percent project growth (beyond listed future points) can be implemented into the VPLCS without any additional cost to the Buyer. The I/O points included in the 20 percent project growth requirement shall be termed “implemented spare I/O”. The 20 percent implemented spare I/O is 20 percent of the total project I/O listed in Appendix A. After factory testing the unused implemented I/O, if any, shall be delivered to the Owner as spare I/O.

3. The Plant PLCS being furnished shall be capable of being modularly expanded to accommodate a twofold increase in process reporting/display requirements and manual input requirements. This does not apply to the Filter Vendor PLCS

4. All equipment and resources shall be able to modularly accept this anticipated future expansion without the need to replace or retire any PLC component or resource.

2.2 PLC ENCLOSURES

A. Each PLC and its corresponding I/O modules, power supply module(s), communication interface device(s), and peripheral equipment, shall be mounted inside suitable enclosures. All I/O wiring from the field to the I/O modules shall be routed within wireways and terminated on terminal blocks in the enclosure. Fiber optic cabling shall be routed within panel wireways, and all fibers (active and spare) terminated within the specified fiber optic patch panel. Fiber jumper cables shall be labeled and routed within wireways.

B. VPLCS enclosures shall be provided in accordance with Specification Section 40 92 00 - Control Panels.

2.3 HARDWARE

A. Programmable Logic Controller:

1. Construction: Each PLC central processing unit (CPU) shall be of solid-state design. All CPU operating logic shall be contained on plug-in modules for quick replacement. Chassis wired logic is not acceptable. The controller shall be capable of operating in a hostile industrial environment (i.e., subject to heat, electrical transients, RFI, vibration, etc.) without fans, air conditioning, or electrical filtering (from 0° to 60° C at 95 percent humidity, non-condensing).

2. Components-General: Each PLC shall have all of the facilities required to implement the control schemes and database shown and specified in the Contract Documents. PLCs shall all have floating point math and PID controller modulating capability. Each CPU shall provide internal fault analysis with a fail-safe mode and a dry contact output for remote location alarming, and a local indicator on the PLC frame in the event of a fault in the PLC.

3. Central Processors: Each central processor shall contain all the relays, timers, counters, number storage registers, shift registers, sequences, arithmetic capability, and comparators necessary to perform the specified control functions. It shall be capable of interfacing sufficient discrete inputs, analog inputs, discrete outputs, and analog outputs to meet the specified requirements plus at least 100 percent excess capacity. All PLCS shall be provided to support and implement closed loop floating and PID control which is directly integrated into the PLC control program. The power supply shall contain capacitors to provide for orderly shutdown in the event that incoming power does not meet specifications. If this occurs, the processor will cease operation, forcing all outputs off. The processor shall have a key type memory protect switch to prevent unauthorized program changes. The processor shall include floating point hardware.

4. Memory: Each programmable controller shall be supported by CMOS semiconductor memory with battery backup. (The CMOS user programming memory shall be as defined under paragraph 2.3.A-8.) The unit shall also be equipped with nonvolatile flash memory of sufficient capacity to store the fully commented control program, tag data, and unit operating system with room for 50% growth. An indicator shall show the status of the batteries and a reference shall be available through the discrete outputs, to alert the Operator that the batteries should be changed. Each controller shall be supplied with an internal lithium battery which shall retain the program during power outages for up to one year.

5. Each unit shall be supplied with sufficient memory to implement the specified control functions plus a reserve capacity of 20 percent of the total provided. This reserve capacity shall be totally free from any system use. The memory shall be programmed in a multi-mode configuration with multiple series or parallel contacts, counters, timers, and arithmetic functions.

6. Controllers: Each programmable controller shall be capable of being programmed with an IEC61131-3 compliant software using simple "ladder diagram" language, and

Sequential Functional Blocks. It shall be easily reprogrammed locally with a portable laptop computer or from a remote location via the control system network.

7. Data Communication: Each programmable logic controller shall be equipped with, or have access via linked backplane to, communication options as required (and in the quantities indicated) on the Network Block Diagrams.

8. CPU: CompactLogix 5380 processors shall support a minimum of .6MB of user memory and 2GB of non-volatile memory. CompactLogix L33ER processor shall support a minimum of 2MB of user memory and 1GB of non-volatile memory. A fully commented copy of the active program and I/O tag set shall be stored on the Flash card.

9. Manufacturer: The Filter Building PLC Panel programmable logic controller shall be as manufactured by **Rockwell Automation, no equal**. Where indicated on the Network Block Diagrams, processor shall be **AB CompactLogix 5380** (or better as recommended by the Contractor to support I/O and communication requirements) with redundant power supplies (as required by the contract drawings). Where indicated on the Network Block Diagrams, Filter Vendor Package PLC processors shall be **Rockwell Automation CompactLogix Model L33ER** with Compact Flash card, integral dual Ethernet port and USB port (or better as recommended by the Vendor to support I/O and communication requirements).

B. PLC Power Supply

1. Redundant “hot-standby” 24vdc power supplies shall be furnished where indicated on the Control Panel Elevations drawing. Filter Vendor Package PLC power supply shall be **AB 1769-PB4** for the **CompactLogix L33ER**.

2. CompactLogix 5380 PLC power shall be provided as follows:

a. MOD Power - MOD power is a DC power source that is required to operate a CompactLogix 5380 system. It is system-side power that powers the system and lets modules transfer data and execute logic. System-side power is provided through the MOD Power Removable Terminal Block (RTB). The MOD power bus shall only use DC power. Do not connect AC power to the MOD power bus. Total continuous current draw across the MOD power bus shall not be more than 10A maximum at 18 – 32VDC. Inrush current requirements must be considered when calculating total MOD power bus current draw in the system. The Contractor shall size MOD power supplies as required to power the connected load.

b. SA Power—SA Power is field-side power that powers some Compact 5000 I/O modules and field-side devices that are connected to them. Field-side power is provided through the SA Power RTB. Some Compact 5000 I/O modules draw current from the SA power bus and then pass the remaining current to the next module. Some I/O modules only pass current along to the SA power bus to the next module. The system may have multiple SA power buses. The first SA power bus starts at the controller and passes across the I/O modules that are installed to the right of the controller. If additional SA power buses are required, a 5069-FPD field potential distributor shall be used to establish the new bus. Each new SA power bus is isolated from the power bus to its left and has a shared common unique to that bus. All inputs that draw current from an SA power bus to power field side devices shall return through circuitry to the SA

terminal on that SA power connector. If a SA power bus uses DC voltage, the total continuous current draw across the bus shall not be more than 10A maximum at 18 – 32VDC. Inrush current requirements must be considered when calculating total SA power bus current draw in the system. The Contractor shall size SA power supplies as required to power the connected load.

c. Separate external power supplies shall be used for MOD power and SA power.

3. Design features of the PLC power supplies shall include diagnostic indicators mounted in a position to be easily viewed by the user. These indicators shall provide the operator with the status of the DC power applied. In addition, a means of disabling power to the PLC shall be possible from a power disconnect switch mounted in a position easily accessible by the operator.

4. The power supplies shall offer fuse protection.

C. PLC Input/Output (I/O) Modules: All I/O housings and modules shall be suitable for hostile industrial environments as described in Paragraph 2.3.A.1 above. All I/O modules shall be isolated and conform to IEEE Surge Withstand Standards and NEMA Noise Immunity Standards. I/O shall be 4-20 mA DC for all analog inputs and outputs. Discrete inputs shall be 24 VDC for the Plant PLCS and 120VAC for the Filter Vendor PLCS. Discrete outputs shall be dry relay contacts. Modules shall be removable without having to disconnect wiring from the module's terminals by means of a swing-arm or plug-in wiring connector.

D. Each PLC location shall contain the I/O modules required to provide all of the I/O points contained in the I/O List plus available capacity to accommodate all future points. As a minimum, each PLC location shall contain an installed spare capacity of 20 percent of each type of I/O used at that location. Circuit components for both remote input and output shall be mounted on plug-in passive backplanes and keyed to prevent incorrect module insertion. Furnished I/O modules and housing chassis shall be as manufactured by **Rockwell Automation**.

1. Discrete Input Modules: Defined as contact closure inputs from devices external to the programmable controller module. Individual inputs shall be optically isolated to prevent possible damage due to electrical transients. The modules shall have LEDs to indicate status of each discrete input. Plant PLCS input signal level shall be 24 VDC. Vendor PLCS input modules shall be 120VAC. The input module shall have a maximum of 16 points each.

2. Discrete Output Modules: Defined as contact closure outputs for ON/OFF operation of devices external to the programmable controller module. The output modules shall be optically isolated to separate module logic and bus circuits from field power. All output modules shall have LEDs to indicate status of each output point. Each output point shall be individually isolated, fused and connected to interposing relays. Interposing relays shall have contact ratings for the attached loads. The PLC system shall offer discrete output hardware consisting of the following types:

   a. 5069 relay outputs rated at 5 – 264 VAC/125 VDC

   b. 1769 relay outputs rated at 5 – 265 VAC/5 - 125 VDC

3. Analog Input Modules: Defined as 4 to 20 mA DC signals, where an analog to digital conversion is performed with a minimum of 16-bit precision and the digital result is entered into the processor. The analog to digital conversion shall be updated with

each scan of the processor. Analog input modules shall have eight differential inputs each. Input modules shall be source or sink to handle 2-wire or 4-wire transmitters respectively. The Contractor (or Vendor package Supplier) shall provide current loop isolators as required to break ground loops.

4. Analog Output Modules: Defined as 4 to 20 mA DC output signals where each output circuit performs a digital to analog conversion (minimum 12-bit precision) with each scan of the processor. Each analog output module shall have four isolated output points which shall be rated for loads of up to 1200 ohms. The Contractor (or Vendor package Supplier) shall provide current loop isolators as required to break ground loops.

2.4 PANEL HARDWARE

A. Contractor furnished fiber optic patch panels (FOPP) shall be as manufactured by **Belden, MIPP Model or equal**.

B. Contractor supplied Cat6 UTP Ethernet plenum cables and patch-cords shall have installation and performance adhering to the requirements of ANSI/TIA/EIA-568-C.2.

C. The Contractor shall provide fiber optic patch cables which meet the performance characteristics of the plant network fiber optic cabling. Single mode, UL rated 50-micron fiber patch cables shall be obtained from the primary fiber optic cable manufacturer with terminators.

D. PLC Control cabinet DLR capable managed Ethernet switch shall be industrial with dual gigabit fiber uplink ports. Units shall be UL-508 rated and IEC 61850-3 rated. PoE will not be used for any device. Ethernet switch shall be as manufactured by **Cisco, Ubiquiti, or equal**. Required port density (using SFP modules) shall be as indicated on the Network Block diagrams with a minimum of two spare ports. For all unused Ethernet switch access ports, the Contractor shall secure the port to allow only registered MAC addresses to access the network. SFP uplink modules shall be minimum rated one gigabyte.

E. PLC panel I/O Ethernet switch shall be Stratix 5700 or equal with a minimum of 10 ports for field connected Ethernet devices

2.5 FIELD INDUSTRIAL WORKSTATION COMPUTER

A. Field Industrial Workstation Computer**:** Where indicated on the Network Block Diagram, the Contractor shall install an industrial monitor and Intel processor based, panel-mounted, UL-listed, industrial panel PC suitable for browser-based applications and server client access. The NEMA 4X, 24Vdc panel-mounted unit shall be equipped with the following minimum:

1. 15-inch XGA (1024x768, 18-bit color) integrated, thin-film transistor (TFT) Active-Matrix Liquid Crystal, LED Backlit touchscreen.

2. System Memory: 8GB memory, 64GB of storage

3. One RS-232 port.

4. Two USB 2.0 ports.

5. One Secure Digital (SD) card slot

6. Two 10/100-BaseT RJ-45 Ethernet port.

Units shall be designed to operate in 0 to 50 degree C temperature range at up to 90% humidity, non-condensing. Each panel-mounted industrial monitor unit shall be as manufactured by **Hope Industrial Systems. Each panel mounted PC shall be as manufactured by OnLogic, or equal, to be used as an Industrial Automation Software Ignition Client.**

2.6 SOFTWARE

A. General: All PLC programming, communication, and data gathering software shall be in accordance with this section and 40 90 10.

2.7 SPARE PARTS

A. PLC system spare parts shall be provided in accordance with Specification Section 40 91 00 - Process Control and Instrumentation Systems.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The Contractor shall utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies which it furnishes. The Contractor shall employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies it furnishes.

B. All components of the PLCS including all communication cabling shall be the installation responsibility of the Contractor unless specifically noted otherwise. The installation of the communication network (inclusive of the Vendor package systems) shall be the complete installation responsibility of the Contractor including all cables, connectors, transceivers, and any required electrical grounds. Grounding shall be shown on submittal drawings and/or the approved Vendor submittal drawings. After installation of the PLCS is completed, the installation shall be inspected jointly by the Contractor and the package Vendor representative. Any problems shall be corrected, and when both are satisfied with the installation, a written certification of the installation shall be delivered to the Engineer. The certification shall state that all PLC communications, I/O modules, system grounds, communication networks, field terminals, and all other components of the PLCS System have been inspected and are installed in accordance with the manufacturer's guidelines, the Vendor requirements, and the requirements of the Contract Documents.

3.2 FACTORY TEST

A. General: Prior to the delivery and installation of the PLCS at the job site, but after the procurement, assembly, and configuration/programming of all components, the Contractor shall conduct a factory test. In identical fashion, each in-contract primary package Vendor shall also be required to conduct a factory test of the associated package VPLCS. Tests shall be witnessed by representatives of the Owner and the Engineer. Each factory test is intended to be a complete PLCS. Factory testing shall demonstrate the functionality and performance of specified features of the PLCS. Each test shall include (as applicable) verification of all PLCS, field terminals and I/O points along with their respective and/or control displays. Each display shall be checked. A complete system checklist shall be available during the test for recording results of selected points. The Contractor shall also

be responsible for coordinating witnessed factory testing of the Vendor packages with Engineer approval as detailed herein.

B. Test Setup: The complete PLCS system shall be assembled and interconnected on the Contractor's factory floor. The interconnections shall include all communication cable segments for the individual node LANs and the networks to simulate as closely as possible the eventual job site installation. (Exceptions to this arrangement must be detailed in the Contractor's submitted FAT plan and approved by the Engineer prior to FAT execution.) The PLC's, field terminals, and communication devices shall be loaded with their applicable software packages and configuration programming. PLC input and output modules shall be installed in their assigned housings and wired to field termination points in the enclosures. The Contractor shall have a complete and current set of wiring diagrams, a PLC register list, and a listing of displays for review throughout the test.

Vendor package VPLCS testing shall be conducted by the associated Vendor at the Vendor facility and subject to identical test setup and coordination requirements.

C. The Contractor shall schedule factory testing after receiving approval of the factory test procedures submittal. The scheduling effort shall include coordination of the Vendor factory tests to avoid scheduling conflict and ensure consistency in planning and execution. A written factory test coordination plan shall be submitted by the Contractor to the Engineer for review and approval at least 6 weeks prior to the start of the first test. The coordination plan shall include a complete schedule of factory tests with the test host contact name/number, location, start date, expected duration and schedule contingency. To support this segregated testing approach, the Contractor shall manage the following exchanges between all concerned parties at least 30 days prior to a scheduled FAT test:

1. Shared I/O addressing or messaging block arrangements to support sharing of data between the Vendor and the Plant Integrator control programs. The factory test host will be expected to provide a test PLC or mimic application to support simulation of shared I/O necessary to allow full logic verification and scenario testing.

2. Share of control screen development standards, navigation schemes, system access control, handling of web-enabled devices and control-mode coordination (as established during the Specification 40 95 20 Graphics Meetings) to ensure that the Vendor package control screens seamlessly integrate into the Plant Integrator developed HMI system.

3. Note: control mode coordination is specifically intended to address management of Vendor package control between the Vendor OIT and the Plant HMI.

4. Share of Ethernet switch configuration requirements and network addressing schemes (as established during the Network Coordination Meeting) to ensure seamless integration of Vendor network equipment and nodes into the plant control system network.

5. Share of each Vendor I/O list, alarm list and native screen inventory with the Plant Integrator.

D. Test Procedure: Each factory test shall be conducted in accordance with the previously submitted and approved test procedures. Test procedures shall include written descriptions of how individual tests shall be performed and shall incorporate testing the following features as a minimum (as applicable to supplied equipment). All testing shall be completed in one continuous factory test which may extend over several continuous

days, as necessary. The witnessing Engineer reserves the right to more closely examine any system, component, or logic structure as necessary to confirm conformance with the contract requirements.

1. Communication: Verify all network components can communicate over the control system network using the contract required protocols and mediums.

2. Power Failure: Redundant power supply testing

3. Software Applications: The primary software applications of each field terminal, as listed in this specification section shall be reviewed for proper installation and configuration and all link and software integration points confirmed through use of proxy machines (furnished temporarily by the FAT host – Contractor or package Vendor - to facilitate testing as necessary) and/or introduction of mimic test data. If applicable, the ability to upload and download files to the vendor PanelView operator interface from the network will be tested. Database templates shall also be reviewed to confirm adherence to contract requirements.

4. I/O Verification: All I/O terminal point wiring shall be verified for all PLC's. The FAT host shall provide a means of easily introducing a discrete or variable analog signal to all I/O points. In addition, a means of establishing communications with any field network device, using the contract required protocol, shall be demonstrated. Signals shall be verified at the associated PLC register and the operator interface.

5. Control Displays: The ability to enter new setpoints, vary control modes, and adjust control parameters shall be demonstrated. The lack of ability to change these items without the correct security level or control mode selection (as applicable to management of Vendor package controls) shall also be demonstrated. Confirmation of changes shall be obtained by checking appropriate PLC registers. Typical PID, VFD, actuator and motor-starter control faceplates shall also be tested. Custom interfaces and control logic for system processes shall also be reviewed in detail making use of tools employed under the I/O verification testing to observe PLC logic and control screen responses with respect to the descriptions in Specification Section 40 90 10 – Control Strategies and/or Engineer approved Vendor control narratives.

6. Display Screens: Incorporation of all approved submittal displays shall be confirmed. Overall quality and accuracy of the control screens shall be reviewed (based on the Graphics' Meeting minutes). Verification of all points on each display screen, and the ability to call up displays via point and click targets or function keys. The ability to print out a display screen shall also be tested. Test web-based displays (links to plc web cards) OIT web access shall be configured to be disabled.

7. Alarm handling: Verification of alarm logging, summary display, outputs to horn/beacons and the ability to disable alarms. Silencing and acknowledging of alarms shall also be tested. Refer to the Specification Section 40 90 10 for any additional specified features.

8. Trend Displays: Pre-configured displays shall be checked for functionally including both historical and real time data and trend printing. A demonstration of the generation of a custom configured trend with all variables shall be performed.

9. All components shall be individually inspected to confirm adherence with contract specification documents. Panel and panel equipment shall be inspected for

appropriate installation, spacing, power, surge protection, grounding, cooling, and labeling.

10. Ethernet switch configuration

E. Test Report: The FAT host – Package Vendor - shall record the results of all factory testing on pre-approved test forms which the Engineer's representatives shall sign. A copy of the completed test forms and a report certifying the results shall be provided to the Engineer by the Contractor within 10 days of completing the test.

F. Rework and Retest: If the PLCS or VPLCS does not operate as required, the FAT host – package Vendor - shall make whatever corrections are necessary, and the failed portion of the test shall be repeated. If, in the opinion of the Engineer's representative, the changes made by the FAT host - Contractor or package Vendor - to affect such a correction are sufficient in kind or scope to effect parts of system operation already tested, then the affected parts shall be re-tested also. If a reliable determination of the effect of changes made by the FAT host - Contractor or package Vendor - cannot be made, then the Engineer's representative may require that all operations be re-tested. The Contractor shall bear all its own costs for the factory test, including any required re-testing.

G. All Engineer's and Owner's travel and per diem costs for factory re-testing (inclusive of package Vendor re-testing) shall be borne by the Contractor.

3.3 CALIBRATION, TESTING, AND INSTALLATION

A. Calibration: All analog inputs and outputs of the PLC shall have their calibration checked at a minimum of 4 points to verify consistency with the balance of the analog loop. This calibration check shall be done in conjunction with the analog loop tests specified in Specification Section 40 91 00 - Process Control and Instrumentation Systems. Workstation / field terminal displays and PLC registers shall both be verified for correctness.

B. Testing: After the PLC installation has been certified and the analog points have been calibrated, the PLC shall be tested to verify that all discrete inputs and outputs of the PLC system, control panel operator interfaces, and plant SCADA screens are correct. All points shall be checked "end to end." For example, valve status inputs shall be checked by stroking the valve and a pump start output shall be checked by using it to start the pump. Simulated testing shall be allowed only when no practical alternative exists. Plant SCADA workstation and field terminal displays shall be verified for correctness simultaneously. An I/O checklist shall be used to record test results and a copy provided to the Engineer upon completion.

C. System Testing: When the PLC installation has been certified and analog loop calibration and discrete I/O testing have been completed, system testing shall be performed in accordance with the approved test procedures. System testing shall operate the various systems of the facility to verify compliance with all functional requirements specified, including the automatic control modes and PLC interlocks described in the control strategies contained in Specification Section 40 90 10 of this Section. Tests which fail to demonstrate the required operation shall be repeated in their entirety or continued after corrective action has been completed at the discretion of the Engineer.

D. Each field terminal display including trend screens, reports, control screens, and alarm summaries and logs shall be verified for correctness during the system testing phase of this project. During system tests, the Contractor and package Vendor (as applicable) shall

have a representative on site continuously who is capable of troubleshooting and modifying the PLC system configuration programming.

E. The Contractor shall submit to the Engineer a system testing completion report when each process system, Vendor package and all aspects of the configuration software have been successfully tested as described herein. The report shall note any problems encountered and what action was required to correct them. It shall include a clear and unequivocal statement that the control systems have been thoroughly tested and are complete and functional in accordance with all specification requirements.

F. Start-Up Test: The support detailed below shall be provided as part of the Work.

1. For each Vendor package system and the Reuse Building PLCS, the Contractor shall be responsible for organizing start-up support to include the package Vendor start-up personnel, electrical and mechanical support personnel, the Engineer and/or the Owner's representatives – all as required during the start-up period to produce a fully operational system.

2. Refer to Specification Section 40 91 00 - Process Control and Instrumentation Systems Part 3 for additional details.

3.4 TRAINING

A. Refer to Specification Section 40 91 00 – Process Control and Instrumentation Systems Part 3 for additional details.

3.5 LADDER LOGIC DOCUMENTATION

A. All PLC ladder logic shall be fully annotated by providing a descriptive label for all relays and function blocks and functional description of each rung.

END OF SECTION

APPENDIX A

PLC Not Specified

AI	8
AO	2
DI	66
DO	22
DSAI	0
DSAO	0
DSDI	0
DSDO	0

IO Tag	I/O Type	Signal Type	Description	PID Drawing No.	Processor Cabinet No.	RIO Cabinet No.	Wiring Diagram No.	Megablock No.	Megablock Channel No.	Terminal Block(TB) No.	TB Channel No.	Network Node	Comments
FIT-101	AI		Sampling and Flow Monitoring SS Manhole Flow	1I-101									
FIT-102	AI		Sampling and Flow Monitoring SS Manhole Flow	1I-101									
FIT-103	AI		Meter Vault Flow	1I-101									
LIT-101	AI		Influent Wet Well Common Channel Level	1I-101									
HS-110	DO		Opened Inclined Screw and Grease Pump No 1 Start/Stop	1I-101	PLC-100								
YL-110A2	DI		Opened Inclined Screw and Grease Pump No 1 In Auto Status	1I-101	PLC-100								
YL-110A1	DI		Opened Inclined Screw Pump No 1 Running Status	1I-101	PLC-100								
YA-110A1	DI		Opened Inclined Screw Pump No 1 Fail Alarm	1I-101	PLC-100								
YA-110A2	DI		Opened Inclined Screw Pump No 1 Emergency Stop Alarm	1I-101	PLC-100								
XS-110B	DI		Grease Pump No 1 Centrifugal Switch Alarm	1I-101	PLC-100								
YL-110B	DI		Grease Pump No 1 Running Status	1I-101	PLC-100								
YA-110B	DI		Grease Pump No 1 Fail Alarm	1I-101	PLC-100								
HS-120	DO		Opened Inclined Screw and Grease Pump No 2 Start/Stop	1I-101	PLC-100								
YL-120A2	DI		Opened Inclined Screw and Grease Pump No 2 In Auto Status	1I-101	PLC-100								
YL-120A1	DI		Opened Inclined Screw Pump No 2 Running Status	1I-101	PLC-100								
YA-120A1	DI		Opened Inclined Screw Pump No 2 Fail Alarm	1I-101	PLC-100								
YA-120A2	DI		Opened Inclined Screw Pump No 2 Emergency Stop Alarm	1I-101	PLC-100								
XS-120B	DI		Grease Pump No 2 Centrifugal Switch Alarm	1I-101	PLC-100								
YL-120B	DI		Grease Pump No 2 Running Status	1I-101	PLC-100								
YA-120B	DI		Grease Pump No 2 Fail Alarm	1I-101	PLC-100								
HS-130	DO		Opened Inclined Screw and Grease Pump No 3 Start/Stop	1I-101	PLC-100								
YL-130A1	DI		Opened Inclined Screw and Grease Pump No 3 In Auto Status	1I-101	PLC-100								
YL-130A2	DI		Opened Inclined Screw Pump No 3 Running Status	1I-101	PLC-100								
YA-130A1	DI		Opened Inclined Screw Pump No 3 Fail Alarm	1I-101	PLC-100								
YA-130A2	DI		Opened Inclined Screw Pump No 3 Emergency Stop Alarm	1I-101	PLC-100								
XS-130B	DI		Grease Pump No 3 Centrifugal Switch Alarm	1I-101	PLC-100								
YL-130B	DI		Grease Pump No 3 Running Status	1I-101	PLC-100								
YA-130B	DI		Grease Pump No 3 Fail Alarm	1I-101	PLC-100								
LSHH-100	DI		Meter Vault Sump High High Level Alarm	1I-101									
HS-210C	DO		Grit Washer Skid No 1 Non-Potable Water Solenoid Operated Valve Open/Close/Auto Command	2I-101									
HS-210D	DO		Grit Washer Skid No 1 Compressed Air Solenoid Operated Valve Open/Close/Auto Command	2I-101									
LIT-210	AI		Grit Washer Skid No 1 Level Indication	2I-101									
HS-210A	DO		Grit Washer Skid No 1 Reverse Command	2I-101									
HS-210B	DO		Grit Washer Skid No 1 Forward Command	2I-101									
YL-210A	DI		Grit Washer Skid No 1 In Auto Status	2I-101									
YL-210B	DI		Grit Washer Skid No 1 Running Status	2I-101									
YA-210A	DI		Grit Washer Skid No 1 Fault Alarm	2I-101									
YA-210B	DI		Grit Washer Skid No 1 Emergency Stop Alarm	2I-101									
TSH-210	DI		Grit Washer Skid No 1 Motor Temp Alarm High	2I-101									
HS-220	DO		Grit Washer Skid No 2 Motor Operated Valve Open/Close/Auto Command	2I-101									
HS-220C	DO		Grit Washer Skid No 2 Non-Potable Water Solenoid Operated Valve Open/Close/Auto Command	2I-101									
HS-220D	DO		Grit Washer Skid No 2 Compressed Air Solenoid Operated Valve Open/Close/Auto Command	2I-101									
LIT-220	AI		Grit Washer Skid No 2 Level Indication	2I-101									
HS-220A	DO		Grit Washer Skid No 2 Reverse Command	2I-101									
HS-220B	DO		Grit Washer Skid No 2 Forward Command	2I-101									
YL-220A	DI		Grit Washer Skid No 2 In Auto Status	2I-101									
YL-220B	DI		Grit Washer Skid No 2 Running Status	2I-101									
YA-220A	DI		Grit Washer Skid No 2 Fault Alarm	2I-101									
YA-220B	DI		Grit Washer Skid No 2 Emergency Stop Alarm	2I-101									
TSH-220	DI		Grit Washer Skid No 2 Motor Temp Alarm High	2I-101									
LALL-304	DO		Intermediate Pump No 4 Low Low Level Alarm	3I-102									
HS-304	DO		Intermediate Pump No 4 START/STOP Command	3I-102									
YL-304A	DI		Intermediate Pump No 4 In Auto Status	3I-102									
SK-304	AO		Intermediate Pump No 4 Speed Control	3I-102									
SI-304	AI		Intermediate Pump No 4 Speed Indication	3I-102									
YL-304B	DI		Intermediate Pump No 4 Running Status	3I-102									
YA-304	DI		Intermediate Pump No 4 Fault Alarm	3I-102									
XA-304	DI		Intermediate Pump No 4 Leak Alarm	3I-102									
TAH-304	DI		Intermediate Pump No 4 Motor Temperature Alarm High	3I-102									
LALL-305	DO		Intermediate Pump No 5 Low Low Level Alarm	3I-102									
HS-305	DO		Intermediate Pump No 5 START/STOP Command	3I-102									
YL-305A	DI		Intermediate Pump No 5 In Auto Status	3I-102									
SK-305	AO		Intermediate Pump No 5 Speed Control	3I-102									

SI-305	AI		Intermediate Pump No 5 Speed Indication	3I-102									
YL-305B	DI		Intermediate Pump No 5 Running Status	3I-102									
YA-305	DI		Intermediate Pump No 5 Fault Alarm	3I-102									
XA-305	DI		Intermediate Pump No 5 Leak Alarm	3I-102									
TAH-305	DI		Intermediate Pump No 5 Motor Temperature Alarm High	3I-102									
HS-310A	DO		Grit Mixer No 1 START/STOP Command	3I-103									
YL-310A2	DI		Grit Mixer No 1 In Auto Status	3I-103									
YL-310A1	DI		Grit Mixer No 1 Running Status	3I-103									
YA-310A1	DI		Grit Mixer No 1 Fault Alarm	3I-103									
YA-310A2	DI		Grit Mixer No 1 Emergency Stop Alarm	3I-103									
TSH-310A	DI		Grit Mixer No 1 Motor Temp Alarm High	3I-103									
HS-310B	DO		Grit Pump No 1 START/STOP Command	3I-103									
YL-310B2	DI		Grit Pump No 1 In Auto Status	3I-103									
YL-310B1	DI		Grit Pump No 1 Running Status	3I-103									
YA-310B1	DI		Grit Pump No 1 Fault Alarm	3I-103									
YA-310B2	DI		Grit Pump No 1 Emergency Stop Alarm	3I-103									
TSH-310B	DI		Grit Pump No 1 Motor Temp Alarm High	3I-103									
HS-320A	DO		Grit Mixer No 2 START/STOP Command	3I-103									
YL-320A2	DI		Grit Mixer No 2 In Auto Status	3I-103									
YL-320A1	DI		Grit Mixer No 2 Running Status	3I-103									
YA-320A1	DI		Grit Mixer No 2 Fault Alarm	3I-103									
YA-320A2	DI		Grit Mixer No 2 Emergency Stop Alarm	3I-103									
TSH-320A	DI		Grit Mixer No 2 Motor Temp Alarm High	3I-103									
HS-320B	DO		Grit Pump No 2 START/STOP Command	3I-103									
YL-320B2	DI		Grit Pump No 2 In Auto Status	3I-103									
YL-320B1	DI		Grit Pump No 2 Running Status	3I-103									
YA-320B1	DI		Grit Pump No 2 Fault Alarm	3I-103									
YA-320B2	DI		Grit Pump No 2 Emergency Stop Alarm	3I-103									
TSH-320B	DI		Grit Pump No 2 Motor Temp Alarm High	3I-103									
HS-310	DO		Grit Pump No 1 Discharge Pnuematic Valve OPEN/CLOSE Command	3I-103									
ZLO-310	DI		Grit Pump No 1 Discharge Pnuematic Valve Open Status	3I-103									
ZLC-310	DI		Grit Pump No 1 Discharge Pnuematic Valve Close Status	3I-103									
HS-320	DO		Grit Pump No 2 Discharge Pnuematic Valve OPEN/CLOSE Command	3I-103									
ZLO-320	DI		Grit Pump No 2 Discharge Pnuematic Valve Open Status	3I-103									
ZLC-320	DI		Grit Pump No 2 Discharge Pnuematic Valve Close Status	3I-103									

SECTION 40 95 20 - PLC-BASED CONTROL SYSTEMS SOFTWARE

PART 1 — GENERAL

1.1 THE REQUIREMENT

A. **General**: The Contractor shall furnish, supervise installation, assemble, configure, program, and place into service the PLC-based control system, hereafter called the PLCS, specified under this Section and in Specification Section 40 95 10 - PLC-Based Control Systems Hardware, all in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS.

A. PLCS software reference specifications, codes, and standards shall be provided in accordance with Specification Section 40 91 00 - Process Control and Instrumentation Systems.

1.3 CONTRACTOR SUBMITTALS

A. **Shop Drawings**: PLCS submittals shall be in accordance with Specification Section 40 91 00. PLCS software submittals shall, however, be made separately from other process control and instrumentation system submittals.

B. **Software Submittals**: The software submittal shall be a singular all-inclusive submittal which shall include but not be limited to:

1. Complete description of the standard application software programs, operating system, and utility programs to be furnished, including modifications and explanation of how the specific functional requirement will be met. A cross reference between the specification and the software submittal shall be provided to allow the Engineer to clearly identify how each specified section or function is being met by the Contractor.

2. A complete set of programmed software algorithms with:

   a. Individual coil register and variable description.

   b. Subroutine, Rung, Program, and Program Group with complete detailed comments.

   c. Memory, coil, register and variable usage mapping.

   d. Source Code of all High-Level Program Language Modules specifically created by the Contractor for this project.

3. A complete written narrative of control strategies which depict all monitoring and control functions on a loop-by-loop basis. Narratives shall enumerate the signal point name, signal description, associated PLC number, associated graphic displays, and system functions activated by the signal (i.e., interlocks, alarms, logs, etc.). The written narrative shall follow the format shown in Specification 40 90 10 Control Strategies, adding detail to fully explain as-programmed control strategies.

4. A complete listing of the PLC database for each data point with relevant parameters such as range, active state, contact orientation, limits, incremental limits, I/O card slot number and rack number, I/O hardware address and PLC assignment. The list shall be divided and grouped by PLC, and divided into type of I/O. In addition to the active I/O, the list shall also include implemented spare I/O. Final format shall be approved by the Engineer.

A. **Display and Report Submittals**: After all software submittals required herein have been approved by the Engineer, the Contractor shall submit the following items. Favorable review and implementation of these submittals is required prior to the start of system testing.

1. All HMI display submittals (both graphic and trend displays) shall be in full color as they will appear on the HMI display. This submittal shall be prepared after the requisite Graphics Meetings specified in this Section.

2. Each display shall be uniquely titled. Locations for process data shall be clearly identified either using simulated data or by showing variables on the displays and providing a reference list describing those variables. All dynamic points shall be identified by tag number as a minimum and their operation shall be described on separate sheets (color change, symbol change, etc.). PDF submittals (with screen prints in color) are required for review by the Engineer. One set will be returned with comments.

3. All periodic reports for the process. Locations for process data shall be clearly identified, either using simulated data or by showing variables on the report and providing a reference list describing those variables. PDF reports shall be submitted for review by the Engineer. One set will be returned with comments.

B. **Additional Requirements**: The following items shall be submitted with the final sets of Owners Manuals required 15 days prior to the plant operational test.

1. All software specified in this Section.

2. All program manuals supplied by the manufacturer(s) with the standard software packages.

3. All original program disks and/or electronic media supplied by the manufacturer(s) with the standard software packages, including any program revisions or updates issued by the manufacturer(s) during the construction period.

4. All PLC program, HMI, and panel computer configuration program files stored on labeled electronic media. The configuration file media shall also be updated as required if any changes or corrections are required in the programming prior to project completion.

5. A change of ownership registration form for each standard software package supplied under this project to allow the Owner to register the software with the manufacturer.

C. **Operations Reference Manual**: The Contractor shall prepare and submit an Operations Manual for the operator interface system for use by the plant operators. This manual shall be a white view binder and shall contain the following:

1. An index to the manual.

2. A list of display screens, trends, and reports, with display name and description.

3. A list of the control screens with the display names and description. It shall also provide a summary of possible commands and operator inputs to these screens including setpoints. All control actions shall be included.

4. A PLCS block diagram with names and locations of major components.

5. Instructions for manually printing screens or reports, both real time and historical as applicable.

6. A summary of security levels and their privileges and limitations.

7. Spaces for operators to make notes.

8. A copy of this manual shall be provided to each operator during. The training class shall include a review of this manual with the operators in addition to more detailed instruction on the panel computer configuration and its use.

9. A fully searchable electronic version of the manual (in PDF format) with all contents listed above shall be integrated into the control system HMI. Access shall be made available under a help index.

1.4 MANUFACTURER'S REPRESENTATIVE

A. PLC-based PLCS hardware manufacturer’s representative services shall be provided in accordance with Specification Section 40 95 10.

PART 2 — PRODUCTS

2.1 GENERAL

A. This Section covers the furnishing of standard and customized software fully installed and configured in the control system specified herein. It is the intent of this Specification to have the Contractor furnish the latest generation, standard, field proven, fully debugged and supported PLC software package for this application with a minimum of additions or changes. Customized or specially written software shall be furnished if required to meet all the functional requirements specified herein. Any custom applications software required shall be fully integrated into the basic software and shall not require unique command structures. No attempt has been made to list all software or list all characteristics of software required by the instrumentation supplier to meet the functional requirements specified herein.

1. Software specified herein is described in broad, functional categories. The instrumentation supplier shall furnish a complete software package including the functional requirements specified herein along with whatever additional software is required for proper and efficient operation of the PLCS System.

2. The software package shall provide a system capable of controlling system level activities and a higher-level process control language allowing the operator to monitor and control the process through an interactive human interface. The software environment shall support a multi-programming atmosphere allowing

concurrent execution of more than one program in a background/foreground mode or multi-tasking mode.

3. Throughout the execution of all software modules, the operator shall be presented with all the command or operation choices available at that point in the program using sufficient verbiage or symbols to make the choices self-explanatory and unambiguous. Question and answer or fill-in-the-blank requests shall only be permitted where file names, tag names, or other unique text or numerical information is required.

2.2 HARDWARE

A. **General**: The PLC, panel computer, and communication equipment, etc., shall be provided under provisions of Specifications Specification Section 40 95 10.

2.3 PLC SOFTWARE

A. **PLC Programming Software**: All PLC programming shall be accomplished using a standard version of Studio 5000 supported by the installed CompactLogix firmware.

1. All programming, monitoring, searching, and editing shall be accomplished using this PLC programming software. It shall be usable while on-line (connected directly to the PLC or indirectly via the control system network), off-line and in the emulation mode (no PLC required). The PLC programming software shall display multiples of series and parallel contacts, coils, timers, counters, and mathematical functions blocks. The software shall be able to monitor the status of all inputs, outputs, timers, counters, and coils. It shall have the capability to disable/force all inputs, outputs, and coils to simulate the elements of the ladder logic by means of color change. It shall include a search capability to locate any address or element and its program location. PLC status information, such as error indication and amount of memory remaining shall be shown on the display screen.

2. The PLC programming software shall have the capability to generate a PLC program printout which is fully documented. Fully documented program listings shall have appropriate rungs, address, and coils shown with labels, descriptors, and identifiers. Comments shall clarify to a reader what each segment of the program accomplishes. A fully documented listing shall also include a cross reference report of program addresses.

3. The PLC programming software package shall be able to monitor and/or control PLCs via the communication network. It shall contain diagnostics to collect troubleshooting and performance data and display it in easy-to-understand graphs and tables.

4. The PLC programming software shall have an I/O database that is fully compatible with, and accessible by, the contract specified HMI system software.

B. **Operator Control**: All programming commands related to changing system configuration or controlling field devices shall be performed only through the HMI and shall require more than one keystroke to protect against inadvertent operations. The HMI configuration commands shall require operator confirmation of a requested action before any change is made. This shall apply to changes in the algorithms, control sequences, and similar configuration related actions, as well as file copy and file delete commands. For any

sequence requiring operator confirmation, the operator shall be able to cancel the operation at any point prior to executing the command.

C. **Reboot Operation**: The PLC shall reload the most recently entered control and alarm setpoints on reboot. Changing these setpoints or alarms shall require operator action. Rebooting a workstation shall not change these alarms or setpoints.

2.4 PANEL COMPUTER AND HUMAN MACHINE INTERFACE (HMI) SOFTWARE

A. **General**: HMI software provided for the Reuse Filter Building PLC Panel operator interface panel computer shall be per the Owner's standard: **Ignition by Inductive Automation**. Contractor shall configure the panel computer operator interface as an Ignition client. All HMI software capabilities and methods of interaction shall be as per Ignition specifications.

1. The system shall provide a mechanism for accepting configuration input directly from the touchscreen.

2. All configuration changes shall be capable of being made on-line, while the system is operating. Data definitions, operator displays, etc. shall be capable of being modified, added, or deleted without having to interrupt the data acquisition.

4. The system shall provide complete user documentation, including examples of how to operate the various modules within the system. An on-line "help" facility shall provide useful, context-sensitive information on the operation of the package. This help facility shall be capable of being invoked on-line through a point-and-click operation.

B. **Data Handling Capabilities:**

HMI shall have the following data handling capabilities:

1. OPC-based and communicates with virtually any OPC server.

2. SQL-based (JDBC) and connects to any number of Databases.

3. Built-in PLC drivers and connects to any PLC (Allen-Bradley, Siemens, Modbus, etc.) through OPC.

4. Supports any web services and launches anywhere.

5. Connects to devices such as barcode scanners, scales, and sensors.

6. Connects to any mobile device such as wireless smartphones and tablets.

7. Connects to any touch panel screen

C. **I/O Device Communications**

HMI shall have the following available drivers:

1. Logix Driver – Connect to Allen-Bradley Logix family devices with firmware v21+.

2. Modbus Driver - communicate with any device that supports the Modbus protocol, that is, the Modbus TCP and Modbus RTU over TCP protocols. Connect directly to devices that support Ethernet communications or also connect to Modbus devices through a Gateway device.

D. **Networking and Distributed Operation**

The HMI platform shall support multiple architectures including:

1. Single Server Installs – a single Gateway that can connect to multiple PLCs, databases, and other devices, with a single licensed install. Ability to launch clients on touch panels from one installation.
2. One Server, Multiple Networks – A Gateway that supports dual-NIC servers, and can act as a bridge between multiple networks, or communicate with multiple sites over a corporate WAN.
3. Two Servers, Redundancy - Two server installations can be linked together, so if one server fails, the other takes over and continues executing. All connected clients will be redirected to the backup machine, and historical data will continue to be logged. The transition shall be seamless, meaning processes will never be prevented from executing due to one server going down.

E. **Graphic Capabilities**

HMI Graphics shall include the following capabilities:

1. Unlimited clients per server.
2. Real-time status and control functionality
3. Display real-time alarms
4. Customizable charts, tables and graphs display real-time and historical data. Allows creation of executive dashboards, tracking of key performance indicators (KPIs), and trend views.
5. Allows integration of data from SQL databases. Data entered by operators may be written directly to any database.
6. Vector-based 2D drawing tools allow creation of distinctive screen designs and layouts with shape-building tools for lines, polygons, rectangles, arrows, and circles. Vector graphics allow programmers to create precision shapes and Bézier curves that scale to any size without losing image quality.
7. State dependent settings and dynamic positioning bind shape properties to data values to create animations.
8. Supports advanced functionality using a built-in Python scripting engine.
9. Ability to instantly deploy client updates by making changes to the master project screen on the server and publishing.

F. **Alarm Handling**

Alarming system shall:

1. Allow configuration of logic for how, why, and when alarm notifications are delivered.
2. Manage alarm notification for groups of users, send notifications via email, and allow alarm acknowledgement by the recipient via email.

3. Provides the following types of alarm notification logic

   a. Delay - Hold off on sending notifications until nearby operators are given time to deal with the problem first

   b. Escalation - Elevate alarm notification when operators are not handling alarms.

   c. Consolidation - Combine multiple alarms into a digested message

   d. Selection - Distribute different alarms to different groups of contacts.

G. **Archiving and Reporting**

HMI software shall provide an easy-to-use design interface that allows creation of rich, dynamic, PDF reports, allows the capability to select report data from multiple sources, and can run reports automatically. Capabilities shall include ability to:

1. Generate reports from existing files or create them from scratch.
2. Specify any number of report parameters and data sources
3. Access information from any SQL database, query data from the historian, or event data from the alarm system.
4. Reports can be generated on a preconfigured schedule, on demand, or by event triggers such as tag changes, shift changes, etc.
5. Build complex SQL queries easily using a drag-and-drop query interface

H. **Security Management**

Built-in security settings shall restrict project access to users on different networks, either by restricting specific components in a project, or denying access to a whole project based on user role and network location.

Any client launched shall be secured using SSL protocols. Authentication groups can be used to strictly limit access to certain areas of a project to only the users with appropriate access levels.

I. The HMI software shall be as manufactured by **Inductive Automation: Ignition**

2.5 OPERATION SYSTEM AND APPLICATION SOFTWARE:

A. The operating system and application software shall be provided for each computer as detailed below. (Specific configuration requirements shall be finalized during the Network Coordination Meeting specified in Section 40 95 10).

Primary SCADA I/O & HMI Server - Owner’s existing Primary Server

Secondary SCADA I/O & HMI Server - Owner’s Redundant Server (if exists)

Historian Server - Owner’s existing Historian Server

Control Room SCADA Client Workstation - Owner’s existing Control Room SCADA Client

PLC Panel Computer – Windows 10 Pro

B. The Contractor shall register all Rockwell Studio 5000 software licenses with the Rockwell Automation Software Support Program for the entire construction period plus two years after final acceptance. This support shall include 24/7 technical support (email and phone), software upgrades and patches at no additional cost. Software support renewal, as applicable, shall be the sole responsibility of the Contractor.

C. To address possible version compatibility problems, the version of each software package to be provided shall be reviewed during the Pre-submittal Conference and confirmed during the Contractor software submittal review process.

2.6 VIDEO TRAINING – Not Required.

2.7 WORKSTATION GRAPHICS GENERATION

A. It is the responsibility of the Contractor to configure the workstations and to develop, design, engineer, configure and test all the HMI graphic displays required for this project. All this work shall consider the specific needs of the end user. To facilitate this, work the Contractor shall conduct the following meetings with the Owner groups:

B. Graphics Meeting No. 1

1. The Contractor shall chair and develop an agenda for a meeting which shall address the basic criteria to be adhered to in the configuration and development of the HMI graphic displays. At this meeting, which shall be attended by plant managerial personnel, the Contractor shall distribute sample display formats for illustration purposes. As a minimum, this meeting shall address the following issues:

    a. All facility conventions for identifying tag names and descriptors (this will include process areas, piping, mechanical equipment, tanks, valves, inline equipment, instruments, workstations/servers, control components and network components)

    b. Designation of groups within each plant or station area along with tag names and descriptors.

    c. The assignment of individual control loops and inputs to specific groups.

    d. Organization of the systems universal display hierarchy.

    e. Paging schemes to be used to enable the movement from one display to another.

    f. An itemization of the type of display to be used at each level in the graphic hierarchy (e.g., pre-formatted displays, templates, custom graphics, etc.)

    g. Color convention to be employed on all graphics for the annotation of various status information, differentiation between alarms on the basis of alarm priority, background colors, static field colorization and dynamic field colorization.

    h. The utilization of blinking and conditional text.

i. Definition of graphic symbolism to be used on the project. This listing shall include but not be limited to symbols to be used for process instrumentation, process equipment, piping, vessels, and valves. All symbolism must be specific as opposed to generic in that shapes must define both function and type (e.g., specific symbols for each valve design, each pump design, each type of flow meter, etc.). If the Contractor's library of shapes does not adequately describe plant or pipeline conditions, the Contractor shall develop additional shapes to meet the plants or pipelines requirements.

j. Definition of all display select commands that enable the operator to move within the display hierarchy.

k. The utilization of cursor movement commands which enable the operator to move within a display.

l. Definition of control input commands which enable the operator to interact with faceplates control stations and custom graphic displays to implement control outputs/functions.

m. Definition of data input commands which enable the operator to enter numeric values into the PLC system.

n. Definition of the utilization of "poke" points or fields which are dynamically sensitive to operator inputs to facilitate operator entry directly into graphic displays.

o. A review of graphic generation procedures.

p. Historian data collection parameters.

q. Electronic O&M production and accessibility at HMI.

r. User groups and process monitoring/control accessibility

s. Overall system navigation and access philosophy and organization of screen monitoring and control data to support.

t. Vendor package control mode coordination – to manage control authority transition from a Vendor package OIT to the Plant HMI and vice versa.

u. Alarm handling, event logging and approach to managing historical alarm and event log access

v. Web-enabled devices web page integration.

w. Control screen wall display compatibility

1. After the adjournment of graphics meeting No. 1, the Contractor shall prepare and formalize a document titled "GRAPHICS CRITERIA" which shall contain detailed meeting minutes and a definition of all graphic guidelines to be adhered to. This report shall be supplemented by a first draft HMI control screen package which illustrates the incorporation and application of each graphic criteria. The report shall be submitted to the Engineer for review / approval within 30 calendar days of the

meeting's adjournment. Engineer comments will be returned to the Contractor for action and response review during Graphics Workshop No.2.

C. Graphics Meeting No. 2

1. After the finalization of the overall system-wide graphics criteria, the Contractor shall develop a second draft HMI control screen package as required to support all workstations being furnished under this project, taking into account the Engineer's first draft review comments. At this meeting, the Contractor shall submit 5 color hard copies of the complete package and present a navigable version of the HMI control screen package using the project HMI software. During the workshop, the Contractor will:

    a. Review the recorded requirements of Graphics Coordination Workshop No.1 and show how each has been addressed

    b. Review the Engineer first draft submittal review comments and show or explain how each has been (or will be) addressed.

    c. Review the entire HMI control screen package for overall content completeness

    d. Demonstrate approach to input command handling, setpoint management and secure access control.

    e. Demonstrate navigability, functionality, and overall quality of delivery.

    f. Collect and record all actionable comments received.

D. After the adjournment of Graphics Coordination meeting No. 2 the Contractor shall prepare a formalized re-submittal of the HMI control screen package for Engineer review/approval along with the detailed meeting minutes. Meeting minutes shall be submitted within 5 working days of meeting adjournment and will include an expected time frame for Contractor delivery of the HMI control screen package re-submittal.

1. The Contractor shall allow 1 day for each meeting.

E. The following HMI graphic displays shall be developed for this project (as minimum):

1. Reuse Building and related processes.

2. All group alarm displays.

3. All control loop tuning displays.

4. All analog faceplate displays.

5. All key macro icon displays.

6. All database archiving control displays.

7. All customer displays for operator set point entry and recipe displays.

8. All historical trending displays.

9. Control system network configuration and diagnostic displays.

10. Redundant communication diagnostic and control displays.

11. All local node diagnostics (include PLC's, Operator Interfacing Units, and Instruments).

12. All group event displays

13. All vendor developed control screens and web-based interfaces shall also be replicated in the final HMI graphics display set.

2.8 PLC SYSTEM DATABASE

A. The workstation software shall incorporate a disk memory resident database which shall store all software elements necessary to implement all data acquisition, calculation, logging, and reporting functions. The system data base shall be comprised of the following elements:

1. Current data base; includes process status information.

2. Historical data base; includes non-current process status information.

B. **PLC System Documenter**: After system configuration or configuration updates, all information which defines the hardware, control, and display configuration of the PLCS system shall be stored in mass memory within the workstations. The workstations shall be provided with all the intelligence and printing/plotting capabilities to enable the automatic generation of system documentation. All documentation shall be printed/plotted in both a text and graphic format. All documentation shall be accessible in report formats. It is not acceptable to utilize screen prints as a documentation report method. The workstation shall provide the means to produce the following documentation.

1. Current control system databases, (including tags, descriptors, alarm limits, engineering units, associated alarm priority, logical states, etc.) control loops and ladder logic.

2. Definition of the current hardware configuration including locations and associated PLC numbers.

3. Definition of the current display hierarchy and all displays currently in the system.

C. **Data Base Generation**: All software shall be provided to enable historical database generation to be accomplished by a conventional fill-in-the-blanks technique on HMI display formats in which operational characteristics (i.e., name, scan class, alarm limits, etc.) are inserted into linkable prewritten software modules which perform scanning, computational and collection functions. Once the information is transcribed into data records, the database software shall:

1. Read and interpret the information.

2. Manage all process input and output hardware assignments.

3. Generate data files.

4. Perform self-documenting functions such as producing hard copies of listings, main and disk memories, and data sorts by analog input, analog output, contact input and contact output.

D. **Data Acquisition**: Scan blocks shall extract data from the communications network at specifiable rates, condition the signals, convert the data to engineering units in a floating-point format, and store the data to produce an IO database. Typical input signals to be scanned include:

1. Limit, status, or position information from open/close valves, motors, and process monitoring devices such as flow, temperature, and pressure switches.

2. Measured variables such as flows, pressures, levels, temperatures, etc.

3. Measurements, set points, and outputs from all PLC's.

4. Computed values such as inferential measurements.

5. Operational commands from workstations keyboards.

E. **Data Collection**: The Contractor shall provide programming that collects current values of specified variables from online data storage areas, statistically manipulates data, and creates and maintains an historical database of collected values. Statistical manipulation shall include linear averaging, filtered averaging, and noting of "bad" values. Statistically manipulated data shall then be stored in a historical database.

1. The frequency of historical collection shall be Engineer selectable (e.g., once per second, once per month, etc.). The type and quantity of historical data shall be selectable by addition and deletion to/from the historical data base.

2. The Contractor shall provide adequate and scalable online storage as detailed in Section 40 95 10.

3. Historical records (daily) shall be incrementally archived to a network accessible storage and shall be an automatic function.

2.9 REPORTS

A. **General**: The PLCS shall support 2 distinct types of report generation: (a) process reporting which generates logs based on processes or equipment scanned or on manually substituted data and (b) management reports which are comprised of lab derived data and process data. The Contractor shall provide software resources which process all requests for data collecting, reporting, and translating of data to an industry standard format, for assembling of data to predefined formats and merging data with appropriate heading information, for storage of data in output files associated with an output device and initiation of the appropriate output handling routine. The workstations shall provide for manually initiated reports via an operator interface at each workstation. Reporting functions shall be designed to report the historical data effectively and clearly. The ordering and amount of historical data, as well as any default specific data to be used, shall be selected by the Owner facility manager. The detailed formatting of the data on a given line shall be pre-specified by the Owner facility manager. The Owner facility manager will select the process inputs that are to appear on any log page and their relative placement across the page, title of the page and column heading for each point. The

package shall automatically print the accumulated value and, when necessary, automatically scale the value. The reporting package shall automatically flag any value that was not valid during any part of the reporting interval. Valid output devices shall be printers or interactive workstations. Reporting data (in industry standard format) shall be made available to other software packages for producing reports containing bar charts, pie charts etc.

B. **Process Reporting**: The reporting package shall use the process database to provide historical records for an average of 1,000 selected variables. The software as a minimum shall:

1. Collect process data and make available historical information for a minimum of 40 pages of logs, each page containing up to 10 log points described by individual column headers.

2. Automatically print any combination of up to 10 separate periodic reports consisting of selected pages of the 40 pages noted above. The data to be printed shall be pre-selected by the Owner operations representative.

3. Period reports shall include an End-of-Day Report, printed at end of the third shift each day, an End-of-Week Report, printed at the end of the third shift on the last day of the week, and an End-of-Month Report, printed at end of third shift on the last day of the month. Although the Daily, Weekly and Monthly Reports shall be printed at the same time, they are different reports and may be structured to satisfy different needs. Each of these five reports shall have its own selection of pages and historical data, chosen independently of the remaining reports.

C. **Overall Management System Reporting**: The reporting package shall provide historical records as per the Owner's reporting requirements.

D. **Configuration of Reports**: It is the sole responsibility of the Contractor to configure the workstations and to develop, design, engineer, configure and test all the reports required for this project. All this work shall take into account the specific needs of the end user. In order to facilitate this work the Contractor shall conduct the following meetings with user groups:

1. The Contractor shall chair and develop an agenda 3 weeks in advance for a meeting which shall address the basic criteria to be adhered to in the configuration and development of the reports. At this meeting, which shall be attended by plant managerial personnel, the Contractor shall distribute sample formats for illustration purposes. As a minimum, this meeting shall address the following issues:

a. All in-plant and remote site data and conventions for identifying tag names and descriptors.

b. Designation of groups within each plant or station area along with tag names and descriptors.

c. The assignment of inputs to specific categories.

d. Organization of the systems universal report categories.

e. An itemization of the type of report available.

f. Definition of terms to be used on the reports.

g. Definition of all report commands that enable the operator to move within the report editor.

h. The utilization of cursor movement commands which enable the operator to move within a report.

i. Definition of data input commands which enable the operator to enter numeric values into the system.

j. A review of report generation procedures and user accessibility

E. **Report Meetings**: To facilitate the work as described in above item the Contractor shall conduct the following meeting with the Owner groups:

1. Report Meeting No. 1: After the adjournment of the report meeting No. 1 the Contractor shall prepare and formalize a document titled "REPORT CRITERIA" which shall contain detailed meeting minutes and a definition of all report guidelines to be adhered to. This report shall be supplemented by first draft reports package. The reports shall be submitted to the Engineer for review/approval within 30 calendar days of the meeting's adjournment. Engineer comments will be returned to the Contractor for action and response review during Reports Meeting No.2.

2. Reports Meeting No. 2 - After the finalization of the overall report format criteria, the Contractor shall develop a second draft complete reports package, taking into account the Contractor's first draft review comments. At this meeting, the Contractor shall submit 5 color hard copies of the complete package including:

a. A review of the report package developed for the process area(s) for content and completeness.

b. A review of the Engineer's first draft submittal review comments and show or explain how each has been addressed.

c. A review of all data fields for process information.

d. A review of all required input commands associated with the report access and control manipulation.

2.10 **Software License and Registration**: All software provided shall be installed and used within the terms of the software manufacturer's license agreement. All software purchased by the Contractor shall be registered to the Contractor during the construction phase of this project. During that time, the Contractor shall be responsible for providing and incorporating minor software package updates issued by the software manufacturer. For example, if version 3.1 of a program is purchased, and versions 3.2 and 3.3 were released prior to project completion, the Contractor shall be responsible for incorporating these later versions into the final project. The Contractor would not be responsible for incorporating major software revisions such as the release of a version 4.0 or 4.1.

A. Prior to substantial completion of this project, the Contractor shall re-register all provided software packages to the Owner and provide the Engineer and Owner with written confirmation of having done so.

2.11 FACTORY TEST

A. General: Factory testing shall be provided in accordance with Specification Section 40 95 10.

PART 3 — EXECUTION

3.1 INSTALLATION AND CONFIGURATION

A. The PLC-based control system software installation shall be provided in accordance with Specification Section 40 95 10.

3.2 PROGRAMMING, TESTING, AND INSTRUCTION

A. General: The PLC-based control system software calibration, testing, and instruction shall be provided in accordance with Specification Section 40 95 10 - PLC-Based Control Systems-Hardware.

3.3 GRAPHICS SCREENS

A. Workstation screens shall be configured to maximize user friendliness for the plant operators. The process of calling up a display screen shall consist of pointing a mouse cursor at preconfigured targets on the current screen and clicking, or of pushing a function key which shall be selected from a labeled list on the current display. Each screen shall include targets or function key labels to related screens and to the main menu screen.

B. The various required screens shall use text of all capital letters except for certain engineering units. All text shall be horizontal. Screens showing equipment shall include the equipment number and name as used in the Contract Drawings. Total equipment run times shall be displayed as hours and tenths of hours adjacent to equipment symbols. Each screen shall show the current time and date which shall appear in the same place on each screen. As a minimum, the Contractor shall provide the major control screens detailed below with supporting pop-up control screens for individual pieces of equipment.

C. In the development of the graphic screens, the Contractor shall make use graphic symbols which closely represent the actual field / control / network equipment depicted and piping and structural images rendered with a graphic representation of the actual construction material and color. The images shall be of suitable resolution so as to present a crisp image with no blurred outlines or borders at the screen resolution best suited to support the furnished workstation displays. Animated GIF files of like quality shall be developed and used to represent operating equipment wherever possible. Compressed graphic file formats (e.g., jpeg) and native vector images shall be used in order to reduce file size; the use of bitmap files shall be minimized. Samples of the type of screen image quality expected to be produced by the Contractor shall be distributed by the Engineer during the Pre-submittal Conference as reference. It shall be understood by the Contractor that simple two-dimensional schematic representations of the process screens shall not be acceptable. However, the graphic screens shall be balanced to highlight and prioritize prominence of the process readings and equipment status over the supporting (grayscale) background graphics while limiting the use of striking colors which may make the screens difficult to view over long periods of time.

C. The Contractor shall coordinate the display screen development with the control room display manufacturer to ensure optimum display of control screens as described in the

previous paragraph. The images and renderings shall be of suitable HD resolution so as to present a crisp image with no blurred outlines or elongated/compressed images.

D. Display Screens: The Contractor shall configure display screens to display all status and analog data contained in the PLCS system database. The Contract Drawings, Control Strategies, I/O Schedule, and Specifications shall form the basis of the PLCS system database. Some status and analog points shall be displayed on more than one display screen, especially where it relates to more than one process or is significant to facility operations. Every analog and status value shall appear on at least one display screen. Analog values shall be displayed with appropriate engineering units and shall use techniques such as variable fill and/or color changes to provide clarity. Separate control palettes shall be developed to help segregate control functions from monitoring functions for each process/control area of the plant as well as control/network system maintenance and configuration areas.

F. Properties for control system graphics, equipment and PID faceplates, navigation, status and alarm handling, and link management shall be as determined by the Owner HMI development standards and the outcome of the Graphics Meetings. All “dumb” objects shown for clarity shall be grey in color.

END OF SECTION

SECTION 43 21 00 – PUMPS, GENERAL

PART 1 -- GENERAL

1.01 SUMMARY

A. Provide pumps and pump systems appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to pumps and pumping equipment throughout the Contract Documents, except where otherwise indicated.

C. Unit Responsibility

1. The pump manufacturer shall be made responsible for furnishing the pumps, drives and motors as one package and for the coordination of design, assembly, testing, installation, and startup of the Work of each specific pump Section.

2. The Contractor shall be responsible to the Owner for compliance with the requirements of each specific pump Section.

D. Single Manufacturer

1. Where 2 or more pump systems of the same type or size are required, provide pumps produced by the same pump manufacturer.

2. Where multiple pumps are of the same size and type, all parts shall be interchangeable and fit including spare parts.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Abbreviations and Acronyms

1. NPSHr - Net Positive Suction Head Required

2. VFDs - Variable Frequency Drives

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design Support and Anchorage
01 75 00	Equipment Testing and Plant Startup
01 77 00	Project Closeout
01 79 00	Owner Staff Training
05 50 00	Miscellaneous Metalwork
09 96 00	High-Performance Coatings
Division 26	Electrical
26 05 10	Electric Motors
26 29 23	Variable Frequency Drive Units

Division 40	Instrumentation and Control
40 05 01	Piping General
Division 43	Pump Sections as specified by the Project

C. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM International (ASTM)	
ASTM A 36	Medium Carbon Steel for fabricated steel bases
ASTM A 48	Gray Iron Castings
ASTM B 148	Standard Specification for Aluminum-Bronze Sand Castings
ASTM A 276	Hot Rolled Annealed and Pickled Stainless Steel Shafts
ASTM A569/AISI 1018, 1020	Low Carbon Steel Shaft
ASTM A569/AISI 1045	Medium Carbon Steel Shaft
ASTM A705	Age-Hardening Stainless Steel Forgings
ASTM B148	Aluminum Bronze Sand Castings
ASTM B140	Copper-Zinc-Lead (Red Brass or Hardware Bronze)
ASTM B 584	Standard Specification for Copper Alloy Sand Castings for General Applications
International Organization for Standardization (ISO)	
ISO 9000	Quality management systems - Fundamentals and Vocabulary
ISO 9001	Quality management systems – Requirements.
ISO 1940-1	Mechanical Vibration – Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances
American National Standards Institute /Hydraulic Institute (ANSI/HI)	
ANSI/HI 3.1- 3.5	Rotary Pumps for Nomenclature, Definitions, Application and Operation
ANSI/HI 3.6	Rotary Pump Tests
ANSI/HI 4.1- 4.6	Sealless, Magnetically Driven Rotary Pumps for Nomenclature, Definitions, Application, Operation, and Test
ANSI/HI 5.1- 5.6	Sealless, Rotodynamic Pumps for Nomenclature, Definitions, Application, Operation, and Test
ANSI/HI 6.1-6.5	Reciprocating Power Pumps for Nomenclature, Definitions, Application, and Operation

ANSI/HI 6.6 -	Reciprocating Pump Tests
ANSI/HI 9.1 – 9.5	Pumps General Guidelines
ANSI/HI 9.6.1	Rotodynamic Pumps – Guideline for NPSH
ANSI/HI 9.6.2	Rotodynamic Pumps for Assessment of Applied Nozzle Loads
ANSI/HI 9.6.3	Rotodynamic Pumps – Guidelines for Operation Regions
ANSI/HI 9.6.4	Rotodynamic Pumps - Guidelines for Vibration Measurements and Allowable Values
ANSI/HI 9.6.6	Rotodynamic Pumps - Guidelines for Pump Piping
ANSI/HI 9.6.8	Rotodynamic Pumps – Guidelines for Dynamics of Pumping Machinery
ANSI/HI 9.8	Rotodynamic Pumps for Pump Intake Design
ANSI/HI 11.6	Rotodynamic Submersible Pumps for Mechanical and Electrical Acceptance Criteria
ANSI/HI 14.1-14.2	Rotodynamic Pumps for Nomenclature and Definitions
ANSI/HI 14.3	Rotodynamic Pumps for Design and Application
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Test
ANSI/HI 40.6	Methods for Rotodynamic Pump Efficiency Testing
National Sanitation Foundation/American National Standards Institute (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects

1.03 SUBMITTALS

A. Product Data

1. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit shop drawings, product data, and general arrangement drawings for pumps as specified in Part 2 – Products.

2. Coating system technical datasheets.

3. Anchorage calculations and required documentations.

4. Submit electric motor data, in accordance with the requirements of Section 26 05 10 – Electric Motors, for the electric motor proposed for each pump.

5. Submit factory performance and functional Test Plan as specified in Part 3 – Execution.

6. Submit Operation and Maintenance Manual prior to shipment as specified in Part 3 – Execution.

7. Submit Plant Operation and Maintenance Training Lesson Plan and schedule as specified in Part 3 – Execution.

C. Technical Manual

1. Submit a Technical Manual containing the required information indicated in Section 01 33 00 – Submittal Procedures and each specific pump Section.

D. Spare Parts List

1. Submit a spare parts list containing the required information indicated in Section 01 33 00 – Submittal Procedures and each specific pump Section.

E. Certifications

1. Certificate of Factory Performance Test by manufacturer for pumps and motors.

2. Certificate of proper installation of pump system signed by the manufacturer and Contractor.

3. Certificate of Field affirmation performance testing signed by the manufacturer and Contractor.

4. Certificate of successful startup and commissioning signed by the Contractor and witnessed by the Engineer.

F. Manufacturers' Instructions

1. Equipment handling, shipping and storage instructions by Manufacturer.

2. Installation instructions by Manufacturer.

3. Startup and commissioning instruction by Manufacturer.

G. Source Quality Control Submittals

1. Statement by Manufacturer indicating adherence to quality procedures per ISO 9001.

H. Manufacturer Reports

1. Submit manufacturer’s factory testing report for all pump system equipment.

1.04 CLOSEOUT SUBMITTALS

A. Submit closeout documents specified in Section 01 77 00 – Project Closeout.

B. Operation and Maintenance Data

1. Submit Operation and Maintenance Manuals necessary for the Work as part of process equipment provisions. Include video when required by Contract Documents for Owner’s instructions.

C. Warranty Documentation

1. Submit final executed warranty documents for pumping equipment.

D. Record Documentation

1. Submit record drawings and specifications of record documentation specific to include items such as annotated drawings, Project Manuals, and submittals and samples, marked up to indicate the actual products used and locations of concealed work or utilities.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts

1. In addition to the list of spare parts listed in each pump specification Section, include list of recommended spare parts, name, part number, number of units, cost and source location, address, contact names and phone numbers.

B. Tools

1. Submit list of tools specified in each Section.

2. Submit list of recommended tools and cost for use to maintain equipment.

3. Submit list of special tools unique to the equipment supplied in the project.

1.06 QUALITY ASSURANCE

A. Submit Quality Assurance procedures applicable to foundry, machine shop, testing, handling, delivery, installation, and startup.

B. Qualifications

1. Submit resume of Manufacturer representative proposed to supervise field installation and startup.

2. Submit resume of Manufacturer representative who will conduct operation and maintenance training of Owner’s Operation and Maintenance personnel.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

1. Delivery, storage, and handling shall conform to the requirements of Section 01 60 00 - Products, Materials, Equipment, and Substitutions.

2. The equipment shall be shipped and stored on site until time of installation per manufacturer's requirements.

3. Any corrosion in evidence or damage to the coatings shall be repaired to the satisfaction of the Engineer.

B. Storage and Handling Requirements

1. Care shall be taken in loading, transporting, and unloading to prevent injury to the pumps, drives and appurtenances, or coatings. Equipment shall not be dropped. All pumps and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired to the satisfaction of the Engineer.

2. Prior to shipping, the ends of all equipment shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until after installation and connecting piping is completed.

3. Special care shall be taken to prevent pumps, drives and appurtenances from being directly exposed to the sun, or exposed to extremes in temperature. See the manufacturer's information for further requirements.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Compliance with the requirements of the specific pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. Performance / Design Criteria

1. Capacities

a. Provide centrifugal pumps with a continuously rising pump curve, or with a pump curve that does not cross the system curve within the pump curve’s “dip region.”

b. Unless otherwise indicated, the required shaft horsepower for the entire pump assembly at any point on the performance curve shall not exceed the rated horsepower of the motor or engine or encroach on the service factor.

c. For VFD driven pumps, the rated horsepower of the selected motor shall be 110 percent of the maximum brake horsepower required by the pump.

2. Compatibility

a. Provide entirely compatible components of each pump system provided under the specific pump Sections.

b. In each unit of pumping equipment, incorporate compatible components such as, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

3. Balancing

a. Unless otherwise specified the rotating assembly shall be dynamically balanced to ISO 1940 G 6.3. Submit balancing certificate including balancing test procedure and test results.

C. Operation

1. General pump systems operation and controls shall be as described in each pump system specification section and in Division 40.

2. Process controls shall be as indicated on the Process and Instrumentation diagram drawings and as described in Division 40.

3. Detailed modes and sequence of operation shall be as described in Division 40.

D. Materials

1. Provide materials suitable for the intended application.

2. For materials not indicated, provide high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and conforming to the following requirements:

a. Bowls and Casings

1) Unless otherwise indicated in the specific pump sections, provide cast iron pump casings constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equal. Unless otherwise indicated on the specific pump sections, cast iron-fitted pumps shall be epoxy lined and coated for better efficiency.

b. Impellers

1) Unless otherwise indicated in the specific pump sections, impellers shall be epoxy coated and constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or hard iron, conforming to ASTM 532 Alloy III, or equal.

c. Unless otherwise indicated in the specific pump sections, provide pump shafts constructed of Type 416 or 316 stainless steel.

d. Unless otherwise indicated in the specific pump sections, provide anti-friction bearings or zero-lead bronze bearings. Bronze bearings shall be Bismuth Tin Bronze ASTM B 584 C89835, or equal.

e. Unless otherwise indicated in the specific pump sections, miscellaneous stainless-steel parts shall be of Type 316.

f. Provide anchor bolts, washers, and nuts in standard service (non-corrosive application) of galvanized steel in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

g. Provide anchor bolts, washers, and nuts in corrosive service of stainless steel in accordance with Section 05 50 00 – Miscellaneous Metalwork.

E. Assembly and Fabrication

1. Assembly and Fabrication Tolerances

a. Equipment shall be assembled in accordance with manufacturer's instructions or industry standard to obtain a level of quality meeting the requirements of the Contract Documents.

b. Equipment tolerances shall be established and followed to obtain a level of quality meeting the requirements of the Contract Documents.

F. Concrete Pump Foundation and Grout Mixes

1. Equipment concrete foundation and mixes shall be in accordance with 03 31 00 – Cast-in-Place Concrete. Concrete and grout mixes shall be specifically designed for the intended application and installed in accordance with the manufacturer's recommendations, free of voids/perforations that may affect the pump operation.

2.02 ACCESSORIES

A. Flanges and Bolts

1. Provide suction and discharge flanges conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, or ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions. Pressure class shall be suitable for the application or as otherwise recommended by the pump manufacturer.

1. Provide flange bolts in accordance with the requirements of Section 40 05 01 – Piping General.

2. Flange gaskets shall be in accordance with Section 40 05 01 - Piping General.

B. Lubrication

1. Pumps for sewage, sludge, and other process fluids shall be grease lubricated or as indicated.

C. Hand Holes

1. Provide hand holes on pump casings shaped to follow the contours of the casing in order to avoid any obstructions in the water passage.

D. Stuffing Boxes

1. Where stuffing boxes are indicated for the pump seal, provide stuffing boxes of the best quality, using the manufacturer's suggested materials best suited for the specific application.

2. For sewage, sludge, drainage, and liquids containing sediments, provide fresh-water-flushed seals, using lantern rings.

3. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.)**,** or equal.

4. Conventional Packing Gland Type Seal

a. Unless otherwise indicated, provide packing material of Teflon braiding, containing 50 percent ultrafine graphite impregnation in order to satisfy the requirements listed in the table below.

b. Acceptable ring materials are asbestos-free die-molded packing rings of braided graphite material free of PTFE, Chesterton 1400R or equal, for non-potable water service, and braided PTFE material, Chesterton 1725 or equal, that is listed under NSF Standard 61 for potable water service.

E. Seal Requirements:

Shaft speeds	up to 2500 fpm
Temperature	up to 500 deg F
pH range	- 14

1. Mechanical Seals

a. Provide mechanical seals of the fresh water-flushed-type, unless otherwise indicated in which case use product water cleaned by a solids separator as indicated above.

b. Provide conventional, non-split-type mechanical seals as manufactured by the following, or equal:

Sewage, Sludge, or Wastewater Pumps	Double seals	John Crane Type 5620P, Flowserve Type ISCPP, Chesterton Type GDS or 255

c. Provide split-type mechanical seals as manufactured by the following, or equal:

Sewage, Sludge, or Wastewater Pumps	Double seals	John Crane Type 3710, Flowserve Type PSS2, Chesterton Type 442

d. Where indicated, circulate a buffer fluid at a minimum 20 psi above discharge pressure, or as required by the manufacturer, in order to maintain reliable seal performance.

e. Equip mechanical seals with non-clogging, flexible–mounted seats with elastomer secondary seals.

f. Provide wetted metal parts constructed of Type 316 stainless steel, Alloy 20, or Hastelloy B or C, whichever has the best corrosion resistance to the pumped fluid.

g. Where double seals are specified, provide double-balanced dual cartridge seals in order to allow for seal integrity in case of flush water pressure reversal.

h. Provide springs in single and double seals, in the non-wetted end of the seal.

i. Wiring shall comply with the requirements of Division 26 – Electrical, and control shall comply with the requirements of Division 40 – Instrumentation and Control.

2.03 PUMP APPURTENANCES

A. Nameplates

1. Equip each pump with a stainless-steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

2.04 PROTECTIVE COATING

A. Coat materials and equipment in accordance with the requirements of Section 09 96 00 – High Performance Coatings.

PART 3 -- EXECUTION

3.01 SOURCE TESTING

A. Factory Testing: Conduct the following tests on each indicated pump system:

1. Motors

a. Test electric motors in accordance with the requirements of Section 26 05 10 – Electric Motors.

b. Furnish test results to the pump manufacturer prior to the pump test.

2. Variable Frequency Drives

a. Test variable frequency drives in accordance with the requirements of Section 26 29 23 – Variable Frequency Drive Units.

b. Furnish test results to the pump manufacturer prior to the pump test.

3. Certified Factory Non-witnessed Test

a. Perform factory non-witnessed tests on centrifugal pumps with drives up to and including 125 hp in accordance with the ANSI/HI 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Test.

b. For pumps with drives smaller than 15 hp, sump pumps, and sample pumps, pumps shall meet hydraulic acceptance criteria Grade "2U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

1) Hydrostatic test in accordance with ANSI/HI 1.46 Appendix B - Hydrostatic Pressure Testing.

2) Performance test at guaranteed design point or duty point documenting head, flow, bhp, and efficiency results.

3) Unless otherwise indicated, it is not required to test NPSHr in the factory. Instead, manufacturer shall submit the published NPSHr curve in accordance with the requirements of this specification section.

4) Additional tests as indicated in the specific pump specification sections.

c. For pumps with drives 15 hp and larger shall meet hydraulic acceptance criteria Grade "1U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

1) Performance Test:

a) Conduct performance testing at maximum speed, obtain a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, and record on data sheets as defined by the Hydraulic Institute Standard.

b) For variable speed driven pumps, test each pump between maximum and minimum speed at intervals no greater than 100 RPM.

c) Submit pump curves showing head, flow, bhp, NPSHr and efficiency results. The manufacturer's certification shall be visible on each submitted curve.

2) Mechanical testing shall be limited to observation during the hydraulic performance test for any abnormal bearing temperature and pump vibration. Any deficiencies shall be corrected by the manufacturer.

3) NPSHr3

a) Perform a net positive suction head required test (NPSHr3), if required by the specific pump Section.

b) Acceptance criteria shall be in accordance with ANSI/HI 14.6

c) If not required by the specific pump Section, submit the published Manufacturer calculated NPSHr3 curve.

4) Additional tests as indicated in the specific pump specification sections.

d. Perform tests for all pumps using the completely assembled project pump, motor, and VFD system (if equipped with variable speed drive). Calibrated factory motor and VFD may be used in lieu of project motor subject to approval of the Engineer.

e. Where multiple pumps are required in the project, one project variable speed drive and motor of each size shall be used for testing for all pumps as completely assembled systems.

f. Testing of prototype models will not be accepted.

g. Submit certification signed by a senior official of the pump manufacturer that the required pump shaft horsepower did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.

h. No equipment shall be shipped until the test data have been approved by the Engineer.

4. Acceptance

a. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.

3.02 SOURCE QUALITY CONTROL

A. Quality Assurance

1. Pump Manufacturer Qualification

a. Manufacturer shall have at least 10-years' experience designing and manufacturing similar to the type and size used in the project.

b. Manufacturer shall provide list of service centers nearest to the project, in the same country the project is located.

2. ISO 9000 Certification and Quality Control Plan

3. Inspection Test Plan (ITP)

3.03 PROTECTION DURING SHIPMENT AND STORAGE

A. General: Unless otherwise specified in the specific Section for the equipment, this paragraph applies.

1. Shipping:

1) Equipment: Ship in sealed, weather-tight enclosed containers with silica gel desiccants to protect equipment from moisture and corrosion during shipment. Equipment shall be properly and protected against from being damaged or stresses during transport to the job site.

b. Bearing housings: Protect antifriction bearings from being damaged in transit due to moisture and contaminants. Shafts locked to equipment housing to prevent bearing damage during shipment.

2. Damage: Correct to conform to the Contract requirements before the assembly is incorporated into the Work.

3. Factory Applied Coatings: Each item of equipment shall be shipped to the site of the Work with the manufacturer's shop applied prime coating.

3.04 SERVICES OF MANUFACTURERS

A. Comply with Section 01 79 00 – Owner Staff Training.

B. Inspection, Startup, and Field Adjustment

a. Where required by the specific pump Section, furnish an authorized service representative of the manufacturer at the Site continuously to supervise the following items and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

1) Installation of the equipment.

2) Inspection, checking, and adjusting the equipment.

3) Startup and field testing for proper operation.

4) Performance of field adjustments to ensure that the equipment installation and operation comply with the indicated requirements.

C. Instruction of Owner's Personnel:

a. Where required by the individual pump Section, furnish an authorized training representative of the manufacturer at the Site for the number of Days indicated in the specific pump Section, to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

b. Furnish instruction specific to the model of equipment provided.

c. Qualifications

1) Furnish a representative with at least 2 years' experience in training.

d. Submit a resume for the representative.

e. Schedule the training a minimum of 3 weeks in advance of the first session.

f. Lesson Plan

1) Submit the proposed training material and a detailed outline of each lesson for review.

2) Incorporate review comments into the material.

3) The trainees will keep the training materials.

4) The Owner may videotape the training for later use with the Owner's personnel.

3.05 INSTALLATION

A. General

1. Install pumping equipment in accordance with the manufacturer's written recommendations.

B. Alignment

1. All pump bases shall be grouted in place after initial fitting and alignment of suction and discharge piping, but before final bolting of the connecting piping. The discharge flange piping shall be laser aligned to the centerline of the pump nozzles and mating flanges square and parallel with each other. No pipe strain shall be transferred to the pump nozzle. After alignment and bolting, connections to the pump flange shall be checked using dial indicators for applied strain by loosening the flange bolts. If any of the flanges or joints move away (axially or laterally) from the true centerline of the pipe is observed, the piping shall be adjusted for proper fit.

2. Check equipment alignment after the grout had cured, all bolts torque checked and coupling adjusted to verify proper alignment and freedom from binding, scraping, shaft run out, or other defects.

3. Rotate the equipment manually and measure if shaft runout is within acceptable tolerance in order to ensure correct alignment without forcing.

4. Ensure that the equipment is secure in position and neat in appearance.

C. Submit certificate of affirmation that the equipment has been installed and aligned in accordance with the manufacturer's instruction. Installation and alignment check certificate shall be signed by the Contractor, Manufacturer and witnessed by the Engineer.

3.06 STARTUP AND COMMISSIONING

A. Comply with Section 01 75 00 – Equipment Testing and Plant Startup.

B. Additional Requirements

1. Contractor to provide the necessary oil and/or grease for initial operation.

3.07 FIELD TESTS

A. Contractor to field-test each pump system after installation simulating all the operational scenarios as specified in order to demonstrate:

1. Satisfactory operation without excessive noise and vibration;

2. No material loss caused by cavitation;

3. No overheating of bearings; and,

4. Meet indicated head, flow, and efficiency at the design point.

B. Conduct the following functional field testing:

1. Startup, check, and operate the pump system over its entire speed range.

2. If the pump is driven by a variable speed drive, test the pump and motor at 100-RPM increments.

3. If the pump is driven by constant speed, test the pump and motor at the maximum RPM.

4. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute standards at a minimum of 4 pumping conditions defined by the Engineer.

5. Field Performance Test: Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed, at 100-RPM increments if equipped with a variable speed drive or at maximum RPM if equipped with a constant speed drive.

6. Check each power lead to the motor for proper current balance.

7. Bearing Temperatures

a. Measure bearing temperatures by a contact-type thermometer.

b. Precede this test with a run time sufficient to stabilize bearing temperatures unless an insufficient liquid volume is available to furnish such a run time.

8. Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.

C. Witnessing

1. Field testing will be witnessed by the Engineer and the Owner representative.

2. Furnish at least 3 Days advance notice of field testing.

D. If the pumping system fails to meet the indicated requirements, modify or replace the pump and re-test as indicated above until it satisfies the indicated requirements.

E. Certification

1. After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.

2. Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.

F. The Contractor shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the Owner will bear.

G. If available, the Owner’s operating personnel will provide assistance in field testing.

3.08 PROTECTION

A. After completion of equipment installation and commissioning, but prior to acceptance by the Owner, the surrounding areas shall be protected from being damaged.

END OF SECTION

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SECTION 43 25 06 - SUBMERSIBLE SOLIDS-HANDLING PUMPS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide submersible solids-handling pumps and appurtenant Work, complete and operable, in accordance with the Contract Documents. The pumps shall be installed at Magna Water District's Water Reclamation Facility (Magna, UT) in an existing wetwell downstream of the fine screens in the East Headworks Facility.

B. The requirements of Section 43 21 00 - Pumps, General apply to this Section.

C. The manufacturer shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 43 21 00 - Pumps, General.

1.3 WARRANTY

A. Manufacturer shall warranty the equipment free against defects in material and workmanship for a minimum of 1 year from the date of acceptance or date of first beneficial use of the equipment by the Owner; cover parts and labor.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Identification: See Equipment Datasheet appended to this Specification Section.

B. Operating Conditions: The Work of this Section shall be suitable for long term operation under the conditions as indicated on the Equipment Datasheet appended to this Specification Section.

C. Performance Requirements: The Work of this Section shall meet the performance requirements as indicated on the Equipment Datasheet appended to this Specification Section.

D. Pump Dimensions: Pump dimensions shall be in accordance with the requirements as indicated on the Equipment Datasheet appended to this Specification Section.

2.2 PUMP REQUIREMENTS

A. General

1. Each pump shall be capable of continuous operation at full load with a water level of 5 feet above the invert of the wet pit, without cavitation or overheating of the motor.

2. Each pump, with its cable and appurtenances, shall be able to withstand continuous submergence to a minimum depth of 65-feet, whether running or off, without leakage.

3. Each pump shall be able to operate for short periods at zero static suction head without causing any damage to any part of the unit.

B. Construction: Construction of submersible solids-handling pumps shall conform to the following requirements:

Connections	Machined metal-to-metal quick disconnect type, for withdrawal of unit from above without disconnecting pipe. When lowered into place, the pump shall automatically connect and lock into the discharge pipe, allowing for zero leakage at all anticipated pump heads.
Pump Design	Single stage, centrifugal type, close-coupled to sealed or submersible electric motor, for operation in dry or wet pit, without external cooling.
Impeller	Maximum 3-port non-clog type with replaceable wear rings on impeller and in casing, to handle raw unscreened sewage, solids, and fibrous materials.
Bearings	Permanently-lubricated, heavy-duty axial and radial ball or roller bearings top and bottom, with a minimum L-10 life of 50,000 hours, at continuous, maximum load and speed, supported by detailed calculations, to be submitted with the Shop Drawings.
Seals	Dual mechanical tandem, one stationary and one revolving shaft seals with individual springs, tungsten carbide or silicon carbide ring, each not requiring any maintenance, and capable of withstanding 1.5 times pump shutoff head. The seals shall be oil lubricated, with moisture detector probes, alarm, and test circuits.
Oil Chamber	To supply oil for lubrication and cooling of the shaft seals.
Support	Cast duckfoot bend or discharge elbow with machined face, anchored to sump floor.
Cables	Include necessary cables for power connection, moisture detection, and overload protection, sheathed, coded, and suitable for submersible pumps. Provide 50 ft of cable for each pump. Cables shall be connected to the pumps and tested at the factory. Cables shall be suitable for submersible wastewater application, sized in accordance with NEC requirements.
Lifting Devices	Type 316 stainless steel guide rails with brackets and stainless steel lifting system of sufficient operating length, or with a stainless steel guide cable system with hooks and tension device, all rated at least 5 times the weight of the pump and motor. Pump manufacturer shall provide an intermediate guide bar support if required based on the guide rail length as shown on the Contract

	Drawings.

C. Materials

Pump, volute, oil casing, sliding bracket, motor frame	Cast iron (ASTM-A48 Class 35B)
Impeller	Cast iron (ASTM-A48 Class 35B) or hard iron (ASTM 532 Alloy III), statically and dynamically balanced
Pump shaft	Type 420 stainless steel, or 1045 carbon steel with Type 420 stainless steel sleeve
Exposed bolts, nuts, washers	Type 316 stainless steel
Mechanical seals	Independently operating tandem tungsten-carbide or silicon carbide and carbon rings with stainless steel springs
Impeller wear rings	ASTM A532 (Alloy IIIA) 25% chrome cast iron or Type 304 or 416 stainless steel and nitrile rubber with steel insert, with a minimum Brinnell hardness of 300
Case wear rings	Cast iron with a minimum Brinnell hardness of 200

2.3 MOTOR

A. Approval: The motors shall be rated Class I, Division 1, Group C and D service as determined by the National Electric Code and approved by a nationally recognized testing agency (UL or FM) at the time of opening Bids. The Contractor shall include in the Bid a copy of the certificate of approval.

B. Insulation: The pump motors shall be designed for continuous duty in hazardous locations. The stator and stator leads shall be moisture-resistant, triple varnished and insulated according to Class H, capable of withstanding a temperature rise of up to 180 degrees C. The allowable temperature rise of the motor at full load condition shall not exceed 80 degrees C.

C. Stator: The motor stator shall be mounted in an air-filled, watertight casing and shall not be fixed in place by externally-mounted screws which may cause leakage in the motor.

D. Motor Rating: Motors shall have service factors of 1.10 or greater. For motors driven by variable frequency drives, motor horsepower shall be the greater of:

1. Non-overloading conditions throughout the pump curve.

2. 1.15 times the horsepower required by the pump at maximum indicated flow.

E. Junction Box: The motor shall have a junction box capable of being sealed completely from the stator casing to prevent leakage through the junction box into the stator housing should a motor cable be damaged or have some other means to prevent leakage into the junction box under any condition.

F. Cable Entry: The cable entry water seal design shall be such that it precludes specific torque requirements to ensure a watertight and submersible seal. It shall permit no entry of water into any high voltage area even if the cable is severed below the water level.

G. Cooling System: Each pump shall be provided with:

1. An adequately designed cooling system using a wastewater jacket and thermal radiator integrally cast with the stator casing. Cooling medium channels and ports shall be non-clogging by virtue of their dimensions. Wastewater jackets are not required for motors that are designed to operate continuously at full load with ambient cooling.

   or

2. A closed loop integral motor cooling system. The cooling jacket shall encircle the stator housing. The cooling system shall be integral to the pump not requiring additional power/control.

H. Motor Protection: Integral thermal sensors in the motors, one for each phase, shall be provided to monitor stator temperatures. An integral leakage sensor shall also be provided. These sensors shall be used in conjunction with and supplemented by external motor over-current protection located at the control panel.

2.4 PUMP CONTROLS

A. Pumps shall be controlled in accordance with Division 40.

2.5 SPARE PARTS

A. Furnish spare parts as indicated:

1. One set of seals

2. One set of O-rings and gaskets

2.6 COATINGS

A. Coating shall be in accordance with Section 09 96 00 – High-Performance Coatings.

2.7 MANUFACTURERS, OR EQUAL

A. **Flygt Corporation**

B. **K.S.B. Pumps**

C. **Wilo**

PART 3 -- EXECUTION

3.1 FACTORY TESTING AND SHIPMENT

A. In addition to the factory tests in Section 43 21 00 – Pumps, General, the following procedures shall be included with the factory test prior to shipment:

1. Verification of the pump characteristic curves by testing at 1/4, 1/2, 3/4, and full flow and recording the measured head and motor current for each flow.

2. Verification of cavitation-free service and absence of motor overheating during conditions simulating the actual operating conditions after installation, whether submerged, semi-submerged, or dry.

3. Pump seals shall be designed for complete water tightness at 65-feet submergence for 30 minutes and data on factory testing and quality control shall be submitted with the Shop Drawings.

4. Parts shall be properly lubricated and protected so that no damage or deterioration will occur even during a prolonged delay from the time of shipment until installation is completed and the pumps are ready for operation.

5. Finished ferrous surfaces not painted shall be properly protected to prevent rust and corrosion.

6. The finished surfaces of exposed flanges shall be protected by strong wooden blind flanges.

7. Each pump shall be properly crated to protect against damage during shipment.

3.2 INSTALLATION

A. In addition to the requirements of Section 43 21 00 – Pumps, General, the Contractor shall ensure that anchor bolts are set only after the discharge piping has been properly installed, to ensure exact fit with embedded piping components.

3.3 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: The service representative of the manufacturer shall be present continuously at the Site for 2 Days to furnish the services required by Section 43 21 00 – Pumps, General.

B. Instruction of Owner's Personnel: The training representative of the Manufacturer shall be present at the Site for 1 Day to furnish the services required by Section 43 21 00 – Pumps, General and Section 01 79 00 – Owner Staff Training.

C. For the purposes of this paragraph, a Day is defined as an 8-hour period at the Site, excluding travel time.

D. The Engineer may require that the inspection, startup, and field adjustment services above be furnished in 3 separate trips.

EQUIPMENT DATASHEET

General Information	
Equipment Tags	PMP-304, PMP-305
Equipment Name	Intermediate Pump No. 4, Intermediate Pump No. 5
Location	East Headworks Facility - Intermediate Pump Station
Quantity	2

Performance Requirements	
Design Point 1	
Flow Capacity, gpm	833
Total Head, ft	39.5
Minimum Pump Efficiency, %	70%
Design Point 2	
Flow Capacity, gpm	1042
Total Head, ft	46.7
Minimum Pump Efficiency, %	70%

Operating Conditions	
Ambient Environment	Submerged
Fluid Service	Wastewater, Screened Influent

Electrical Requirements	
Maximum Motor Size, HP	25
Motor Voltage Requirements	460V, 3 PH, 60 HZ
Maximum Motor Speed, rpm	1800
Motor Drive Type	Variable Frequency

END OF SECTION

SECTION 43 30 52 – MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves, apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

40 05 51	Common Requirements for Process Valves

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

PART 2 -- PRODUCTS

2.01 CORPORATION STOPS

A. Unless otherwise indicated, corporation stops shall be made of solid brass for key operation, with screwed ends with corporation thread or iron pipe thread, as required.

B. Manufacturer, or Equal

1. Ford Meter Box Company, Inc.

2. James Jones Company (Watts, ACV)

3. Mueller Company

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with this Section.

END OF SECTION

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SECTION 46 10 00 – EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.01 SUMMARY

A. The provisions of this Section shall apply to all equipment throughout the Contract except where otherwise indicated. The Contractor shall provide equipment and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. The equipment Arrangement: Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available from manufacturers at the time of design and it is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the Drawings are diagrammatic, and some features of the illustrated equipment arrangement may require revision by the Contractor to meet the actual equipment requirements proposed by the Contractor. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered by the Contractor to accommodate the equipment provided. No additional payment will be made to the Contractor for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the fabrication of equipment.

C. Unit Responsibility:

1. The Contractor shall furnish, coordinate, assemble, install, and test the system as an operating unit.

2. The Contractor shall furnish, coordinate equipment selection with the manufacturer of the driven equipment to insure compatibility. The manufacturer shall assure selected components of the system are checked for compatibility, ease of construction, and efficient operation and maintenance. The manufacturer shall ensure coordination of design of all system components such that all equipment furnished under the specifications for the equipment system, including equipment specified elsewhere but referenced in the specification, is compatible and operates properly to achieve the performance requirements specified. Agents, representatives, or other entities who are not a direct component of the manufacturing corporation will not be acceptable as a substitute for the manufacturer's corporation in meeting this requirement.

3. This requirement for unit responsibility shall in no way relieve the Contractor of responsibility for meeting the overall performance of equipment as specified in the Contract Provisions.

4. The Contractor shall assure that all equipment systems provided for the project are products for which unit responsibility has been coordinated by the responsible party.

5. Where the specification requires a Certificate of Unit Responsibility, submit a statement signed by an officer of the manufacturer's corporation, and certified by the Contractor that the equipment have been designed, selected and coordinated are compatible with the overall integrated system as specified.

6. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory.

D. Single Manufacturer: Where two or more pieces of equipment of the same type or same size are required, the equipment shall be produced by the same Manufacturer.

E. Protection During Shipment and Storage

1. General: Unless otherwise specified in the specific Section for the equipment, this paragraph applies.

2. Shipping:

a. Equipment: Ship in sealed, weather-tight enclosed containers with silica gel desiccants to protect equipment from moisture and corrosion during shipment. Equipment shall be properly and protected against from being damaged or stresses during transport to the job site.

b. Bearing housings: Protect antifriction bearings from being damaged in transit due to moisture and contaminants. Shafts locked to equipment housing to prevent bearing damage during shipment.

3. Damage: Correct to conform to the Contract requirements before the assembly is incorporated into the work.

4. Factory applied coatings: Each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied prime coating.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 10 00	Summary of Work
01 33 00	Submittal Procedures
01 33 17	Structural Design Support and Anchorage
01 75 00	Equipment Testing and Plant Startup
01 79 00	Owner Staff Training
03 60 00	Grouting
05 50 00	Miscellaneous Metalwork
09 96 00	High-Performance Coatings
26 05 10	Electric Motors
40 05 01	Piping, General
40 05 07	Hangers and Supports for Process Piping
43 21 00	Pumps, General

B. Reference Standards

American Bearing Manufacturers Association (ABMA)	
American Gear Manufacturers Association (AGMA)	
American National Standards Institute (ANSI)	
ANSI B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)

ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)	
American Society of Mechanical Engineers (ASME)	
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ASME B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and other Special Alloys
ASME B46.1	Surface Texture
ASME B1.20.1	General Purpose Pipe Threads (Inch)
ASME B31.1	Power Piping
ASME B31.3	Process Piping
American Water Works Association (AWWA)	
AWWA M11	Steel Pipe – A Guide for Design and Installation
AWWA C206	Field Welding of Steel Water Piping
AWWA C207	Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Steel Tanks for Water Storage
American Welding Society (AWS)	
American Society for Testing and Materials (ASTM)	
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality
Federal Specifications (FS)	
Hydraulic Institute (HI)	
Mechanical Power Transmission Association (MPTA)	
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 820 Standard for Protection in Wastewater Treatment and Collection Facilities	
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects
Occupational Safety and Health Administration (OSHA).	
Underwriters Laboratories (UL)	
Rubber Manufacturers Association (RMA)	

1.03 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data

1. Submit product data consisting of manufacturer's printed data sheet or catalog cuts illustrating product information required to demonstrate that the equipment meet project section subject to review by the Engineer.

B. Shop Drawings Submittals

1. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

2. Shop Drawings: Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the Engineer, Shop Drawings shall include clear, concise calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the Contractor.

3. Spare Parts List: The Contractor shall obtain from the manufacturer and submit as part of Shop Drawings a list of specified and recommended spare parts for each piece of equipment. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.

1.04 QUALITY ASSURANCE

A. Costs: Responsibility shall be by the Contractor's for performing and paying the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives. The Owner will pay for costs of power and water. If available, the Owner's operating personnel will provide assistance in the field testing.

B. Inspection: The Contractor shall inform the local authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, cranes, and related items to obtain required permits and certificates, and shall pay inspection fees.

C. Quality and Tolerances: Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

D. Machine Work shall be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members or machine parts without machined or milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.

E. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The Engineer shall be notified of larger defects. No repair welding of such defects shall be carried out without the Engineer's written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress, then the casting may be rejected. Costs of casting new material shall be the Contractor's responsibility as part of the Work.

F. Materials shall meet the physical, chemical, metallurgical and mechanical properties in accordance with the reference standards. All materials or products shall be new and from a Manufacturer specializing in the manufacture of the product. All materials shall be high-grade, standard commercial quality, free from all defects and imperfection, and shall be recommended by the Manufacturer for the intended application.

G. Machine Finish: The type of finish shall be the most suitable for the application as recommended by the equipment manufacturer in micro-inches in accordance with ANSI B46.1 Surface Texture (Roughness, Waviness, Lay). In the absence of manufacturer's recommendations, the following surface finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for surfaces in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.

4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

H. Manufacturer's Experience: Equipment manufacturer shall have a record of proven experience of at least 5 years of successful, trouble-free operation in similar applications, type, model and size equal or larger than the equipment specified in this Contract. Where indicated in each individual equipment specifications, the Contractor shall submit this experience record to the Engineer for approval.

I. Certificates

1. Submit all equipment certificates to demonstrate that the equipment met provisions of specification in performance, materials, function, controls and operation as specified in each specific equipment specification sections.

J. Manufacturer's Instructions

1. Submit equipment manufacturer's instruction documenting packaging, shipping and delivery, storage, installation, startup, and operation and maintenance.

K. Source Quality Control Submittals

1. Submit source quality control procedures for foundry, machining, welding assembly and field installation in accordance with ISO 9001 Quality Procedures. Include non-destructive testing procedures as required to demonstrate and ensure quality of finished product. Equipment manufacturer shall be responsible of enforcing quality assurance procedures to producers for sub-manufactured parts.

L. Field Quality Control Submittals

1. Submit field quality control procedures for equipment from installation, startup and commissioning. Quality control procedure shall clearly describe specification performance requirement, function and controls, checkout steps, sign-off by Inspector. Submit test results and certificate signed by the equipment manufacturer representative, contractor and witnessed by the field engineer.

1.08 MAINTENANCE MATERIAL SUBMITTAL

A. Spare Parts

1. Submit list of spare parts as specified in each equipment specification Section.

2. Submit list of spare parts recommended by the equipment manufacturer in addition to what was already required as part of the contract.

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Noise Level: When the equipment is in operation, no equipment shall exceed the following OSHA permissible noise exposure levels per day; 105 dBA for one hour, 100 dBA for two hours or 90 dBA for eight hours.

B. High Noise Level Location: The Contractor shall provide one personal hearing protection station at each location defined as follows:

1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise permissible level for a 2-hour exposure. Where such equipment is separated by a distance of more than 20-feet, measured between edges of footings, the area for each group of equipment shall be provided with a separate hearing protection station.

2. Indoor Location

a. Any single equipment item or any group of equipment items located within a single room not normally occupied, that produces noise exceeding OSHA noise permissible level for a 2-hour exposure.

b. Any single equipment item or any group of equipment items located within a single room normally occupied by workers that produces noise exceeding OSHA noise permissible level for an 8-hour exposure.

C. Personal Hearing Protection: The Contractor shall furnish 3 pairs of high attenuation hearing protectors in the original unopened packaging. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, provided at an approved location near the noise producing equipment.

D. Drive Trains and Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque (whichever is the greatest), speed, and horsepower. Applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, and temperature. Drive train components include couplings, shafts, gears, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	**Service Factor**	**Load Classification**
Centrifugal Fans	1.0	Uniform
Pumps		
centrifugal or rotary	1.0	Uniform
reciprocating	1.8	Moderate Shock

Type of Equipment	Service Factor	Load Classification
progressing cavity	1.0	Uniform
Mixers		
constant density	1.0	Uniform
variable density	1.25	Moderate Shock
rapid mixer	1.25	Moderate Shock
flocculator	1.25	Moderate Shock
sludge mixer	2.5	Moderate Shock
surface aerator	2.5	Heavy Shock
Grit Handling Equipment	1.25	Moderate Shock

E. Mechanical Service Factors

	Mechanical Service Factors
	Electric Motor
Uniform	1.25
Moderate Shock	1.50
Heavy Shock	2.00

F. For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to the manufacturer sizing information.

G. For service factors of electric motors, see Section 26 05 10 – Electric Motors.

H. Where load classifications are not indicated, the equipment manufacturer's recommendations for service factors shall be utilized.

I. Welding: Unless otherwise indicated, welding shall conform to the following:

1. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

2. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a smooth and acceptable appearance with uniform weld contours and dimensions. Sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3. Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent corrosion of hard-to-coat metallic surfaces.

4. Welded steel piping: Latest revision of AWWA C206.

J. Protective Coating: Equipment shall be painted or coated in accordance with Section 09 96 00 – High-Performance Coatings, unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

K. Protection of Equipment: Machined and coated surfaces shall be protected by rust inhibitor material prior to shipment. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry. Equipment with anti-friction bearings or sleeve bearings shall be protected from being damaged due to jarring motion during shipment. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized, and shafts shall be rotated per manufacturer's recommendation. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, recoated, or otherwise corrected to restore it to original condition.

L. Identification of Equipment Items

1. At the time of shipping, each item of equipment shall have a legible identifying mark corresponding to the equipment number in the Contract Documents for the particular item.

2. After installation, each item of equipment shall be given stainless steel plate nametags.

M. Vibration Isolators: Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.

N. Equipment Maximum Allowable Vibration Level: Unless otherwise indicated, maximum allowable vibration level shall be in accordance with the acceptance criteria recommended by the reference Standard for that particular type of equipment.

O. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.

P. Controls: Equipment and system controls shall be in accordance with Division 40.

2.02 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Equipment components and supports, anchors, and seismic restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greatest of the following design criteria:

1. Design Criteria noted in Section 01 33 17 – Structural Design Support and Anchorage.

B. Submit design calculations for equipment supports, anchors, and seismic restrainers signed and sealed by an engineer registered in the State of Utah. Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, and normal operation plus wind loadings in accordance with Section 01 33 17 – Structural Design Support and Anchorage.

1. Wall-mounted equipment weighing more than 250 pounds, or which is within 18-inches above the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

2. Seismic requirements: Freestanding and wall-hung equipment shall be anchored in place by methods that satisfy Section 01 33 17 – Structural Design Support and Anchorage. Calculations shall be performed and signed and stamped for equipment weighing more than 400 pounds. Calculations shall analyze lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

3. Wind requirements: Exterior freestanding equipment shall be anchored in place by methods that satisfy Section 01 33 17 – Structural Design Support and Anchorage. Calculations shall be performed and signed and stamped, analyzing lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

4. Anchors: Anchor bolts shall be in accordance with Section 05 50 00 – Miscellaneous Metalwork. Contractor shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the Shop Drawings.

5. Equipment Grout: Mechanical equipment installed on top of concrete foundations or bases shall be provided with non-shrink concrete or epoxy grout as indicated and as specified in Section 03 60 00 - Grouting. Grout shall be applied between the base plate and the concrete foundation or base in accordance with the grout manufacturer’s recommendation. Grout shall be free of void space.

2.03 COUPLINGS

A. Mechanical couplings shall be provided between the driver and the driven equipment. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads.

B. Each coupling size shall be determined based on the rated horsepower of the motor, speed of the shaft, and the load classification service factor. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, 2 sets of flexible disc pack couplings or as recommended by equipment manufacturer shall be provided.

D. Taper-Lock or equal bushings may be used to provide for easy installation and removal of shafts of various diameters.

2.04 SHAFTING

A. General: Equipment manufacturer shall be responsible for designing and manufacturing shafting to carry all loads applied to the shaft. Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. Design Criteria: Shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications.

C. Materials: Shafting materials shall be compatible with the type of service and load transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.

1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.

2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.

3. Other grades of carbon steel alloys shall be suitable for service and load.

4. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

2.05 GEARS AND GEAR DRIVES

A. Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used unless specifically approved by the Engineer.

B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather with humidity control filter to allow air to escape but keep moisture, dust and dirt out. The casing shall be of cast iron, ductile iron, or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.

C. Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be selected by the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.

E. Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with required appurtenances shall be provided when necessary.

F. Where gear drive input or output shafts from one manufacturer connect to couplings or sprockets from a different manufacturer, the Contractor shall have the gear drive manufacturer furnish a matching key taped to the shaft for shipment.

2.06 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains meeting ASME Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided in each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and be suitable for the process fluid.

2.07 SPROCKETS

A. General: Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

B. Materials: Unless otherwise indicated, materials shall be as follows:

1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.

2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.

3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. Sprockets shall be accurately machined to ASME Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with key seat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with Taper-Lock bushings as required.

F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

2.08 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ASME, MPTA, and RMA Standards.

B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.

C. Sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.

D. To facilitate installation and disassembly, sheaves shall be provided complete with Taper-Lock or QD bushings as required.

E. Finish bored sheaves shall be complete with key seat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.09 DRIVE GUARDS

A. Power transmission trains, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform to the OSHA Safety and Health Standards (29CFR1910). The guards shall be constructed of minimum 10-gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication, and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.10 BEARINGS

A. General: All bearings shall be selected and sized by the equipment manufacturers and reviewed by bearing manufacturers. Bearing life calculation shall be submitted and reviewed by bearing manufacturer. Bearing shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).

B. To assure satisfactory bearing application, ambient temperature, humidity, internal clearances, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

C. Re-lubricatable type bearings shall be equipped with hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. Anti-Friction Type Bearing Life: Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	**Design Life, years**	**L-10 Design Life, hours**
	(whichever comes first)	
8-hour shift	10	20,000

16-hour shift	10	40,000
Continuous	10	60,000

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve Type Bearings: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing manufacturer.

H. Plate Thrust Bearings: Thrust bearings shall be the Kingsbury Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, manufacturer shall provide heat exchangers, incluging necessary intrumentation and controls, piping, filters, and valves.

2.11 PIPING CONNECTIONS

A. Pipe Hangers, Supports, and Guides: Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with Section 40 05 07 – Hangers and Supports for Process Piping.

B. Flanges and Pipe Threads: Flanges on equipment and appurtenances shall conform to ASME B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ASME B1.20.1 and Section 40 05 01 – Piping General.

C. Flexible Connectors: Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of Section 40 05 01 – Piping General. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

D. Insulating Connections: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the specifications.

2.12 GASKETS AND PACKINGS

A. Gaskets and packings shall be in accordance with the requirements of the specifications. Gaskets and packings in contact with drinking water shall be NSF 61 approved.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane Everseal, or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O" rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the Engineer, in accordance with Section 43 21 00 - Pumps, General.

2.13 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.14 SPECIAL TOOLS AND SPARE PARTS

A. Tools: The Contractor shall furnish one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.

B. Spare parts shall be furnished as indicated in the individual equipment sections. Spare parts shall be suitably packaged in a metal box and labeled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.15 EQUIPMENT LUBRICANTS

A. The Contractor shall provide lubricants for equipment during shipping, storage, and prior to testing, in accordance with the manufacturer’s recommendations. Lubricants that could come in contact with potable water shall be food grade lubricants. After successful initial testing, final testing, and satisfactory completion startup testing per Section 01 75 00 - Equipment Testing and Plant Startup, the Contractor shall conduct one complete lubricant change on equipment. In addition, the Contractor shall be responsible for the proper disposal of used lubricants. The Owner will then be responsible for subsequent lubricant changes

PART 3 -- EXECUTION

3.01 SERVICES OF MANUFACTURER

A. Installation Supervision, Inspection, Startup, and Field Adjustment: An authorized, experienced, and competent service representative of the manufacturer shall visit the Site to perform the following:

1. Supervision of the installation of the equipment.

2. Inspection, checking, and adjusting the equipment and approving its installation.

3. Startup and field testing for proper operation, efficiency, and capacity.

4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements.

5. Verify, affirm and certify that the specified equipment performance acceptance criteria and conditions such as temperature and vibration amplitude, have been meet. Submit test certificate signed by the Contractor and witnessed by the Engineer representative.

6. Certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

7. Unless otherwise indicated, factory representative shall be present at the job site for at least the following number of days:

    a. Half a day per equipment for smaller than 500 horsepower.

    b. One day per equipment for 500 horsepower and larger.

B. Owner Staff Training

1. Owner staff training shall be in accordance with Section 01 79 00 – Owner Staff Training. An authorized training representative of the Manufacturer shall visit the site for a number of days indicated in those sections to instruct the Owner's personnel in the operation and maintenance of the equipment, including step by step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least two years' experience in training. A resume of the representative shall be submitted.

3. Unless otherwise indicated, a minimum of one day of training shall be provided for each type of equipment.

3.02 TESTING

A. General requirements

1. All mechanical equipment shall undergo factory and field performance and functional test to demonstrate that the process equipment system meet the requirement of the Contract Document. Detailed testing requirement are specified in each equipment specification sections.

2. Unless otherwise specified, equipment factory testing procedure shall follow the Industry Standard test procedure that applies to that equipment.

3. Submit test procedures for review by the engineer one month prior to the scheduled test.

B. Test sequence

1. Factory functional and performance testing

2. Component tests

3. System tests

4. Individual system or train test

5. Overall facility operational tests

3.03 STARTUP AND COMMISSIONING

A. Startup and commissioning test shall be as specified in Division1

3.04 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.

B. If the packaged system has any additional features (such as safety interlocks, etc.) other than required by the Contract Documents, the Contractor shall coordinate such features with the Engineer and provide material and labor necessary for a complete installation as required by the manufacturer.

3.05 FIELD ASSEMBLY

A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with Never Seize compound or equal.

3.06 FIELD TESTS

A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.

B. The following field testing shall be conducted:

1. Operational Readiness Tests (ORT)

a. Check equipment for proper installation, baseplates leveled, grouted and anchor bolts properly torqued to manufacturer’s specifications and rotating assemblies balanced and shafts aligned.

b. Install all instruments and their associated components, controls panels, wirings are installed, calibrated and termination checked.

c. Install and check all PLC’s, Input/output wires and all terminations.

d. Install all power cables from MCC to motors and checked.

2. Perform trial operation. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.

3. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.

4. Operate equipment indicated in Section 01 75 00 – Equipment Testing and Plant Startup.

C. The Engineer shall witness field-testing. The Contractor shall notify the Engineer of the test schedule 3 Days in advance.

D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

END OF SECTION

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