SET NO. _____

PROJECT MANUAL

BID SET

TOWN OF TELLURIDE

2015 RAW LIFT STATION IMPROVEMENT PROJECT

APRIL 20, 2015

PROJECT MANUAL

BID SET

TOWN OF TELLURIDE

2015 RAW LIFT STATION IMPROVEMENT PROJECT

JVA, Inc.
214 8th Street
Glenwood Springs, CO 81601

JVA Job No. 2374c

April 20, 2015

PROJECT MANUAL

TABLE OF CONTENTS

TOWN OF TELLUIRDE
2015 RAW LIFT STATION IMPROVEMENT PROJECT

Section No.	Subject	# of Pages
DIVISION 0 – GENERAL CONDITIONS		
00010	Advertisement to Bid	1
00020	Invitation to Bid	1
00100	Instructions to Bidders	6
00310	Bid Form	6
00410	Bid Bond	1
00420	Statement of Contractor's Qualifications	2
00430	Schedule of Major Subcontractors	1
00430	EJCDC Bid Bond Penal Sum Form 2007-2012	2
00510	Notice of Award	1
00520	Agreement	10
00530	Certificate of Insurance	1
00550	Notice to Proceed	1
00560	Consent of Surety	1
00570	Final Inspection Report	1
00580	Warranty Period Inspection Report	1
00610	Performance Bond	2
00615	Labor and Material Payment Bond	2
00620	Contractor's Application for Payment	4
00625	Certificate of Substantial Completion	1
00700	Standard General Conditions of the Construction Contract	27
00800	Supplementary Conditions	12

00940	Work Change Directive	1
00941	Change Order	1
00942	Field Order	1

DIVISION 1 – GENERAL REQUIREMENTS

01010	Summary of Work	6
01035	Modification Procedures	2
01039	Coordination and Meetings	6
01080	Identification Systems	3
01200	Payment Procedures	5
01340	Shop Drawings, Product Data, and Samples	13
01380	Construction Photographs	3
01400	Quality Control	6
01500	Construction Facilities and Temporary Controls	7
01550	Cutting and Patching	5
01600	Materials and Equipment	12
01650	Starting of Systems	2
01700	Contract Closeout	7
01730	Operation and Maintenance Data	6

DIVISION 2 – SITE WORK

02220	Demolition	5
02300	Earthwork	28
02510	Water Distribution System	21
02530	Sanitary Sewer System	12
02616	Site Piping	22
02676	Disinfection of Water Systems	4
02950	Seeding	7

DIVISION 3 – CONCRETE

03300	Cast-In-Place Concrete	20
03400	Precast Concrete Roof Members	7
03600	Non-Shrink Grout	3

DIVISION 4 – MASONRY

04810	Unit Masonry Assemblies	16

DIVISION 5 – METALS

05500	Metal Fabrications	11
05517	Alternating Tread Ships Ladder	3

DIVISION 6 – WOOD, PLASTICS, AND COMPOSITES

Not Used

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

07200	Building Insulation	2
07215	Foamed-In-Place Masonry Insulation	2
07531	EPDM Elastomeric Membrane Roofing	5
07920	Joint Sealers	6

DIVISION 8 – OPENINGS

08120	Aluminum Doors and Frames	5
08700	Door Hardware	4

DIVISION 9 – FINISHES

09900	Coatings	10
09910	Structural Coatings	10

DIVISION 10 – MISCELLANEOUS SPECIALTIES

Not Used

DIVISION 11 – EQUIPMENT

11273	Mechanical Course Screen and Washing Compactor	13

DIVISION 14 – CONVEYING SYSTEMS

14620	Manual Hoists	2

DIVISION 15 – MECHANICAL

15060	Pipe and Pipe Fittings	20
15090	Supports and Anchors	5
15100	Valves, Cocks and Hydrants	12
15145	Water Piping Specialties	3
15400	Plumbing Fixtures and Equipment	5
15517	Sleeves and Sleeve Seals for Plumbing Piping	4
15523	General-Duty Valves for Plumbing Piping	17
15529	Hangers and Supports for Plumbing Piping and Equipment	9
15553	Identification for Plumbing Piping and Equipment	4
15700	Plumbing Insulation	28
15756	Domestic Water Piping	15
15777	Sanitary Waste and Vent Piping	12
15795	Facility Storm Drainage Piping	10
15815	Common Work Results for HVAC	5
15833	Common Motor Requirements for HVAC Equipment	3
15856	Identification for HVAC Piping and Equipment	4
15872	Testing, Adjusting, and Balancing for HVAC	16
15888	HVAC Insulation	37
15913	Facility Natural-Gas Piping	17
15953	Metal Ducts	17
15956	Air Duct Accessories	16

15976 Diffusers, Registers, and Grilles 4

DIVISION 16 – ELECTRICAL

16050 Basic Electrical Materials and Methods 20

16900 Instrumentation and Controls 12

SECTION 00010

ADVERTISEMENT FOR BIDS

2015 Raw Lift Station Improvement Project

OWNER: Town of Telluride
P.O. Box 397
Telluride, CO 81435

Separate sealed bids for construction of the 2015 Raw Lift Station Improvement Project in Telluride, Colorado, shall be received by the TOWN prior to 2:00 PM MST, Friday, May 8th, 2015, at the Town of Telluride Public Works Facility, 1370 Black Bear Road, Telluride, Colorado 81435.

A mandatory pre-bid conference will be held on Thursday, April 30th, 2015, at 2:00 PM, at Public Works Conference room at 1370 Black Bear Rd. in Telluride.

Copies of the Bid Documents may be obtained beginning Monday, April 20th, 2015 at the Town of Telluride Public Works Department, 1370 Black Bear Road or on the Town's website at www.telluride-co.gov.

Date: April 20th, 2015

SIGNED: _____
Paul Ruud

TITLE: Public Works Director

SECTION 00020

INVITATION TO BID

2015 Raw Lift Station Improvement Project

Date: April 20th, 2015

Separate sealed bids for construction of the 2015 Raw Lift Station Improvement Project in Telluride, Colorado, shall be received by the TOWN prior to 2:00 PM local time, Friday, May8th, 2015, at the Town of Telluride Public Works Facility, 1370 Black Bear Road, Telluride, Colorado 81435.

At said place and time, and promptly thereafter, all Bids that have been duly received will be publicly opened and read aloud.

The Contract Documents provide for construction of the **2015 Raw Lift Station Improvement Project**. The project includes

Copies of the Construction Documents, complete with Construction Specifications and Drawings, may be examined at and/or obtained from the Town of Telluride Public Works Department 1370 Black Bear Road or on the Town's website at www.telluride-co.gov. There will be no charge for documents.

The Work is expected to commence on June 8th, 2015. Substantial Completion of the Work is required as specified in the Agreement – Section 00520 as September 4th, 2015. Final Completion is specified in the Agreement – Section 00520 as October 30th, 2015.

The successful Bidder will be required to furnish a Performance Bond and a Payment Bond guaranteeing faithful performance and the payment of all bills and obligations arising from the performance of the Contract.

No Bid may be withdrawn within a period of forty-five (45) days after the date fixed for opening Bids.

The OWNER reserves the right to reject any and all Bids, and to waive any informalities and irregularities therein.

Bid security in the amount of not less than five percent (5%) of the total Bid must accompany each Bid in the form specified in the Instructions to Bidders (Section 00100).

Sales Prohibited / Conflict of Interest: No officer, employee, or their dependent or person residing in and sharing the expenses of their household, shall have a financial interest in the sale to the Town of any real or personal property, equipment, material , supplies, or services. This rule also applies to subcontractors with the Town. This shall not apply to members of any authority, board, committee or commission of the Town other than the members of the Town Council. Soliciting or accepting any gift, gratuity, favor, entertainment, kickback, or any items of monetary value from any person who has or is seeking to do business with the Town of Telluride is prohibited. Any vendor knowing of this type of activity is encouraged to report in confidence to the Town Attorney or Town manger so the matter can be dealt with.

SECTION 00100

INSTRUCTIONS TO BIDDERS

2015 Raw Lift Station Improvement Project

1.0 DEFINED TERMS

Terms used in these Instructions to Bidders are defined in the General Conditions of the Agreement. The term "Bidder" means one who submits a Bid to OWNER, as distinct from a sub-bidder, who submits a Bid to Bidder. The term "Successful Bidder" means the lowest qualified, responsible and responsive Bidder to whom OWNER (on basis of OWNER'S evaluation as hereinafter provided) makes an award. The term "Bidding Documents" includes the Advertisement for Bids (Section 00010) or Invitation to Bid (Section 00020), Instructions to Bidders (Section 00100), the Bid Form (Section 00410), the Construction Designs, and the proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

2.0 COPIES OF BIDDING DOCUMENTS

2.1 Complete sets of Bidding Documents may be obtained as stated in the Invitation to Bid. No partial sets will be issued. The Bidding Documents may be examined at the locations identified in the Invitation to Bid.

2.2 Complete sets of Bidding Documents shall be used in preparing Bids; neither OWNER nor ENGINEER assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.3 The submitted Bid proposal shall include Section 00310 – Bid Form, Section 00410 – Bid Bond, Section 00420 – Statement of Bidder's Qualifications, and Section 00430 – Schedule of Subcontractors, fully executed.

2.4 OWNER and ENGINEER, in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining Bids on the Work and do not confer a license or grant for any other use.

3.0 QUALIFICATION OF BIDDERS

3.1 To demonstrate qualifications to perform the Work, each Bidder must submit with the Bid proposal a written statement of qualifications including financial data, a summary of previous experience, and previous commitments. Each Bid must contain evidence of Bidder's qualification to do business in the State where the Project is located or covenant to obtain such qualifications prior to award of the contract. Prepare the Statement of Qualifications on the form provided in Section 00420.

3.2 The following factors will be considered to determine the Bidder's qualifications: Work previously completed by the Bidder and whether the Bidder (a) maintains a permanent place of business, (b) has adequate material, equipment, and experience to do the Work properly and expeditiously, (c) has sufficient resources to complete the project on time or ahead of schedule, (d) has the financial resources to meet all obligations incidental to the Work, and (e) has appropriate technical experience.

3.3 Each Bidder may be required to show that s/he has handled former Work so that no just claims are pending against such Work. No Bid will be accepted from a Bidder who is engaged on any other Work that would impair his ability to perform or finance the Work.

3.4 No Bidder shall be in default on the performance of any other contract with the OWNER or in the payment of any taxes, licenses, or other monies due to the OWNER.

4.0 EXAMINATION OF CONTRACT DOCUMENTS AND SITE

4.1 It is the responsibility of each Bidder before submitting a Bid to (a) examine the Contract Documents thoroughly, (b) visit the site to familiarize themselves with local conditions that may in a manner affect cost, progress, or performance of the Work, (c) familiarize themselves with federal, state, and local laws, ordinances, rules, and regulations that may in any manner affect cost, progress, or performance of the Work, (d) study and carefully correlate (Bidder's observations with the Contract Documents, and (e) notify the OWNER of all conflicts, errors or discrepancies in the Contract Documents.

4.2 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of the Article 3, that without exception the Bid is premised upon performing and furnishing the Work required by the Contract Documents and such means, methods, techniques, sequences, or procedures of construction as my be indicated in or required by the Contract Documents, and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

5.0 INTERPRETATIONS AND ADDENDA

5.1 All questions about the meaning or intent of the Bidding Documents are to be submitted in writing to the OWNER. Interpretation or clarifications considered necessary in response to such questions will be issued only by Addenda. Questions received less than seven (7) days prior to the date for opening Bids may not be answered. Only questions answered by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

5.2 All questions should be directed to the OWNER.

5.3 Addenda may also be issued to modify the Bidding Documents, as deemed advisable by OWNER.

5.4 Addenda will be mailed or delivered to all parties recorded by the OWNER as having received the Bidding Documents.

6.0 BID SECURITY

6.1 Each Bid must be accompanied by Bid Security made payable to "Town of Telluride" in the amount stated in the Invitation to Bid. The required security must be in the form of a certified or bank cashier's check payable to OWNER or a Bid Bond on the form enclosed herewith. The Bid Bond must be executed by a Surety Company that is authorized to transact business in the State of Colorado and be accepted by the OWNER.

6.2 The Bid Security of the successful Bidder will be retained until such Bidder has executed the Agreement and furnished the required contract security, whereupon Bid Security will be returned. If the successful Bidder fails to execute and deliver the Agreement and furnish the required Contract Security with ten (10) days of the Notice of Award, OWNER may annul the Notice of Award and the Bid Security of that Bidder will be forfeit. The Bid Security of other Bidders whom the OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until the earlier of the seventh (7th) day after the effective date of the Agreement or the thirtieth (30th) day after the Bid Opening, whereupon Bid Security furnished by such Bidders will be returned. Bid Security, with Bids that are not competitive, will be returned within seven (7) days after the Bid Opening.

7.0 CONTRACT TIME

The number of days within which, or the date by which the Work is to be substantially complete and also completed and ready for Final Payment (the CONTRACT TIMES), are set forth in the Agreement (Article 2). The CONTRACTOR will submit a proposed schedule to illustrate how the milestone dates will be met.

8.0 LIQUIDATED DAMAGES

Provisions for liquidated damages are set forth in the General Conditions of Agreement (Article 9).

9.0 SUBSTITUTE ("OR EQUAL") MATERIAL AND EQUIPMENT

9.1 The Contract, if awarded, will be on the basis of material and equipment described on the Drawings or specified in the Specifications without consideration of possible substitute or "or equal" items.

9.2 Whenever it is indicated on the Drawings or specified in the Specifications that a substitute or "or equal" item of materials or equipment may be furnished or used by CONTRACTOR, and is acceptable to OWNER, application for such acceptance will not be considered by OWNER until after the "effective date of the Agreement". The procedure for submitting any such application by CONTRACTOR and considerations by OWNER are set forth in the General Conditions of Agreement (Article 5).

10.0 SUBCONTRATORS, SUPPLIERS AND OTHERS

10.1 Each Bidder shall submit at the Bid opening to OWNER a list of major subcontractors s/he proposes to use in the Work. Refer to Section 00430 contained within these Bid Documents.

10.2 If OWNER after due investigation has reasonable objection to any proposed Subcontractor, either may, before the Notice of Award is given, request the apparent successful Bidder to submit an acceptable substitute without an increase in Bid price. If the apparent successful Bidder declines to make any substitution, OWNER may award the contract to the next lowest responsible Bidder that proposed to use acceptable subcontractors. Subcontractors, suppliers, and other persons or organizations listed and to whom the OWNER does not make written objection prior to the giving of the Notice of Award will be deemed acceptable the OWNER subject to revocation of such acceptance after the effective date of the Agreement.

10.3 CONTRACTOR shall not be required to employ any subcontractor, supplier or other persons or organizations against which they have reasonable objection. The use of subcontractors listed by the Bidder and accepted by the OWNER prior to the Notice of Award will be required in the performance of the Work. The OWNER will approve any subcontractor changes by the CONTRACTOR before the Work is performed.

11.0 BID FORM

11.1 A separate unbound copy of the Bid Form is enclosed for submission with the Bid.

11.2 Bid Forms must be completed in ink or typed. Totals must be stated in words and numbers; in case of conflict, words will take precedence. Unit prices shall govern over extensions of sums.

11.3 Bids by corporations must be executed in the corporate name by the president or a vice-president (or other appropriate officer accompanied by evidence of authority to sign) and the corporate seal shall be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation shall be shown below the corporate name.

11.4 Bids by partnerships must be executed in the partnership name and signed by each partner, his title must appear under his signature and the official address of the partnership must be shown below the signature.

11.5 Bids by joint venture shall be signed by each participant in the joint venture or by an authorized agent of each participant. The full name of each person or company interested in the Bid shall be listed on the Bid Form. The joint venture companies will designate a person and a single company as the sole / primary responsible party of the Work as outlined in the Agreement.

11.6 The Bid shall contain an acknowledgment of receipt of all Addenda (the numbers of which must be filled in on the Bid Form).

11.7 No alternations in Bids, or in the printed forms therefore, by erasures, interpolations, or otherwise will be acceptable unless each such alteration is signed or initialed by the Bidder. If initialed, OWNER may require the Bidder to identify any alteration so initialed.

11.8 The address and telephone number for communications regarding the Bid shall be shown.

12.0 BID PRICING

Bids must be priced as set forth in the Bid Form – Section 00310 Article 5, Basis of Bid.

13.0 SUBMISSION OF BIDS

13.1 Bids shall be submitted at the time and place indicated in the Invitation to Bid and enclosed in an opaque sealed envelope marked with the Project Title, name, and address of the Bidder, and accompanied by the Bid Form, Bid Bond, Statement of Bidders Qualifications, and Schedule of Subcontractors.

13.2 Bids shall be deposited at the designated location prior to the time and date for receipt of Bids indicated in the Invitation to Bid, or any extension thereof made by addendum. Bids received after the time and date for receipt of Bids will be returned unopened. Bidder shall assume full responsibility for timely delivery at the location designated for receipt of Bids.

13.3 Oral, telephonic, telegraphic, facsimile, or electronic (email) Bids are invalid and will not be considered.

13.4 No Bidder may submit more than one Bid. Multiple Bids under different names will not be accepted from one firm or association.

14.0 MODIFICATION AND WITHDRAWAL OF BIDS

14.1 Bids may be modified or withdrawn by an appropriate document duly executed (in a manner that a Bid must be executed) and delivered to the place where Bids are to be submitted at any time prior to the opening of Bids.

14.2 Bids may also be modified or withdrawn in person by the Bidder, or an authorized representative provided s/he proves his identity and authority at any time prior to the opening of Bids.

14.3 Withdrawn Bids may be resubmitted up to the time designated for receipt of Bids provided that they are then fully in conformance with these Instructions to Bidders.

15.0 OPENING OF BIDS

Bids will be opened and (unless obviously non-responsive) read aloud publicly, as indicated in the Invitation to Bid. An abstract of the amounts of the Base Bids and major alternates (if any) will be made available after the opening of Bids.

16.0 BIDS TO REMAIN OPEN SUBJECT TO ACCEPTANCE

All Bids shall remain open for thirty (30) days after the day of the Bids Opening, but OWNER may, in his/her sole discretion, release any Bid and return the Bid Security prior to that date.

17.0 AWARD OF CONTRACT

17.1 OWNER reserves the right to reject any and all Bids, to waive any and all informalities not involving price, time, or changes in the Work, to negotiate contract terms with the Successful

Bidder, and the right to disregard all nonconforming, nonresponsive, unbalanced or conditional Bids.

Also, OWNER reserves the right to reject the Bid of any Bidder if OWNER believes that it would not be in the best interest of the project to make an award to that bidder, whether because of doubtful financial ability or failure to meet any other pertinent standards or criteria established by OWNER. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

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

17.3 OWNER may consider the qualification and experience of subcontractors, suppliers, and other persons and organizations proposed for those portions of the Work as to which the identity of subcontractors, suppliers, and other persons and organizations is submitted as requested by OWNER. OWNER also my consider the operating costs, maintenance requirements, performance data and guarantees of major items of material and equipment proposed for incorporation in the Work when such data are required to be submitted prior to the Notice of Award.

17.4 OWNER may conduct such investigations as deemed necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications, and financial ability o the Bidder's proposed subcontractors, suppliers, and other persons and organizations to do the Work in accordance with the Contract Documents to OWNER'S satisfaction within the thirty (30) days allowed in Article 16.0 of the Instructions to Bidders, above.

17.5 If the Contract is to be awarded, it will be awarded to the lowest responsive, responsible, and qualified Bidder whose evaluation by OWNER indicates to OWNER that the award will be in the best interest of the Project. The basis for award shall be the Bid Total for the Schedule.

17.6 If the Contract is to be awarded, OWNER will give the Successful Bidder a Notice of Award within thirty (30) days after the date of the Bid opening.

18.0 CONTRACT SECURITY

The General Conditions and the Supplementary Conditions set forth OWNER'S requirements as to performance and other bonds. The Successful Bidder must deliver the executed Agreement to the OWNER with the required Contract Security.

19.0 SIGNING OF AGREEMENT

When OWNER gives a Notice of Award to the Successful Bidder, it will be accompanied by three (3) unsigned counterparts of the Agreement with all other written Contract Documents attached. Within ten (10) days thereafter, CONTRACTOR shall sign and deliver the required number of counterparts of the Agreements and attached documents to OWNER with required Bonds. Within the ten (10) days thereafter, OWNER shall deliver one (1) fully signed counterpart to CONTRACTOR. Each counterpart is to be accompanied by a complete stet of the Drawings with appropriate identifications

20.0 TAXES

OWNER is exempt from Colorado State Sales and Use taxes on materials and equipment to be incorporated in the Work. Said taxes shall not be included in the Contract Price. Reference is made in Article 5.9 of the General Conditions.

21.0 COLLUSIVE OR SHAM BIDS

Any Bid deemed by the OWNER in its sole discretion to be a collusive or sham Bid will be rejected and reported to authorities as such. Bidder's authorized signature of this Bid assures that such Bid is genuine

and is not a collusive or sham Bid. Also, any Bid deemed by the OWNER in its sole discretion to be unbalanced will be rejected.

22.0 BID RESULTS

For information regarding results for individual Bids, send a self-addressed, self-stamped envelope and a Bid tally will be mailed to you. Bid results will be posted in the office of the OWNER seven (7) days after the Bid Opening. Bid results will also be posted on the Town of Telluride Web Site at www.telluride-co.gov.

END OF SECTION

SECTION 00310

Bid Form

Project Identification: **2015 Raw Lift Station Improvement Project**

TABLE OF ARTICLES

	Page
Article 1 - Bid Recipient	1
Article 2 - Bidder's Acknowledgments	1
Article 3 - Bidder's Representations	1
Article 4 - Further Representations	2
Article 5 - Basis of Bid	3
Article 6 - Time of Completion	3
Article 7 - Attachments to Bid	4
Article 8 - Defined Terms	4
Article 9 - Bid Submittal	4

ARTICLE 1 - BID RECIPIENT

1.01 This Bid Is Submitted To: The Town of Telluride

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

ARTICLE 2 - BIDDER'S ACKNOWLEDGMENTS

2.01 Bidder accepts all of the terms and conditions of the Advertisement for Bids and Instructions to Bidders, including without limitations those dealing with the dispositions of Bid security. The Bid will remain subject to acceptance for up to thirty (30) days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 - BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

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

Addendum No.	Addendum Date
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

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

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

D. Bidder has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in SC-4.02, and (2) reports and drawings of a Hazard Environmental Condition, if any, which has been identified in SC-4.06.

E. Bidder has obtained and carefully studied (or accepts the consequences for not doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by the Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents to be employed by Bidder, and safety precautions and programs incident thereto.

F. Bidder does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents.

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

H. Bidder has correlated the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents.

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

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

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

ARTICLE 4 - FURTHER REPRESENTATIONS

4.01 Bidder further represents that:

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

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

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

D. Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Owner.

ARTICLE 5 - BASIS OF BID

5.01 Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

TOWN OF TELLURIDE
2015 RAW LIFT STATION IMPROVEMENT PROJECT
BID SCHEDULE

Item No.	Description	Quantity	Unit	Unit Cost	Item Price
1.	WWTF Improvements	100%	LS	$ _____	$ _____

Total Bid Schedule (Items 1) **$ _____**

A. Unit Prices have been computed in accordance with information provided in the Bidding Documents.

B. Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Bid items will be based on actual quantities, determined as provided in the Contract Documents.

ARTICLE 6 - TIME OF COMPLETION

6.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Article 11 of General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

6.02 Bidder accepts the provisions of the General Conditions as to liquidated damages in the event of failure to complete the work within the Contract Times.

ARTICLE 7 - ATTACHMENTS TO THIS BID

7.01 The following documents are attached to and made a condition of the Bid:

A. Required Bid security in the form of a Bid Bond (Section 00410) or Certified Check (circle type of security provided);

B. Statement of Bidder's Qualifications; and

C. A Schedule of Subcontractors.

ARTICLE 8 - DEFINED TERMS

8.01 The terms used in this Bid with the initial capital letters have the meanings indicated in the Instructions to Bidders and the General Conditions.

ARTICLE 9 - BID SUBMITTAL

9.01 This Bid submitted by:

If Bidder is:
An Individual

Name (typed or printed): _____

By: _____
(Individual's signature)

SEAL, if required by State

Doing business as: _____

A Partnership

Partnership Name: _____

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

SEAL, if required by State

Name (typed or printed): _____

A Corporation

Corporation Name: _____

State of Incorporation: _____

Type (General Business, Profession, Service, Limited Liability): _____

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

Name (typed or printed): _____

Title: _____

Attest _____
(Signature of Corporate Secretary)

CORPORATE SEAL, if required by State

Date of Qualification to do business in _____ [State where Project is located] is ___/___/_____

A Joint Venture

Name of Joint Venture: _____

First Joint Venture Name: _____

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

SEAL, if required by State

Name (typed or printed): _____

Title: _____

Second Joint Venture Name: _____

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

SEAL, if required by State

Name (typed or printed): _____

Title: _____

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

Bidder's Business address: _____

_____

Business Phone No. (_____)_____

Business FAX No. (_____)_____

Business E-Mail Address _____

State Contractor License No. _____. (If applicable)

Employer's Tax ID No. _____

Phone and FAX Numbers, and Address for receipt of official communications, if different from Business contact information:

_____

_____

9.02 Bid submitted on _____, 2015.

SECTION 00410

BID BOND

Know all men by these presents: THAT WE, THE UNDERSIGNED _____ AS Principal, and _____ unto the Town of Telluride, Colorado, as OWNER, in the sum of $ _____ for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, successors, and assigns.

THE CONDITION of this obligation is such that whereas the Principal has submitted to the Town of Telluride , Colorado, the accompanying Bid and hereby made a part hereof to enter into a construction Agreement for Town of Telluride Project **2015 Raw Lift Station Improvement Project**. NOW THEREFORE,

a. If said Bid shall be rejected, or

b. If said Bid shall be accepted and the Principal shall execute and deliver a Contract in the form of Contract attached hereto (properly completed in accordance with said Bid) and shall furnish a BOND for his faithful performance of said Contract, and for payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the Agreement created by the acceptance of said Bid, then this obligation shall be void,; otherwise the same shall remain in force and effect, it being expressly understood and agreed that the liabil8ty of the Surety for any and all claims hereunder shall in not even, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulated and agrees that the obligations of said Surety and its BOND shall be in no way impaired or affected by any extension of the time within which the OWNER may accept such Bid; and said Surety does hereby waive notice of any such extension.

Surety Companies executing bonds must b e authorized to transact business in the State of Colorado and be accepted by the OWNER.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals this _____ day of _____, 20__, and such of them as are corporations have caused their corporate seal to be hereto affixed and these presents to b signed by their proper officers, the day and year first set forth above.

PRINCPAL		**SURETY**
Name:	_____	_____
Address:	_____	_____
	_____	_____
	_____	_____

ATTEST:

By: _____

(Seal)

SECTION 00420

STATEMENT OF CONTRACTOR'S QUALIFICATIONS

All questions must be answered and the data given must be clear and comprehensive. This statement must be notarized. If necessary, questions may be answered on separate attached sheets. The Bidder may submit any additional information desired.

1. Name of Contractor: _____

2. Permanent main office address: _____

3. When organized: _____

4. If a corporation, where incorporated: _____

5. How many years have you been engaged in the contracting business under your present firm or trade name?
   _____

6. Contracts on hand: (Schedule these, showing the amount of each contract and the anticipated dates of completion.)
   _____
   _____
   _____
   _____
   _____
   _____

7. General character of Work performed by your company:
   _____
   _____
   _____

8. Have you ever failed to complete any Work awarded to you? _____ (yes/no)

9. Have you ever defaulted on a contract: _____ (yes/no)
   If so, where and why? _____
   _____
   _____

10. List the projects similar in scope and scale recently completed by your team, stating the approximate cost of each and the month and year completed, location, and type of construction.
    _____
    _____
    _____
    _____
    _____

11. Background and experience of the principal members of your organization, including officers:
    _____
    _____
    _____
    _____
    _____

_____

12. Credit available: _____

13. Bank reference: _____

14. Are you licensed as a General Contractor? _____ (yes/no).
    If yes, in what city, county, state? _____

15. Who are the subcontractors that will do Work under this Contract?

    _____
    _____
    _____
    _____
    _____

16. Are any lawsuits pending against you or your firm at this time? _____ (yes/no)
    If yes, provide details.

    _____
    _____
    _____

17. What are the limits of your public liability? _____
    What company? _____

18. What are your company's bonding limitations? _____

19. The undersigned hereby authorizes and requests any person, firm or corporation to furnish any information requested by the OWNER in verification of the recital comprising this Statement of Contractor's Qualifications.

Dated at _____ this ____ day of _____, 2015.

_____
Name of Contractor

By: _____
Title: _____
State of _____)
County of _____)
_____being duly sworn deposes and says that
they are _____ of _____
(Name of Organization)

and that the answers to the foregoing questions and all statement therein contained are true and correct.

Subscribed and sworn to before me this _____ day of _____ 2015.

_____
Notary Public

_____
_____

My commission expires _____

SECTION 00430

SCHEDULE OF MAJOR SUBCONTRACTORS

The Contract is based on subcontracting certain major portions of the Work to subcontractors, as listed below.

ITEM	SUBCONTRACTOR

NOTICE OF AWARD

TO: _____

PROJECT: **2015 Raw Lift Station Improvement Project**

OWNER: Town of Telluride, Colorado

DATE: _____

Please be advised that on _____, 2015, the Town of Telluride, Colorado awarded the Contract to construct the **2015 Raw Lift Station Improvement Project** to your company in the amount of $_____ per your responsible, responsive, low bid. In accordance with the Contract Documents, you are required to execute two (2) of the Agreement and return all copies with the required bonds and certificates of insurance within ten (10) days of the date of this Notice of Award.

The beginning date of the Contract shall be the date the purchase order is issued which shall be the official notice to proceed.

Failure to comply with these conditions within the time specified will entitle the Town to consider your bid abandoned, to annul this Notice of Award and to declare your Bid Security forfeited.

TOWN OF TELLURIDE, COLORADO

BY: _____

TITLE: _____

DATE: _____

ACCEPTANCE OF NOTICE OF AWARD BY CONTRACTOR:

BY: _____

TITLE: _____

DATE: _____

Agreement
Between The Town Of Telluride, A Municipal Corporation,
And _____

To Construct the 2015 Raw Lift Station Improvement Project

THIS AGREEMENT ("Agreement") is entered into this ____day of _____, 2015, by and between the Town of Telluride, a home-rule municipality in the State of Colorado, hereinafter referred to as the "Town," and _____, hereinafter referred to as the "Contractor".

In consideration of their mutual promises and obligations, the parties hereto agree as follows:

1. WORK

Description. The Contract Documents provide for construction of the **2015 Raw Lift Station Improvement Project**. The project includes

1.1. This project will include the following:

-

Refer to the Construction Plans for more details.

1.2. **Scope**. CONTRACTOR shall complete all Work as specified or indicated in the Contract Documents. The Project, for which the Work under the Contract Documents may be the whole or only a part, is defined as the **2015 Raw Lift Station Improvement Project.**

2. CONTRACT TIMES

2.1. The CONTRACT will commence on **Monday, July 30, 2014**.

2.2. Substantial completion for this project will be no later than close of business on **October 28, 2014.**

2.3. The WORK for this project will be completed and ready for Final Payment and Acceptance in accordance with the General Conditions no later than **November 14, 2014.**

2.4. Project Close Out will be completed no later than **November 28, 2014.**

2.5. Refer to Article 9 of the General Conditions concerning changes of Contract Times.

3. CONTRACT PRICE

The TOWN agrees to pay, and CONTRACTOR agrees to accept, in full payment for the performance of the WORK Specified within this Agreement, an amount not to exceed _____ ($_____).

4. INSURANCE

4.1. CONTRACTOR shall not commence the Work specified under this Agreement until it has obtained all insurance required by the contract documents and the TOWN has approved that insurance. CONTRACTOR shall not allow any subcontractor to commence work on the project until all similar insurance required of the subcontractor has been obtained and approved. For the duration of this Agreement, the CONTRACTOR must maintain the insurance coverage required in this Article.

4.2. CONTRACTOR shall procure and maintain, and cause each Subcontractor or Supplier of the Contractor to procure and maintain (or shall insure the activity of Contractor's Subcontractors and Suppliers in Contractor's own policy) the minimum insurance coverages listed below. Such coverages shall be procured and maintained with forms and insurers acceptable to the TOWN. All coverages shall be continuously maintained from the date of commencement of the Work. In the case of any claims made

policy, the necessary retroactive dates and extended reporting periods shall be procured to maintain such continuous coverage.

4.2.1. **Worker's Compensation**. Contractor shall provide Worker's Compensation insurance to cover obligations imposed by applicable laws for any employee engaged in the performance of work under this contract, and Employer's Liability Contractor shall provide Worker's Compensation insurance to cover obligations imposed by applicable insurance with minimum limits of FIVE HUNDRED THOUSAND DOLLARS ($500,000) each accident, FIVE HUNDRED THOUSAND ($500,000) disease-policy limit, and FIVE HUNDRED THOUSAND DOLLARS disease-each employee. Evidence of qualified self-insured status may be substituted for the Workmen's Compensation requirements of this paragraph.

4.2.2. **Commercial General Liability**. Contractor shall provide General Liability insurance with the minimum combined single limits of ONE MILLION DOLLARS ($1,000,000) and TWO MILLION DOLLARS ($2,000,000) aggregate. The policy shall be applicable to all premises and operations. The policy shall include coverage for bodily injury, broad form property damage (including completed operations), personal injury (including coverage for contractual and employee acts), blanket contractual, independent contractors, products, and completed operations. The policy shall include coverage for explosion, collapse, and underground hazards. The policy shall contain a severability of interests provision.

4.2.3. **Automobile Liability**. Contractor shall provide Comprehensive Automobile Liability insurance with minimum combined single limits for bodily injury and property damage of not less than ONE MILLION DOLLARS ($1,000,000) each occurrence with respect to each of the Contractor's owned, hired or non-owned vehicles assigned to or use in the performance of services. The policy shall contain a severability of interests provision.

4.3. All required policies, except for Workers' Compensation Insurance and Employers' Liability Insurance, shall endorse the TOWN OF TELLURIDE, and its officers and employees, as additional insured. Every policy required above shall be primary insurance, and any insurance carried by the TOWN, its officers, or its employees, shall be excess and not contributory insurance to that provide by the Contractor. The additional insured endorsement for the General Liability insurance required above shall not contain any exclusion for bodily injury or property damage arising from completed operations. The Contractor shall be solely responsible for any deductible losses under each of the policies required above.

4.4. CONTRACTOR'S insurance agent shall complete certificates of insurance as evidence that policies providing the required coverage, conditions, and minimum limits are in full force and effect. These certificates of insurance shall be subject to review and approval by the TOWN. Each certificate shall identify the Project Name ("**2015 Raw Lift Station Improvement Project**") and shall provide that the coverage afforded under the policies shall not be cancelled, terminated or materially changed until at least 45 days prior written notice has been given to the TOWN. If the words "endeavor to" appear in the portion of the certificate addressing cancellation, those words shall be stricken from the certificate by the agent(s) completing the certificate. The TOWN reserves the right to request and receive a certified copy of any policy and any endorsement thereto.

4.5. Failure on the part of the contractor to procure or maintain policies providing the required coverage, conditions, and minimum limits shall constitute a material breach of contract upon which the Town of Telluride may immediately terminate the contract, or at its discretion Town may procure or renew any such policy or any extending reporting period thereto and may pay any and all premiums in connection therewith, and all monies so paid by the Town shall be repaid by Contractor to the Town upon demand, or the Town of Telluride may offset the cost of the premiums against any monies due to Contractor from the Town.

4.6. The parties hereto understand and agree that the Town is relying on, and does not waive or intend to waive by any provision of this contract, the monetary limitations (presently $350,000 per person and $990,000 per occurrence) or any other rights, immunities, and protections provided by the Colorado Governmental Immunity Act, Section 24-10-101 et seq., 10 C.R.S., as from time to time amended, or otherwise available to the Town, its officers, agents, or its employees.

5. PAYMENT PROCEDURES

CONTRACTOR shall submit to the TOWN for review and approval an application for payment fully completed and signed by CONTRACTOR covering the work completed through the last day of the month or a regular date that is mutually agreed upon and accompanied by such supporting documentation (e.g., receipts) as the Town may request.

5.1. **Progress payments**

5.1.1. The TOWN shall make progress payments on the basis of CONTRACTOR's applications for payment once each month during design and construction of the Work as provided below and in the General Conditions.

5.1.2. Progress payments will be made in the amount equal to 90 percent of the completed Work, and /or 90 percent of materials and equipment not incorporated in the Work (but delivered, suitably stored and accompanied by documentation satisfactory to the TOWN as provided in the General Conditions), but in each case, less the aggregate of payments previously made and such less amounts as the TOWN may withhold, in accordance with the General Conditions.

5.2. **Final payment**. Upon final completion and acceptance of the Work in accordance with the General conditions, the TOWN shall pay the remainder of the Contract Price after twenty (20) days once the Town is satisfied that all subcontractors have been paid. If subcontractors do come forward with a claim, the CONTRACTOR, will be given the opportunity to settle the claim or the TOWN may opt to pay the claim out of the final payment amount.

6. CONTRACTOR REPRESENTATIONS AND RESPONSIBILITIES

In entering into this Agreement, CONTRACTOR makes the following representations and commitments:

6.1. During the Work, CONTRACTOR will provide a single, qualified Construction Superintendent on site as needed to adequately coordinate completion of the Work. The construction superintendent shall not be replaced without three (3) days notice to the TOWN, except under extraordinary circumstance and only with TOWN approval. The Construction Superintendent must be capable of following the project schedule and coordinating the Work to complete the project on schedule, and working with the TOWN's ENGINEER.

6.1.1. The Construction Superintendent will be Contractor's representative at the site and shall have authority to act on behalf of CONTRACTOR. All communications to the Construction Superintendent shall be as binding as if given to Contractor. The Construction Superintendent shall be the normal recipient of work site communications from the ENGINEER. Important communications from the TOWN will be made through the Town's ENGINEER, shall be in writing, and shall be made by field order or a reasonable facsimile thereof. Other important communications from CONTRACTOR to the TOWN shall also be in writing.

6.1.2. When the Construction Superintendent is away from the site, the Construction Superintendent shall designate a single agent at the site as the point of contact. That agent shall be authorized to act immediately on emergency communications given by the TOWN. If the TOWN issues an emergency communication to the Contractor, but there is no authorized representative of the Contractor able to act on the emergency communication, the TOWN may take whatever action is necessary to deal with the emergency, at the Contractor's cost. Alternatively, the TOWN may suspend contractor operations that are affected by the emergency communication until the emergency has been resolved.

6.2. CONTRACTOR has examined and carefully studied the contract documents, has given the TOWN written notice of all conflicts, errors, ambiguities or discrepancies that CONTRACTOR has discovered in the contract documents, the written resolution thereof by the ENGINEER is acceptable to

CONTRACTOR, and the contract documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing the Work.

6.3. CONTRACTOR has inspected the site and become familiar with and is satisfied as to the general, local and site conditions that may affect cost, progress, performance or finishing of the Work.

6.4. Contractor shall furnish and assume full responsibility for all designs, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the furnishing, performance, testing, start-up and completion of Work.

6.5. CONTRACTOR is familiar with and is satisfied as to all applicable federal, state and local laws that may affect cost, progress and finishing of the Work. As used in this section, and hereafter, the term "laws" shall include, without limitation, all federal, state and town codes, charters, ordinances, laws, standards, rules and regulations. The TOWN shall not be responsible for monitoring Contractor's compliance with any laws or regulations. If Contractor performs any Work knowing or having reason to know that it is contrary to any laws or regulations, Contractor shall bear all claims, costs, losses and damages caused by, arising out of or resulting there from.

6.5.1. CONTRACTOR agrees to not cause or allow, in connection with the Work hereunder, the discharge, emission, release, or escape of any hazardous or toxic substance and/or waste, pollutant, contaminant or other substance in violation of any laws or regulations. If violations occur and are not fixed within twenty-four (24) hours, a Stop Work Order will be issued until the problem is fixed. The CONTRACTOR is responsible for all costs associated with such a delay.

6.5.2. CONTRACTOR agrees to report to TOWN (and to all appropriate governmental authorities if caused or allowed by the Contractor) immediately all accidents or occurrences resulting in actual or threatened damage to the Work site or to the environment by contaminated media, including discovery of accidents or occurrences in which contaminated media are or may be encountered, or which results in contaminated media. The Contractor shall stop Work immediately upon encountering any contaminated media or potentially contaminated media and shall thereafter, upon the TOWN’s written directive, proceed as directed.

6.5.3. CONTRACTOR agrees to comply with all federal, state and city non-discrimination rules and regulations so long as CONTRACTOR is under contract with the TOWN.

6.5.4. CONTRACTOR agrees to strictly adhere to the United States Department of Labor, Occupational Safety and Health Administration (OSHA) standards for excavating and trenching operations.

6.6. CONTRACTOR will carefully study all data and reports related to existing drainage and topography; drainage improvements; subsurface conditions at or contiguous to the site; and all drawings of physical conditions relating to surface or subsurface structures at or contiguous to the site, which have been identified in the General Conditions. CONTRACTOR accepts the determination set forth in said General Conditions. CONTRACTOR acknowledges that such reports and drawings are not contract documents and may not be complete for CONTRACTOR purposes. CONTRACTOR acknowledges that the TOWN does not assume responsibility for the accuracy or completeness of information and data shown or indicated in the contract documents with respect to such reports, drawings or to Underground Facilities at or contiguous to the site. CONTRACTOR will conduct, obtain and carefully study (or assumes responsibility for having done so) all necessary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise, which may affect cost, progress, performance or finishing of the Work or that relate to any aspect of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto. CONTRACTOR does not believe that any additional examinations, investigations, explorations, tests, studies or data are necessary to perform and finish the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the contract documents. If necessary, changes in Contract Price or Contract Times will be made in accordance with the contract documents.

6.7. CONTRACTOR will check all available information and data with respect to existing Underground Facilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Facilities prior to commencing construction.

6.8. CONTRACTOR will provide survey reference points, construction stakes, lines and grades required for the completion of the work.

6.9. CONTRACTOR will correlate the information known to CONTRACTOR, information and observations obtained from visits to the site, reports and drawings, investigations, explorations, tests, studies and data.

6.10. **Responsibility for Work**

6.10.1. CONTRACTOR shall have the charge and care thereof, and shall take every necessary precaution against injury or damage to any part thereof by the effects of the elements or from any other cause. CONTRACTOR, at its own expense, shall redesign, rebuild, repair, restore, and correct all injuries or damages to any portion of the work occasioned by any causes before its completion and acceptance.

6.10.2. In case of suspension of work from any cause whatsoever, CONTRACTOR shall be responsible for all materials and shall properly store same, if needed, and shall provide suitable drainage, barricades, and warning signs, where necessary.

6.10.3. CONTRACTOR shall be relieved of the responsibilities provided in this section upon final acceptance of the work by the TOWN, except no such relief shall apply to damages or injuries caused by or related to actions of Contractor or its subcontractors.

6.11. CONTRACTOR will use its best skill and workmanship to provide Work of the highest quality.

6.12. CONTRACTOR will provide survey reference points, construction stakes, lines and grades required for the completion of the work.

6.13. **Illegal Aliens as Laborers**. As used in this agreement, "Basic Pilot Program" means the basic pilot employment verification program created in Public Law 208, 104th Congress, as amended, and expanded in Public Law 156, 108th Congress, as amended, that is administered by the United States Department of Homeland Security.

6.13.1. CONTRACTOR shall not knowingly employ or contract with an illegal alien to perform work under this contract nor shall CONTRACTOR enter into a contract with a subcontractor that fails to certify to CONTRACTOR that the subcontractor shall not knowingly employ or contract with an illegal alien to perform work under this contract.

6.13.2. CONTRACTOR has verified or attempted to verify through participation in the Basic Pilot Program that CONTRACTOR does not employ any illegal aliens. If CONTRACTOR is not accepted into the Basic Pilot Program prior to executing this contract for service, CONTRACTOR shall apply to participate in the Basic Pilot Program every three (3) months until CONTRACTOR is accepted or this contract has been completed, whichever is earlier. This paragraph shall not be effective if the Basic Pilot Program is discontinued.

6.13.3. CONTRACTOR shall not use the Basic Pilot Program procedures to undertake pre-employment screening of job applicants while this contract is being performed.

6.13.4. If CONTRACTOR obtains actual knowledge that a subcontractor performing work under this contract knowingly employs or contract with an illegal alien, CONTRACTOR shall notify the subcontractor and the TOWN within three (3) days that CONTRACTOR has actual knowledge that the subcontractor is employing or contracting with an illegal alien; and terminate the subcontract with the subcontractor if within three (3) days of receiving the notice required pursuant to this paragraph, the subcontractor does not stop employing or contracting with the illegal alien. Except that CONTRACTOR shall not terminate the contract with the subcontractor

if during such three (3) days the subcontractor provides information to establish that the subcontractor has not knowingly employed or contracted with an illegal alien. If the contract is terminated for any violation of this Section, Illegal Aliens as Laborers, the Contractor shall be liable for actual and consequential damages to the Town of Telluride.

6.13.5. CONTRACTOR shall comply with any reasonable request by the Colorado Department of Labor and Employment made in the course of an investigation that the Colorado Department of Labor and Employment is undertaking.

6.14. CONTRACTOR can terminate contract if Town fails to pay without cause or otherwise materially breaches this Agreement.

7. TOWN REPRESENTATIONS AND RESPONSIBILITIES

In entering into this Agreement, the TOWN makes the following representations and commitments:

7.1. The ENGINEER will be the TOWN's representative at the site and shall have authority to act on behalf of TOWN. All communications to the ENGINEER shall be as binding as if given to TOWN. The ENGINEER shall be the normal recipient of work site communications from the Construction Superintendent. Important communications from the CONTRACTOR will be made through the Contractor's Construction Superintendent, shall be in writing, and shall be made by field order or a reasonable facsimile thereof. Other important communications from TOWN to the CONTRACTOR shall also be in writing.

7.2. Drew Lloyd is TOWN's ENGINEER for the purposes of this Agreement.

7.3. **Clarifications and Interpretations.** When needed, the TOWN will issue with reasonable promptness written or verbal clarifications or interpretations of the requirements of the contract documents. These shall be consistent with the intent of and reasonably inferable from the contract documents. Such written clarifications and interpretations will be binding on the TOWN and CONTRACTOR. If the TOWN or CONTRACTOR believes that a written clarification or interpretation justifies an adjustment in the Contract Price or the Contract Times and the parties are unable to agree to the amount or extent thereof, if any, the TOWN or CONTRACTOR may make a written claim therefore.

7.4. **Authorized Variations in Work.** The TOWN, with CONTRACTOR consent, may authorize minor variations in the work from the requirements of the contract documents that do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Work. These variations may be accomplished by a Field Order and will be binding on the TOWN and CONTRACTOR, who shall perform the Work involved promptly.

7.5. **Rejecting Defective Work.** The TOWN will have authority to disapprove or reject Work that it reasonably believes to be defective, will not produce a completed project that conforms to the contract documents, or will prejudice the integrity of the design concept of the completed Work. The TOWN will also have authority to require special inspection or testing of the work.

7.6. **Timing of Change Orders.** The TOWN shall use reasonable efforts to grant or deny change orders within twenty-four (24) hours and not later than seventy-two (72) hours after the request of the CONTRACTOR. The ENGINEER shall be authorized to approve change orders that do not increase the price of the work. Change orders that increase the price of work shall be approved or denied in writing by the Town Manager.

7.7. **Termination of Contract.** Nothwithstanding the provisions of Article 1, TOWN shall have the right to terminate this Agreement at any time for any of the following reasons:

7.7.1. For cause, which for purposes of this Agreement includes, without limitation (i) CONTRACTOR'S merger or consolidation, or (ii) CONTRACTOR'S negligence or misconduct that would make its continued association with Town prejudicial to the best interest of the parties or (iii) bankruptcy by, against, or on behalf of CONTRACTOR; (iv) an adverse change in the

financial condition of CONTRACTOR that affects the ability of CONRACTOR to perform the Services required hereunder; or (v) CONTRACTOR's breach of any term or condition of this agreement;

7.7.2. Without cause, for Town's convenience, upon written notice to CONTRACTOR. In the event of termination for TOWN's convenience, TOWN shall incur no liability to CONTRACTOR by reason of such termination, except that contractor shall receive the compensation for Basic Services together with Reimbursable Expenses then due or incurred.

7.7.3. **Remedies.** Except as otherwise expressly provided herein, termination of this Agreement pursuant to this Article shall not in any way compromise or constitutes a waiver of any right or remedy or either party at law or in equity, or (b) affect any provision of this Agreement that is intended to survive the termination of this Agreement.

8. CONTRACT DOCUMENTS

The contract documents, which constitute the entire agreement between the TOWN and CONTRACTOR concerning the Work, are all written documents that define the Work and the obligations of the CONTRACTOR in performing the Work and the TOWN in providing compensation for the Work. The contract documents shall consist of those listed below, and there are no contract documents other than as listed:

8.1. This Agreement.

8.2. General Conditions.

8.3. Special Provisions

8.4. Construction Drawings

8.5. Change Orders and other documents which may be required or specified including, but not limited to:

8.5.1. Certificates of Insurance
8.5.2. Field Order
8.5.3. Change Order
8.5.4. Application for Payment
8.5.5. Certificate of Substantial Completion
8.5.6. Final Inspection Report
8.5.7. Guarantee Period Inspection Report

8.6. The following, which may be delivered or issued after the Effective Date of the Agreement and are attached hereto: All Written Amendments and other documents amending, modifying, or supplementing the Contract Documents pursuant to the General Conditions.

8.7. In the event of conflict between the above documents, the prevailing document shall be as follows:

8.7.1. Permits from other agencies, as may be required.
8.7.2. This Agreement
8.7.3. Special Provisions and Detail Drawings.
8.7.4. Technical Specifications and Design/Build Drawings.
8.7.5. Drawings and Technical Specifications are intended to be complementary. Anything shown or called for in one and omitted in another is binding as if called for or shown by both.
8.7.6. Supplementary Conditions, if applicable.
8.7.7. General Conditions.
8.7.8. Town Design and Construction Standards, if applicable.
8.7.9. Reference Specifications.

8.8. In case of conflict between prevailing technical references above, the one having the more stringent requirements will govern.

8.9. The contract documents may only be amended, modified or supplemented as provided in the General Conditions.

9. INDEMNIFICATION

To the fullest extent permitted by law, the CONTRACTOR agrees to indemnify and hold harmless the Town of Telluride, its officers, agents, employees, consultants, and insurers, from and against all liability, claims, and demands, on account of injury, loss, or damage, including without limitation claims arising from bodily injury, personal injury, sickness, disease, death, property loss or damage, or any other loss of any kind whatsoever, which arise out of or are in any manner connected with the Work and this contract, if such injury, loss, or damage, or any portion thereof, is caused by, or claimed to be caused by, the act, omission, error, professional error, mistake, negligence, or other fault of the CONTRACTOR, any subcontractor of the CONTRACTOR, or which arises out of any worker's compensation claim of any employee of the CONTRACTOR or of any employee of the subcontractor of the CONTRACTOR. The CONTRACTOR agrees to investigate, handle, respond to, and provide defense for and defend against any such liability, claims, or demands at the sole expense of the CONTRACTOR. The Contractor's indemnification obligation shall not be construed to extend to any injury, loss, or damage which is caused by the act, omission, or other fault of the TOWN.

10. MISCELLANEOUS

10.1. Terms used in this Agreement, which are defined in the General Conditions, shall have the meanings indicated in said General Conditions.

10.2. **Ownership & Use of Documents.** All material, information, documents, and products submitted to the Owner by the Contractor pursuant to this Agreement are the property of the Town of Telluride. The TOWN reserves the right to use such documents, products, and materials generated by the Contractor for other projects provided that the Contractor is not held liable for future project applications other than the project pursuant to this Agreement.

10.3. **Acceptance of Work.** Only Final Payment by the TOWN shall be evidence of Acceptance of Work. No act of the Town, or of any representative thereof, either in superintending or directing the Work, or any extension of the time for the completion of the Work, shall be regarded as an acceptance of such work or any part thereof, or of materials used therein, either wholly or in part. Before Final Payment is made, CONTRACTOR shall execute an affidavit that it accepts the same in full payment and settlement of all claims on account of work done and materials furnished under this Contract. And that all claims for materials provided or labor performed have been paid or set aside in full. No waiver of any breach of this contract by Town or anyone acting on their behalf shall be held as a waiver of any other subsequent breach thereof. Any remedies provided herein shall be cumulative.

10.4. **Warranty of Work.** CONTRACTOR agrees to warranty all work under this Agreement for a period of one (1) year from the date of final payment by the Town. If any unsatisfactory condition or damage develops within the time of this warranty due to materials or workmanship that are defective, inferior, or not in accordance with the Agreement, as reasonably determined by TOWN and CONTRACTOR, then the CONTRACTOR shall, when notified by Town, immediately place such warranty work in a condition satisfactory to Town. The Town shall have all available remedies to enforce such warranty, except that Town shall not have any work performed independently to fulfill such warranty and require CONTRACTOR to pay Town such sums as were expended by the Town for such work, unless the Town has first given notice to the CONTRACTOR of the deficiency and given the CONTRACTOR a reasonable opportunity to cure the same.

10.5. 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, moneys that may become due and moneys 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 that assignor from any duty or responsibility under the contract documents.

10.6. The TOWN and CONTRACTOR each binds itself, its partners, successors, assigns and legal representatives to the other party hereto, its partners, successors, assigns and legal representatives in respect to all covenants, agreements and obligations contained in the contract documents.

11. OTHER PROVISIONS

11.1. **Third party beneficiaries.** The Agreement is not intended to create any right for the public or any member thereof, any subcontractor or supplier, or any other third party, or to authorize anyone not a party to the contract to maintain a suit to enforce its terms. The duties, obligations, and responsibilities of the parties to the contract, with respect to third parties, shall remain as imposed by law. This section shall not apply to any surety to the extent it is acting under any labor and materials bond or performance bond entered into by the CONTRACTOR.

11.2. **Integration.** The Contract Documents represent the entire integrated Agreement between the TOWN and the CONTRACTOR and supersede all prior negotiations, representations, or agreement, whether written or oral. No modification, amendment, waiver or innovation shall be valid unless incorporated in a written amendment or change order properly executed by both parties.

11.3. **Severability.** To the extent that the performance of the parties' obligations may be accomplished within the intent of the contract, the terms of the contract are severable, and should any term or provision of the contract be declared invalid or become inoperative for any reason, such invalidity or failure shall not affect the validity of any other contract term or provision.

11.4. **Waiver.** If the TOWN fails to enforce any term of the Agreement for any period, this shall not act as a waiver. No waiver of any breach of any term thereof shall be effective unless set forth in writing and signed by both the ENGINEER and CONTRACTOR. The waiver of any breach of a term thereof shall not be construed as waiver of any other term.

11.5. **Compliance with laws**. At all times during the performance of the contract, Contractor shall strictly adhere to all Federal, State, and local laws that have been or may hereafter be established. This shall include, without limitation, the U.S. Department of Labor Office of Safety and Health Administration (OSHA) standards for excavating and trenching operations. As used for this Agreement, the term “law” shall include, without limitation, all Federal, State, and Town codes, charters, ordinances, laws, standards, rules, and regulations.

11.6. **Choice of law.** In all litigation arising out of the Contract, the statutory and common law of the State of Colorado shall be controlling, and venue shall be in the District Court of San Miguel County, Colorado.

12. INDEPENDENT CONTRACTOR

12.1. CONTRACTOR and any persons employed by Contractor for the performance of Work hereunder shall be independent contractors and not employees or agents of the Town. Nothing herein shall be construed as establishing a quality standard for any individual, or as establishing any right on the part of the Town to oversee the actual work of the Contractor or to instruct any individual as to how the work will be performed.

12.2. CONTRACTOR shall have the right to employ such assistance as may be required for the performance of work under this Agreement. Said Contractor shall be responsible for compensation, insurance, and all clerical detail pertaining to such assistance, and shall be solely responsible for providing any training, tools, benefits, materials, and equipment.

12.3. As an independent contractor, CONTRACTOR and Contractor’s employees and subcontractors are not entitled to Workers’ Compensation benefits except as may be provided by the independent contractor, nor to Unemployment Insurance benefits, unless the independent contractor or some other entity provides Unemployment Compensation coverage. CONTRACTOR is obligated to pay all federal and state income tax on any moneys earned or paid pursuant to this contract.

IN WITNESS WHEREOF, the TOWN and CONTRACTOR have signed this Agreement in duplicate. One

counterpart each has been delivered to the TOWN and CONTRACTOR. All portions of the Contract Documents have been signed, initialed or identified by the TOWN and CONTRACTOR.

This Agreement is effective as of __ July 2015.

CONTRACTOR	ATTEST
By: _____	_____
President	Secretary

TOWN OF TELLURIDE	ATTEST
By: _____	_____
Stuart Fraser, Town Manager	Lauren Bloemsma, Town Clerk

Address for giving notices:

_____
_____
_____
_____

Approved as to form: _____
Town Attorney

CERTIFICATE OF INSURANCE

Contractor shall insert its own standard form for Certificate of Insurance.
The Town of Telluride shall be named as an additional insured.

CLAIM RELEASE

PROJECT: **2015 Raw Lift Station Improvement Project**

OWNER: Town of Telluride, Colorado

Application for Payment Number: _____

Application for Payment Amount: _____

Application for Payment Date: _____

For valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the undersigned hereby releases the Town of Telluride, Colorado, and waives all rights of the undersigned to file a claim for material, equipment, tools, machinery or services heretofore furnished for use in and for labor heretofore performed upon the construction, alteration, addition to or repair of the structure or improvements described in the Contract Documents as:

PROJECT: **2015 Raw Lift Station Improvement Project**

OWNER: Town of Telluride, Colorado

We acknowledge that the foregoing is an adequate description of the real property and improvement inasmuch as the foregoing description is the description given in the Contract Documents, which govern the performance of the Work for which consideration has been received.

In executing this release, we certify that all claims for labor or materials, or both, furnished or performed by the undersigned or on our behalf by our material suppliers or subcontractors have been paid or that satisfactory arrangements for payment have been made.

In further consideration of the payment made or to be made to the undersigned and to induce said payment, we agree to defend and indemnify the Town of Telluride from any claim or claims on the part of our material suppliers, laborers, employees, servants, and agents, or subcontractors arising from our work on this project, and we further agree to fully satisfy any such claim brought against the Town and reimburse the Town for any and all costs, including reasonable attorney fees, which it may incur as a result of such claims.

This release is valid only if check no. _____, drawn by _____ on the _____ bank, for $ _____, dated _____, 20__, is paid.

_____	_____
SUPPLIER or SUBCONTRACTOR	CONTRACTOR
By: _____	By: _____
President	President
Date: _____	Date: _____

NOTICE TO PROCEED

TO: _____

PROJECT: **2015 Raw Lift Station Improvement Project**

OWNER: Town of Telluride, Colorado

AGREEMENT DATE: _____

You are hereby notified that the Purchase Order for the above Contract has been issued; therefore the Contract Time under the above Agreement will commence to run on _____, 2015. On that date, you are to begin performing the Work in accordance with the Contract Documents and you are to complete the Work within ___ Contract Days thereafter. The date of Substantial Completion of all Work is therefore _____, 2015.

TOWN OF TELLURIDE, COLORADO

BY: _____

TITLE: _____

DATE: _____

Receipt of the above Notice to Proceed is hereby acknowledged.

CONTRACTOR

BY: _____

TITLE: _____

DATE: _____

CONSENT OF SURETY

TO: Town of Telluride Colorado

CONTRACTOR: _____

PROJECT: **2015 Raw Lift Station Improvement Project**

CONTRACT DATE: _____

In accordance with the provisions of the Contract between the OWNER and the CONTRACTOR as indicated above, for _____ on bond of (Surety) _____
_____
_____
hereby approves of the Final Payment to the CONTRACTOR, and agrees that the Final payment to the CONTRACTOR shall not relieve the Surety Company of any of its obligations to the OWNER, as set forth in the said Surety Company's Bond.

IN WITNESS WHEREOF, the Surety Company has hereunto set in hand this _____day of _____, 20__.

(Surety Company)

By: _____

ATTACH: Power of Attorney and Certificate of Authority of Attorney(s)-in-Fact.

FINAL INSPECTION REPORT

DATE: _____, 20__
TO: _____

PROJECT: **2015 Raw Lift Station Improvement Project**

OWNER: Town of Telluride, Colorado

The ENGINEER has performed final inspection of the Work, and accepts the Work subject to the Contractor's performance and completion of the following repairs, corrections and/or replacements:

_____

_____

_____

_____

_____

_____

_____

_____

The ENGINEER does/does not (circle) hereby finally accept the Work, and the ENGINEER does/does not (circle) hereby certify that the Contractor is eligible to receive final payment of the Work.

TOWN OF TELLURIDE, COLORADO	CONTRACTOR(S)
BY: _____	BY: _____
TITLE: ENGINEER	TITLE:_____
DATE: _____	DATE:_____

WARRANTY PERIOD INSPECTION REPORT

DATE: _____, 20__
TO: _____

PROJECT: **2015 Raw Lift Station Improvement Project**

OWNER: Town of Telluride, Colorado

The ENGINEER has performed final inspection of the Work, and accepts the Work subject to the Contractor's performance and completion of the following repairs, corrections and/or replacements:

_____

_____

_____

_____

_____

_____

_____

_____

The ENGINEER does/does not (circle) hereby finally accept the Work and an end to the Warranty Period. The ENGINEER does/does not (circle) hereby certify that the Labor and Performance Bond secured for this project be released.

TOWN OF TELLURIDE, COLORADO	CONTRACTOR(S)
BY: _____	BY: _____
TITLE: ENGINEER	TITLE:_____
DATE: _____	DATE:_____

PERFORMANCE BOND

1. **KNOW ALL MEN BY THESE PRESENTS, THAT:**

_____
(name)

_____
(address)

as Principal, hereinafter called Principal, and

_____
(surety name)

_____,
(surety address)

a corporation organized and existing under the laws of the State of _____ and AUTHORIZED TO DO BUSINESS WITHIN THE STATE OF COLORADO, as Surety, hereinafter called Surety, are held firmly bound unto the TOWN OF TELLURIDE, COLORADO as Obligee, hereinafter called the Obligee, in the amount of:

_____ Dollars ($ _____), lawful money of the United States of America, together with interest as may be provided by law, for the payment whereof Principal and Surety bind themselves, their heirs, executors, successors and assigns, jointly and severally, firmly by these presents.

2. **WHEREAS,** Principal and the Obligee have entered into a contract dated the _____ day of _____, 20__ for the following Project:

2015 Raw Lift Station Improvement Project

which contract is by reference made a part hereof, and is hereafter referred to as the Contract.

3. **NOW THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH THAT**, if the Principal shall promptly, and faithfully perform all terms, conditions and other obligations of the Contract, and any modifications or extensions thereof granted by the Obligee, then this obligation shall be null and void; otherwise this obligation shall remain in full force and effect.

4. The Surety for value received agrees that no extension of time, change in, addition to, or other alteration or modification of the terms, conditions or obligations of the Contract or work to be performed thereunder, or any forbearance on the part of either the Obligee or the Principal to the other shall in any way release or affect the Surety's liability or obligation on this Bond, and the surety hereby waives notice of any such extension of time, change, addition, modification, alteration or forbearance.

Signed and sealed on the dates set forth below.

_____ FOR: _____
(witness) (Principal's Name)

BY: _____

(seal) ITS: _____

this ___ day of _____, 20__

_____ FOR: _____
(witness) (Surety's Name)

BY: _____

(seal) ITS: _____

this ___ day of _____, 20__

BOND# _____

This Bond (___ is) (___ is not) a SBA Guaranteed Bond.

LABOR AND MATERIAL PAYMENT BOND

1. **KNOW ALL MEN BY THESE PRESENTS, THAT:**

_____
(name)

_____
(address)

as Principal, hereinafter called Principal, and

_____
(surety name)

_____,
(surety address)

a corporation organized and existing under the laws of the State of _____ and AUTHORIZED TO DO BUSINESS WITHIN THE STATE OF COLORADO, as Surety, hereinafter called Surety, are held firmly bound unto the TOWN OF TELLURIDE, COLORADO as Obligee, hereinafter called the Obligee, for the use and benefit of claimants as hereinbelow defined, in the amount of

_____ Dollars ($ _____), lawful money of the United States of America, together with interest as may be provided by law, for the payment whereof Principal and Surety bind themselves, their heirs, executors, successors and assigns, jointly and severally, firmly by these presents.

2. **WHEREAS,** Principal and the Obligee have entered into a contract dated the _____ day of _____, 20__ for the following (project):

2015 Raw Lift Station Improvement Project

which contract is by reference made a part hereof, and is hereafter referred to as the Contract.

3. **NOW THEREFORE, THE CONDITION OF THIS OBLIGATION** is such that, if the Principal shall promptly make payments of all amounts lawfully due to all persons supplying or furnishing the Principal or the Principal's subcontractors with labor, materials, rental machinery, tools or equipment used or performed in the prosecution of the work provided for in the Contract; and if the Principal shall indemnify and save harmless the Obligee to the extent of any payments in connection with the carrying out of the Contract which the Obligee may be required to pay under the law, all in accord with Colorado State Law, Section 38-26-105 C.R.S., then this obligation shall be null and void; otherwise this obligation shall remain in full force and effect.

AND FURTHER, should the Principal or the Principal's subcontractors fail to duly pay for any labor, materials, team hire, sustenance, provisions, provender, or other supplies used or consumed by the Principal or the Principal's subcontractors in the performance of the work contracted to be done or fails to pay any person who supplies rental machinery, tools or equipment, all amounts due as the result of the use of such machinery, tools, or equipment, in the prosecution of the work under the Contract, the Surety shall pay the same in an amount not exceeding the sum specified in this Bond together with interest at the rate of eight percent per annum, in accord with Colorado State Law, Section 38-26-106 C.R.S.

In accordance with Colorado State Law, Section 38-26-105 C.R.S., actions against the Principal and Surety under this Bond shall be brought within six months after the final completion of the Contract as defined by the ordinances, rules and regulations of the Town of Telluride and not afterwards.

4. The Surety for value received agrees that no extension of time, change in, addition to, or other alteration or modification of the terms, conditions or obligations of the Contract or work to be performed thereunder, or

any forbearance on the part of either the Obligee or the Principal to the other shall in any way release or affect the Surety's liability or obligation on this Bond, and the Surety hereby waives notice of any such extension of time, change, addition, modification, alteration or forbearance.

Signed and sealed on the dates set forth below.

_____	FOR: _____
(witness) (Principal's Name)	
	BY: _____
(seal)	ITS: _____
	this ___ day of _____, 20__
_____	FOR: _____
(witness)	(Surety's Name)
	BY: _____
(seal)	ITS: _____
	this ___ day of _____, 20__

BOND# _____

This Bond (___ is) (___ is not) a SBA Guaranteed Bond.

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

Contractor's Application for Payment No.

	Application Period:	Application Date:
To (Owner): Town of Telluride	From (Contractor):	Via (Engineer): JVA, Inc.
Project: 2015 Raw Lift Station Improvement Project	Contract:	
Owner's Contract No.:	Contractor's Project No.:	Engineer's Project No.: 1770.1c

Application For Payment

Change Order Summary

Approved Change Orders		
Number	Additions	Deductions
TOTALS		
NET CHANGE BY CHANGE ORDERS		

1. ORIGINAL CONTRACT PRICE..... $ _____

2. Net change by Change Orders..... $ _____

3. Current Contract Price (Line 1 ± 2)..... $ _____

4. TOTAL COMPLETED AND STORED TO DATE
(Column F on Progress Estimate)..... $ _____

5. RETAINAGE:

a. 5% X _____ Work Completed..... $ _____

b. 5% X _____ Stored Material..... $ _____

c. Total Retainage (Line 5a + Line 5b)..... $ _____

6. AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5c)..... $ _____

7. LESS PREVIOUS PAYMENTS (Line 6 from prior Application)..... $ _____

8. AMOUNT DUE THIS APPLICATION..... $ _____

9. BALANCE TO FINISH, PLUS RETAINAGE
(Column G on Progress Estimate + Line 5 above)..... $ _____

Contractor's Certification

The undersigned Contractor certifies that to the best of its knowledge: (1) all previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with Work covered by prior Applications for Payment; (2) title of all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to Owner at time of payment free and clear of all Liens, security interests and encumbrances (except such as are covered by a Bond acceptable to Owner indemnifying Owner against any such Liens, security interest or encumbrances); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

By:	Date:

Payment of: $ _____
(Line 8 or other - attach explanation of the other amount)

is recommended by: _____ _____
(Engineer) (Date)

Payment of: $ _____
(Line 8 or other - attach explanation of the other amount)

is approved by: _____ _____
(Owner) (Date)

Approved by: _____ _____
Funding Agency (if applicable) (Date)

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Progress Estimate - Lump Sum Work

Contractor's Application

For (Contract):	Application Number:
Application Period:	Application Date:

			Work Completed		E	F		G
A		B	C	D				
Specification Section No.	Description	Scheduled Value ($)	From Previous Application (C+D)	This Period	Materials Presently Stored (not in C or D)	Total Completed and Stored to Date (C + D + E)	% (F / B)	Balance to Finish (B - F)
	Totals							

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Progress Estimate - Unit Price Work

Contractor's Application

For (Contract):	Application Number:
Application Period:	Application Date:

A				B	C	D	E	F		
Item		Bid Item Quantity	Unit Price	Bid Item Value ($)	Estimated Quantity Installed	Value of Work Installed to Date	Materials Presently Stored (not in C)	Total Completed and Stored to Date (D + E)	% (F / B)	Balance to Finish (B - F)
Bid Item No.	Description									
	Totals									

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Stored Material Summary

Contractor's Application

For (Contract):								Application Number:			
Application Period:								Application Date:			
A		B	C		D		E	Subtotal Amount Completed and Stored to Date (D + E)	F		G
					Stored Previously				Incorporated in Work		
Bid Item No.	Supplier Invoice No.	Submittal No. (with Specification Section No.)	Storage Location	Description of Materials or Equpment Stored	Date Placed into Storage (Month/Year)	Amount ($)	Amount Stored this Month ($)		Date (Month/ Year)	Amount ($)	Materials Remaining in Storage ($) (D + E - F)
				Totals							

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CERTIFICATE OF SUBSTANTIAL COMPLETION

TO: _____

PROJECT: **2015 Raw Lift Station Improvement Project**

OWNER: Town of Telluride, Colorado

This Certificate of Substantial Completion applies to all Work under the Contract Documents or to the following specified parts thereof:

_____

_____

_____

_____

_____

_____

The Work to which this Certificate applies has been inspected by authorized representatives of the TOWN, and that Work is hereby declared to be substantially complete in accordance with the Contract Documents on

_____
DATE OF SUBSTANTIAL COMPLETION

A tentative list of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include an item in the list does not alter the responsibility of CONTRACTOR to complete all the Work in accordance with the Contract Documents. The items in the tentative list shall be completed or corrected by CONTRACTOR within 15 Contract days of the above date of Substantial Completion.

CONTRACTOR shall maintain all contractual responsibilities until Final Acceptance.

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

_____

_____

_____

_____

(For items to be attached see definition of Substantial Completion as supplemented and other specifically noted conditions precedent to achieving Substantial Completion as required by the Contract Documents.)

This certificate does not constitute an acceptance of Work or start of the guarantee period nor its release of CONTRACTOR'S obligation to complete the Work in accordance with the Contract Documents. Issuance of Substantial Completion does not commence the guarantee period with this certificate.

TOWN OF TELLURIDE, COLORADO	ACCEPTED BY CONTRACTOR(S)
BY: _____	BY: _____
TITLE: _____	TITLE: _____
DATE: _____	DATE: _____

GENERAL CONDITIONS

ARTICLE 1. DEFINITIONS

1.1 **Abnormal Weather**: Snowfall, rainfall, freezing temperatures, or wind conditions in excess of those encountered in the TOWN during the past 10 years that delay the Contractor's performance.

1.2 **Addenda**: Written or graphic instruments issued prior to the opening of Bids that clarify, correct or change the Bidding Requirements or the contract documents.

1.3 **Agreement**: The written contract between the TOWN and Contractor covering the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein.

1.4 **Application for Payment**: The form accepted by the TOWN and used by Contractor to request progress or final payments and accompanied by supporting documentation as is required by the contract documents.

1.5 **Bonds**: Performance and Payment bonds and other instruments of security.

1.6 **Change Order**: A document recommended by Project Manager, and signed by Contractor and the TOWN authorizing an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Times and issued on or after the Effective Date of the Agreement.

1.7 **Contract Day**: A Contract Day specifies that construction will be completed Monday through Friday, excluding Saturdays, Sundays, legal holidays and Abnormal Weather days.

1.8 **Contract Documents**: The Agreement and all documents specified in the Agreement as constituting the contract documents.

1.9 **Contract Price**: The moneys payable by the TOWN to Contractor for completion of the Work in accordance with the Contract Documents (subject to the provisions of these General Conditions applicable to Unit Price Work).

1.10 **Contract Times**: The numbers of days or the dates stated in the Agreement: (i) to achieve Substantial Completion, and (ii) to complete the Work so that it is ready for final payment as evidenced by Project Manager's written recommendation of final payment.

1.11 **Contractor**: The person, firm or corporation with whom the TOWN has entered into the Agreement, and it's duly authorized agents.

1.12 **Defective**: Work that is unsatisfactory, faulty or deficient, not conforming to the contract documents, or not meeting the requirements of any inspection, reference standard, test or approval referred to in the contract documents, or has been damaged prior to Project Manager's recommendation of final payment (unless responsibility for the protection thereof has been assumed by the TOWN at Substantial Completion).

1.13 **Drawings**: The drawings referred to in the Contract Documents which show the scope, extent and character of the Work to be furnished and performed by Contractor and which have been prepared or approved by the TOWN. Shop drawings are not Drawings as so defined.

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

1.15 **Field Order**: A written order issued by Project Manager that orders minor changes in the Work but does not involve a change in the Contract Price or the Contract Times.

1.16 **Hazardous Waste**: The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended.

1.17 **Laws and Regulations (or Laws or Regulations)**: Any and all applicable laws, rules, regulations, ordinances, codes and orders of any and all governmental bodies, agencies, authorities and courts having jurisdiction over the project.

1.18 **Legal Holidays**: Those days observed by the Town of Telluride (Memorial Day, Fourth of July, Labor Day, Thanksgiving, etc.)

1.19 **Liens**: Liens, charges, security interests or encumbrances upon real property or personal property.

1.20 **Milestone**: A principal event specified in the Contract Documents relating to an intermediate completion date.

1.21 **Notice of Award**: The written notice by the TOWN 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 TOWN will sign and deliver the Agreement.

1.22 **Notice to Proceed**: A written notice given by the TOWN to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform Contractor's obligations under the contract documents.

1.23 **Partial Utilization**: Use by the TOWN of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion of all the Work.

1.24 **Plans**: The term plans as used in the Contract Documents shall have the same meaning as Drawings.

1.25 **Product**: Includes materials, equipment and systems.

1.26 **Project**: The total construction of the work to be provided under the Contract Documents or a part as indicated elsewhere in the contract documents.

1.27 **Project Manager**: The Public Works Director, or authorized representative of such person.

1.28 **Provide**: Furnish and install specified materials and equipment, unless the context requires otherwise.

1.29 **Regular Working Hours**: 8:00 am to 6 p.m., Monday through Friday.

1.30 **Samples**: Physical examples of materials, equipment, or workmanship that represent some portion of the Work and which establish the standards by which such portion of the Work will be judged.

1.31 **Shop Drawings**: All drawings, diagrams, illustrations, schedules and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work.

1.32 **Specifications**: Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

1.33 **Subcontractor**: An individual, firm or corporation having a direct contract with Contractor or with any other Subcontractor for the performance of work at the site.

1.34 **Substantial Completion**: The Work (or a specified part thereof) has progressed to the point where, in the opinion of the TOWN as evidenced by the TOWN's definitive certificate of Substantial Completion, 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; or if no such certificate is issued, when the Work is complete and ready for final payment as evidenced by the TOWN's written recommendation of final payment.

1.35 **Supplementary Conditions**: The part of the Contract Documents that amends or supplements these General Conditions.

1.36 **Supplier**: A manufacturer, fabricator, supplier, distributor, material man or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the work.

1.37 **TOWN**: Shall mean the Town of Telluride, Colorado, and its duly authorized agents. Except as otherwise specified in the Contract Documents. The TOWN's Project Manager shall perform the responsibilities of the TOWN as provided for in these General Conditions.

1.38 **Town's Project Manager**: The Public Works Director or authorized representative of such person.

1.39 **Underground Facilities**: All pipeline, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities that have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems or water.

1.40 **Work**: All permitting, and construction, or the various separately identifiable parts thereof, required to be furnished under the contract documents. Work includes and is the result of performing or furnishing labor, furnishing and incorporating materials and equipment into the construction, performing or furnishing services, and furnishing documents, all as required by the contract documents**.**

1.41 **Work Change Directive**: A written directive to Contractor, issued on or after the Effective Date of the Agreement and signed by the TOWN and recommended by Project Manager, ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen physical conditions under which the Work is to be performed as provided in paragraph 4.1 or 4.2 or emergencies under paragraph 6.29. A Work Change Directive will not change the Contract Price or the Contract Times, but is evidence that the parties expect that the change directed or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times as provided in these General Conditions.

1.42 **Written Amendment**: A written amendment of the Contract Documents, signed by the TOWN and Contractor on or after the Effective Date of the Agreement and normally dealing with the non-engineering or non-technical rather than strictly construction-related aspects of the Contract Documents.

ARTICLE 2. PRELIMINARY MATTERS

2.1 **Delivery of Insurance:** Insurance certifications shall be delivered prior to commencing project construction.

2.2 **Pre-work Conference:** A pre-construction conference will be held.

2.2.1 CONTRACTOR shall participate in the conference accompanied by all major Subcontractors.

2.2.2 CONTRACTOR shall designate/introduce the Construction Superintendent and major Subcontractors' supervisors assigned to the project.

2.2.3 CONTRACTOR shall submit in writing proposed daily construction hours to TOWN for approval.

2.2.4 The PROJECT MANAGER must review and approve any proposals for on-site staging.

2.2.5 Contractor shall submit a Construction Mitigation Plan, as required by Town Ordinance No. 1063, to the PROJECT MANAGER for review at the Pre-construction Meeting.

2.2.6 The PROJECT MANAGER shall invite all utility companies involved in the Work.

2.2.7 The Utilities will be asked to designate their coordination person, provide utility plans, and their anticipated schedules.

2.3 **Initially Acceptable Schedules—Monthly Progress Reports**

2.3.1 During the construction phase of the project, unless otherwise provided in the Contract Documents, at least seven (7) days before submission of the first Application for Payment, the Contractor, Project Manager and others as appropriate will hold a conference to review the Application for Payment. No progress payment shall be made to Contractor until the progress schedule is submitted to and accepted by the Project Manager as provided herein. The progress schedule provides an orderly progression of the work through to a specific completion date, with specified milestones and contract times, and shall be in content and format acceptable to the Project Manager. Such acceptance will neither impose on the Project Manager responsibility for sequencing, scheduling or progress of the Work, nor interfere with or relieve the Contractor's full responsibility therefor. The Contractor's schedule of Shop Drawing and Sample submissions shall provide a workable arrangement for reviewing and processing the required submittals, and shall be acceptable to the Project Manager.

2.3.2 The Contractor shall prepare a monthly progress report for the project in a form, in sufficient detail, and of a character approved by the TOWN. The progress report shall specify an estimated percentage of completion (including percentage of completion of each activity and event shown on the progress schedule), whether the project is on schedule and, if not, the reasons therefore, any proposed adjustments to the schedule and the Work anticipated to be completed in the succeeding month.

2.4 **Figured Dimensions to Govern:** Dimensions and elevations indicated on the drawings shall be accurately followed even if different from scaled measurements. No work indicated on the drawings, the dimensions of which are not indicated, shall be executed until necessary dimensions have been obtained from the TOWN.

ARTICLE 3. CONTRACT DOCUMENTS—INTENT, AMENDING, REUSE

3.1 **Intent:** The Contract Documents comprise the entire agreement between the TOWN and 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 laws of the State of Colorado.

3.2 It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work, 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 will be furnished and performed whether or not specifically called for. When words or phrases that have a well-known technical or construction industry or trade meaning are used to describe the Work, materials or equipment, such words or phrases shall be interpreted in accordance with that meaning. The TOWN will issue clarifications and interpretations of the Contract Documents as provided in these General Conditions.

3.3 **Reference to Standards & Specifications of Technical Societies—Reporting and Resolving Discrepancies**

3.3.1 Reference to standards, 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 Effective Date of the Agreement, except as may be otherwise specifically stated in the Contract Documents.

3.3.2 If, during the performance of 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 the TOWN in writing at once. Contractor shall not proceed with the Work affected thereby (except in an emergency) until an amendment or supplement to the Contract Documents has been issued. Upon notification to the TOWN, CONTRACTOR shall proceed with other parts of the Work not affected by the conflict, error, ambiguity or discrepancy.

3.3.2 Except as otherwise specifically stated in the Contract Documents or as may be provided by amendment or supplement thereto, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the provisions of the Contract Documents and

3.3.2.1 the provisions of any standard, specification, manual, code or instruction (whether or not specifically incorporated by reference in the contract documents); or

3.3.2.2 the provisions of any laws or regulations applicable to the performance of Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such law or regulation).

3.4 No provision of any standard, specification, manual, code or instruction shall be effective to change the duties and responsibilities of the TOWN, CONTRACTOR, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents. Nor shall it be effective to assign to the TOWN any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with any provision of the Contract Documents.

3.5 Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "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 TOWN as to the Work, it is intended that such requirement, direction, review or judgment will be solely to evaluate, in general, the completed Work for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Work as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to the TOWN 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 any provisions of the Contract Documents.

3.6 **Amending and Supplementing Contract Documents:** The Contract Documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways:

3.6.1 Formal Written Amendment
3.6.2 Change Order

3.7 In addition, requirements of the Contract Documents may be supplemented and minor variations and deviations in Work may be authorized, in one or more of the following ways:

3.7.1 Field Order
3.7.2 Project Manager's written interpretation or clarification

3.8 **Reuse of Documents:** Contractor, and any Subcontractor or Supplier or other person or organization performing or furnishing any of the Work under a direct or indirect contract with the TOWN (i) shall not have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents (or copies thereof) prepared by or bearing the seal of an Engineer or an Engineer's Consultant, and (ii) shall not reuse any of such Drawings, Specifications, other documents or copies on extensions of the Project or any other project without written consent of the TOWN and specific written verification or adaptation by Project Manager.

ARTICLE 4. AVAILABILITY OF LANDS – SUBSURFACE AND PHYSICAL CONDITIONS

4.1 **Availability of Lands:** The TOWN shall furnish, as indicated in the Contract Documents, the lands upon which Work is to be performed, rights-of-way and easements for access thereto, and such other lands which are designated for the use of Contractor. If the TOWN is not the owner of such lands, the TOWN is responsible for obtaining the required permission and/or easement to accomplish the Work. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by the TOWN, unless otherwise provided in the Contract Documents. If Contractor and the TOWN are unable to agree on entitlement to or the amount or extent of any adjustments in the Contract Price or the Contract Times as a result of any delay in the TOWN's furnishing these lands, rights-of-way or easements, Contractor may make a claim there for. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.2 **Subsurface and Physical Conditions:** The Contractor is responsible for examining and determining for itself the location and nature of the proposed Work, the amount and character of the labor and materials required there for, and the difficulties which may be encountered. The Contractor may not rely on oral or written representations made by the TOWN, including reports and drawings, unless the TOWN has guaranteed in writing that such representation is factually accurate, and by submitting its Bid, Contractor waives all liability for any error in any representation made by the TOWN to Contractor. Contractor shall inspect the site and its surroundings and conduct such supplementary examinations, investigations, and tests concerning conditions at or contiguous to the site (including surface and subsurface) which may affect cost, progress, performance, or furnishing of the Work or which relate to any aspect of the means, methods, techniques, sequences, or procedures of construction to be employed by Contractor and safety precautions and programs incident thereto for performing the Work in accordance with the Contract Documents. By failing to make such an inspection, the Contractor waives all rights to claim extra payment or time extensions due to unexpected conditions, which could have been determined had the site been reasonably inspected. If concealed or unknown conditions differ materially from those ordinarily encountered and generally recognized as inherent in the Work, or differ materially from the conditions indicated in the contract documents, then an equitable adjustment in the Contract Price or in the Contract Time will be allowed by change order as provided in Article 10 or Article 11 respectively. By submitting its Bid, the Contractor represents that the Contractor's observations at the site are not inconsistent with the requirements of the proposed Contract Documents, unless otherwise noted by the Contractor.

4.2.1 **Limited Reliance by Contractor Authorized-Technical Data:** Reports and drawings are not Contract Documents. Unless otherwise set forth in the Contract Documents, or the TOWN has otherwise guaranteed in writing that such representation is factually accurate, Contractor may not rely upon or make any claim against the TOWN with respect to the accuracy of any "technical data" contained in reports and drawings and Contractor may not rely upon or make any claim against the TOWN with respect to the following:

4.2.1.1 The completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto;

4.2.1.2 Other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

4.2.1.3 Any Contractor interpretation of or conclusion(s) drawn from, any "technical data" or any such data, interpretations, opinions or information.

4.2.2 Contractor shall not be entitled to any adjustment in the Contract Price or Times if:

4.2.2.1 Contractor knew of the existence of such conditions at the time Contractor made a final commitment to the TOWN with respect to Contract Price and Contract Times by the submission of a bid or becoming bound under a negotiated contract; or

4.2.2.2 The existence of such conditions could reasonably have been discovered or revealed as a result of an examination, investigation, exploration, test or study of the site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such final commitment. CONTRACTOR is responsible for investigating the existence of any subsurface mine waste or any other mining related material, and accepts responsibility for mitigation required in the event that it is encountered as part of the project.

4.2.3 If the TOWN and Contractor are unable to agree on entitlement to or as to the amount or length of any equitable adjustment in the Contract Price or Contract Times, a claim may be made there for. However, the TOWN shall not be liable to Contractor for any claims, costs, losses or damages sustained by Contractor on or in connection with any other project or anticipated project.

4.3 **Physical Conditions - Underground Facilities:**

0.3.1 **Shown or Indicated:** The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the site is based on information and data furnished to the TOWN by the owners of such Underground Facilities or by others.

0.3.1.1 The TOWN shall not be responsible for the accuracy or completeness of any such information or data; and

0.3.1.2 The cost of all of the following will be included in the Contract Price and Contractor shall have full responsibility for: (i) reviewing and checking all such information and data, (ii) locating all Underground Facilities shown or indicated in the Contract Documents, (iii) coordination of the Work with the owners of such Underground Facilities during construction, and (iv) the safety and protection of all such Underground Facilities as provided in these General Conditions, and repairing any damage thereto resulting from the Work.

0.3.2 **Not Shown or Indicated:** If an Underground Facility is uncovered or revealed at or contiguous to the site which was not shown or indicated in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by paragraph 6.29), identify the owner of such Underground Facility and give written notice to that owner and to the TOWN. Contractor shall be responsible for the safety and protection of such Underground Facility as provided in these General Conditions. Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, to the extent that they are attributable to the existence of any Underground Facility that was not shown or indicated in the Contract Documents and that Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated. If the TOWN and Contractor are unable to agree on entitlement to or the amount or length of any such adjustment in Contract Price or Contract Times, Contractor may make a claim therefor as provided in Articles 10 or 11. However, the TOWN, Project Manager and Project Manager's Consultants shall not be liable to Contractor for any claims, costs, losses or damages incurred or sustained by Contractor on or in connection with any other project or anticipated project.

0.4 **Hazardous Waste or Radioactive Material:** The Contractor agrees to comply with all present and future applicable laws and regulations affecting land, water, air, and the products thereof, which are now or may become applicable to operations covered by this Agreement or arising out of the performance of such operations. The Contractor shall not cause or allow, in connection with the Work hereunder, the discharge, emission, release, or escape of any hazardous or toxic substance and/or waste, pollutant, contaminant or other substance including asbestos or PCBs or other hazardous substance, including those defined in 42 U.S.C. Section 9601(14)(hereinafter all called "contaminated media") in violation of any laws or regulations, and shall pay for all costs and damages incurred as a result thereof. The Contractor agrees to report to the Project Manager (and to all appropriate governmental authorities if caused or allowed by the Contractor) immediately

all accidents or occurrences resulting in actual or threatened damage to the Work site or to the environment by contaminated media, including discovery of accidents or occurrences in which contaminated media are or may be encountered, or which results in contaminated media. The Contractor shall stop Work immediately upon encountering any contaminated media or potentially contaminated media and shall thereafter, upon the Project Manager's written directive, proceed as directed by the Project Manager.

ARTICLE 5 - CONTRACTOR'S RESPONSIBILITIES

5.1 **Labor:** CONTRACTOR shall provide competent, suitably qualified personnel to design, survey, lay out, and construct the Work as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the site. Except as otherwise required for the safety or protection of persons or the Work or property at the site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the site shall be performed in accordance with applicable local ordinances.

5.2 **Materials and Equipment:** All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. All guarantees specifically called for shall expressly run to the benefit of the TOWN. If required by the TOWN, the Contractor shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with instructions of the applicable Supplier, except as otherwise provided in the contract documents.

5.3 **Substitutes and "Or-Equal" Items:**

5.3.1 Whenever material(s) or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function and quality required. Unless the specification or description contains or is followed by words indicating that no like, equivalent or "or-equal" item or no substitution is permitted, other items of material or equipment of other Suppliers may be accepted by Project Manager under the following circumstances.

5.3.1.1 **"Or-Equal":** If in the TOWN's sole discretion an item of material or equipment proposed by the Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by the TOWN as an "or-equal" item, in which case review and approval of the proposed item may, in the TOWN's sole discretion, be accomplished without compliance with some or all of the requirements for acceptance of proposed substitute items.

5.3.1.2 **Substitute Items:** If in the TOWN's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item, it will be considered a proposed substitute item. The Contractor shall submit sufficient information as will allow TOWN to determine whether the proposed item of material or equipment is essentially equivalent to that named and an acceptable substitute there for. The procedure for review by the TOWN will include the requirements of this paragraph and such additional requirements the TOWN decides as appropriate under the circumstances. Only the Contractor may request review of proposed substitute items of material or equipment to the TOWN. If the Contractor wishes to furnish or use a substitute item of material or equipment, the Contractor shall first make written application to the TOWN for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar in substance to that specified, and be suited to the same use as that specified. The application will state the extent, if any, to which the evaluation and acceptance of the proposed substitute will prejudice the Contractor's achievement of Substantial Completion on time, whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with the TOWN for work on the Project) to adapt the design to the proposed substitute and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty. All variations of the

proposed substitute from that specified will be identified in the application, and available maintenance, repair and replacement service will be indicated. The application will also contain an itemized estimate of all costs or credits that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which will be considered by the TOWN in evaluating the proposed substitute. The TOWN may require the CONTRACTOR to furnish additional data about the proposed substitute.

5.3.2 **Contractor's Expense:** All data required by Contractor to support a proposed "or-equal" or substitute item will be obtained at the Contractor's expense.

5.3.3 **Substitute Construction Methods or Procedures:** If a specific means, method, technique, sequence or procedure of construction is shown or indicated in and expressly required by the Contract Documents, the Contractor may furnish or use a substitute means, method, technique, sequence or procedure of construction, if acceptable to the TOWN. Contractor shall submit sufficient information to allow the TOWN, in its sole discretion, to determine whether the substitute proposed is equivalent to that expressly called for by the Contract Documents.

5.3.4 **Town's Evaluation:** The TOWN will be allowed a reasonable time for evaluating each proposal or submittal made. The TOWN will be the sole judge of acceptability. No "or-equal" or substitute will be ordered, installed or used without the Town's prior written acceptance evidenced by a Change Order, with an approved Drawing when appropriate. The TOWN may require the Contractor to furnish, at the Contractor's expense, a special performance guarantee or other surety with respect to any "or-equal" or substitute. TOWN will record the time required to evaluate substitutes proposed or submitted by Contractor and in making changes in the Contract Documents (or in the provisions of any other direct contract with the TOWN for work on the Project) occasioned thereby.

5.4 **Subcontractors, Suppliers and Others:**

5.4.1 Prior to employing any Subcontractor, Supplier or other person or organization, whether initially or as a substitute, CONTRACTOR shall consider any reasonable objection posed by the TOWN.

5.4.2 The Contractor shall be fully responsible to the TOWN for all acts and omissions of the Subcontractors, Suppliers, and other persons and organizations, whether performing or furnishing any of the Work under a direct or indirect contract with the Contractor, in the same manner as the Contractor is responsible under the Contract Documents for Contractor's own acts and omissions. The TOWN may contact any Subcontractor, Supplier or other person or organization to determine the status of any payments due from the Contractor, may furnish to any such Subcontractor, Supplier or other person or organization evidence of amounts paid to Contractor in accordance with Contractor's Applications for Payment, and may (but is not required to) make joint check arrangements for the payment of any such Subcontractor, Supplier or other person or organization. Nothing in the Contract Documents shall create for the benefit of any such Subcontractor, Supplier or other person or organization any contractual relationship between the TOWN and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of the TOWN to pay or to see to the payment of any moneys due any such Subcontractor, Supplier or other person or organization.

5.4.3 Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under any direct or indirect contract with the Contractor. The Contractor shall require all Subcontractors, Suppliers and such other persons and organizations performing or furnishing any of the Work to communicate with the TOWN through the CONTRACTOR.

5.5 All Work performed for the Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between the Contractor and Subcontractor or Supplier, which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of these contract documents.

5.6 The CONTRACTOR shall cooperate with all other contractors who may be performing work on behalf of the TOWN and workers who may be employed by the TOWN in the vicinity of the work under this Agreement and shall conduct operations to minimize interference with the work of such contractors, or workers. Contractor shall promptly make good at the Contractor's own expense any injury or damage that results from the Contractor's work and is sustained by other contractors, employees of the TOWN, or others. Any difference or conflict that may arise between the Contractor and other contractors shall be resolved as determined by the TOWN. If the work of the Contractor is delayed because of any acts or omissions of any other contractor, the Contractor shall have no claim against the TOWN on that account other than an extension of time. If any part of the Contractor's work is dependent upon the quality and completeness of work performed under another contractor, the Contractor shall inspect the other contractor's work and promptly report defects therein which render such work unsuitable for the proper execution of the work under this contract. Failure to report such defects to the TOWN shall constitute the Contractor's acceptance of such work as suitable to receive the Contractor's work.

5.7 **Patent Fees and Royalties:** 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 TOWN its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by the TOWN in the contract documents. To the fullest extent permitted by laws and regulations, the Contractor shall indemnify and hold harmless the TOWN, its officers, employees, and agents from and against all claims, costs, losses and damages arising out of or resulting from 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.

5.8 **Permits:** Unless specified in writing by the TOWN, the CONTRACTOR is responsible for obtaining all required state or federal permitting and coordination. The Contractor shall obtain and pay for all permits and licenses relating to the Work, except for those required specifically by the Town. The Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable on the Effective Date of the Agreement. The Contractor shall pay all charges of utility owners for connections to the Work, and the TOWN shall pay all charges of such utility owners for capital costs related to the work such as plant investment fees.

5.8.1 Prior to the commencement date for the Work set forth in the Notice to Proceed, the Contractor and all subcontractors shall be or shall become licensed in accordance with all applicable laws and regulations.

5.8.2 The Town shall provide water necessary for all planting, irrigation and maintenance related to this project, if a part of the scope.

5.8.3 Contractor shall obtain a Right-of-Way Permit from the TOWN for all Work to be completed within a TOWN right-of-way.

5.9 **Taxes:** 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 Work which are applicable during the performance of the Work. The Contractor shall apply for and receive a Certificate of Exemption from the Colorado Department of Revenue and, if required by the Supplementary Conditions, from the TOWN, for construction materials to be physically incorporated into the Work. Pursuant to such Certificate of Exemption, the Contractor shall neither pay nor include in estimated costs any Sales and Use Taxes on construction materials physically incorporated into the Work. Sales and Use Taxes of the State of Colorado and the County are collected by the State of Colorado. All applicable Sales and Use Taxes (including State collected taxes) on any items other than construction materials physically incorporated into the Work are to be paid by the Contractor. Contractor and any Subcontractor assume all liability for the nonpayment of taxes, or the payment

of exempt taxes resulting from a failure to obtain or use the Certificate of Exemption required by this paragraph.

5.10 **Use of Premises:** Contractor shall confine construction equipment, the storage of materials and equipment and the operations of workers to the site, land, areas identified in and permitted by the Contract Documents, other land and areas permitted by laws and regulations, rights-of-way, permits and easements, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof or of any adjacent land or areas, resulting from the performance of the Work.

5.11 During progress of the Work, Contractor shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the Work. Upon completion of the Work, Contractor shall remove all waste materials, rubbish and debris from and about the premises as well as all tools, appliances, construction equipment and machinery and surplus materials. The Contractor shall leave the site clean and ready for occupancy by the TOWN at Substantial Completion of the Work. The Contractor shall restore to original condition all property not designated for alteration by the Contract Documents.

5.12 **Record Documents:** The Contractor shall maintain in a safe place at the site one record copy of all Construction Drawings, Written Amendments, Change Orders, Field Orders and written interpretations and clarifications (issued pursuant to these General Conditions) in good order and annotated to show all changes made during construction. These record documents will be available to the TOWN for reference and shall be given to the TOWN for its files upon completion of the Work.

5.13 **Safety and Protection:** The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. The Contractor shall take all reasonable safety precautions and provide all reasonable protection to prevent damage, injury, or loss to:

5.13.1 All employees at the work site and all other persons affected by the work;
5.13.2 All materials and equipment in the care, custody, or control of the Contractor or subcontractor, whether stored on or off the work site;
5.13.3 All Work;
5.13.4 All property at the site including walks, pavements, roadways, structures and utilities, and all neighboring property which may be affected by the Work; and
5.13.5 All plant materials including without limitation grasses, trees, and shrubs except where specifically identified for removal.

5.14 Contractor shall repair or replace any damage, injury, or loss to all public or private property caused directly or indirectly, in whole or in part, by the Contractor or any subcontractor or their employees or agents or anyone directly or indirectly employed by them or anyone for whose acts any one of them may be responsible. The Contractor shall give all notices and comply with all applicable laws bearing on the safety of persons or property or their protection from damage, injury, or loss.

5.15 Contractor shall take all measures necessary to mitigate the impact of weather so that the Work may continue on schedule. In no event shall the TOWN be liable for extra costs incurred on materials and any part of the Work due to Contractor's failing to take all measures necessary to protect the Work from weather, and Contractor shall not be entitled to such claims. Also, no extension of the Contract Time shall be allowed if the Contractor is able, notwithstanding weather, to proceed with other Work under the Agreement.

5.16 Contractor shall satisfy all environmental quality standards imposed by laws and regulations and take reasonable steps to minimize environmental impact(s) of the Work. These environmental quality standards include, without limitation, noise control, air pollution control, water pollution control, and dust control, which may be placed at risk by the activities of the Contractor. Contractor shall not burn any trash, rubbish, or other materials, except as specifically permitted by law. Should the Contractor or its subcontractors fail to satisfy environmental quality standards, the TOWN shall have the right to employ outside assistance, TOWN employees, or a private contractor to provide control and clean up, as needed. All such costs may be deducted from any payment due to the Contractor or charged to the Contractor directly.

5.17 **Emergencies:** In emergencies affecting the safety or protection of persons or the Work or property at the site or adjacent thereto, the Contractor, without special instruction or authorization from the TOWN, is obligated to act to prevent threatened damage, injury or loss. The Contractor shall give the TOWN prompt written notice if the Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby. If the TOWN determines that a change in the Contract Documents is required because of the action taken by the Contractor in response to such an emergency, a Change Order will be issued to document the consequences of such action.

5.18 **Construction Drawings:**

5.18.1 After checking and verifying all field measurements, the Contractor shall submit to the TOWN for review and approval in accordance with the accepted schedule, two (2) copies of all drawings, which shall have been checked and approved by the Contractor. The data shown on the Construction Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to show the TOWN all materials and equipment the Contractor proposes to provide and enable the TOWN to review the information.

5.18.2 When requested by the TOWN, the Contractor shall submit Samples of proposed construction materials for review and approval in accordance with the accepted schedule. Each Sample will be identified clearly as to material, Supplier, pertinent data such as catalog numbers, and the use for which intended to enable TOWN to review the submittal.

5.19 **Submittal Procedures:**

5.19.1 Before submitting each Sample, the Contractor shall have determined and verified:

5.19.1.1 all field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar information with respect thereto;

5.19.1.2 all materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the Work; and

5.19.1.3 all information relative to the Contractor's sole responsibilities with respect to means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto.

5.19.2 Contractor shall have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the contract documents.

5.19.3 Each submittal will bear a stamp or specific written indication that the Contractor has satisfied it’s obligations under the Contract Documents with respect to its review and approval of that submittal.

5.19.4 At the time of each submission, the Contractor shall give TOWN written notice of any variations that a Sample submitted may have from the requirements of the Contract Documents. The notice will be a written communication separate from the specific notations that the Contractor shall also make on each Construction Drawing and Sample submitted to TOWN for review and approval of each such variation.

5.20 TOWN will review and approve Samples in accordance with the schedule. The Town’s review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project. The Project Manager's review and approval will not extend to means, methods, techniques, sequences or procedures of construction (except where a particular means, method, technique, sequence or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the whole in which the item functions. Contractor shall make corrections required by TOWN, and shall return the required number of corrected copies for review and approval. The Contractor

shall direct specific attention in writing to revisions other than the corrections called for by TOWN on previous submittals.

5.21 TOWN's review and approval of Samples shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has in writing called the TOWN's attention to each such variation at the time of submission and the TOWN has given written approval of each such variation by specific written notation incorporated in or accompanying the Sample approval.

5.22 Where a Shop Drawing or Sample is required by the Contract Documents or the schedule accepted by the TOWN, any related Work performed prior to TOWN's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

5.23 **Continuing the Work:** The Contractor shall carry on the Work and adhere to the progress schedule during all disputes or disagreements with the TOWN. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as the TOWN and Contractor may otherwise agree in writing.

5.24 **Contractor's General Warranty and Guarantee:**

5.24.1 The CONTRACTOR warrants and guarantees to the TOWN that all Work will be in accordance with the Contract Documents and will not be defective. The Contractor's warranty and guarantee hereunder excludes defects or damage caused by (i) abuse, modification or improper maintenance or operation by persons other than Contractor, Subcontractors or Suppliers; or (ii) normal wear and tear under normal usage.

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

5.24.2.1 Observations by the TOWN;
5.24.2.2 Recommendation of any progress or final payment by TOWN;
5.24.2.3 Issuance of a Certificate of Substantial Completion or any payment by the TOWN to the Contractor under the Contract Documents;
5.24.2.4 Use or occupancy of the Work or any part thereof by the TOWN;
5.24.2.5 Any acceptance by the TOWN or any failure to do so;
5.24.2.6 Any review and approval of a Construction Drawing or Sample submittal or the issuance of a notice of acceptability by TOWN;
5.24.2.7 Any inspection, test or approval by others; or
5.24.2.8 Any correction of defective Work by the TOWN.

5.24.3 The Contractor warrants that, unless otherwise specified in the Contract Documents, the materials and equipment installed in the Work will be new, merchantable, and fit for the purpose for which they are intended, and that the Work will be performed in a workmanlike manner. The Contractor also warrants the workers who perform the Work will be sufficiently skilled to produce a high quality product.

5.24.4 The Contractor is under a continuing duty to warn the TOWN of any possible defect in the design of the Work and materials incorporated in the Work and against potentially unsafe uses of products incorporated in the Work which may cause personal injury or property damage, as soon as the Contractor discovers the possible defect or has notice that the product may be unsafe. The Contractor's duty under this paragraph shall be continuing, and shall not expire when the TOWN accepts the Work or when the Contractor's guarantee expires. If the Contractor fails to warn the Owner of a design or product defect of which the Contractor is aware, and if personal or property damage thereafter results from such design or product defect, the Contractor shall be liable jointly and severally with any other party responsible at law for all damages resulting from such defect.

5.25 **Survival of Obligations:** All representations, indemnifications, warranties and guarantees 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 and termination or completion of the Agreement.

5.26 **Preservation of Monuments and Stakes:** The Contractor shall carefully preserve all monuments, benchmarks, property pins, reference points, stakes, and offsets. The Contractor will be charged the expense of replacing any such items destroyed and shall be responsible for any mistake or loss of time that may be caused. Permanent monuments or benchmarks that must be removed or disturbed shall be protected until they can be properly referenced for relocation. The Contractor shall furnish materials and assistance for properly replacing such monuments or benchmarks, but a licensed surveyor shall complete the actual replacement.

ARTICLE 6. OTHER WORK

6.1 **Related Work at Site:** The TOWN may perform other work related to the Work at the site by TOWN's own forces, or let other direct contracts there for which shall contain General Conditions similar to these, or have other work performed by utility owners. If the fact that such other work is to be performed was not noted in the contract documents, then: (i) written notice thereof will be given to Contractor prior to starting any such other work, and (ii) Contractor may make a claim there for if Contractor believes that such performance will involve additional expenses to the Contractor or requires additional time and the parties are unable to agree as to the amount of extend thereof.

6.2 The Contractor shall afford each other contractor who is a party to such a direct contract and each utility owner (and TOWN, if TOWN is performing the additional work with TOWN'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 connect and coordinate the Work with theirs. Unless otherwise provided in the Contract Documents, the Contractor shall do all cutting, fitting and patching of the Work that may be required to make its several parts come together properly and 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 TOWN and the others whose work will be affected. The duties and responsibilities of Contractor under this paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of Contractor is said direct contracts between TOWN and such utility owners and other contractors.

6.3 If the proper execution or results of any part of Contractor's work depends upon work performed by others under this Article 6, the Contractor shall inspect such other work and promptly report to the TOWN orally and in writing any delays, defects or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. The Contractor's failure so to report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent or non-apparent defects and deficiencies in such other work.

6.4 **Coordination:** The TOWN shall have sole authority and responsibility in respect to such coordination.

6.5 Should the CONTRACTOR cause damage to the Work or property of any separate contract at the site, or should any claim arising out of Contractor's performance of the Work at the site be made by any separate contractor against Contractor, TOWN, or any other person, Contractor shall promptly attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by arbitration or at law. Contractor shall, to the fullest extent permitted by laws and regulations, indemnify and hold TOWN, its officers, employees, and agents harmless from and against all claims, damages, losses and expenses (including, but not limited to, fees of engineers, architects, attorneys and other professionals and court and arbitration costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any separate contractor against TOWN to the extent based on a claim arising out of Contractor's performance of the Work. If Contractor is delayed in performing or furnishing Work by any act or neglect of a separate contractor and TOWN and Contractor are unable to agree as the extent of any adjustment in Contract Time attributable thereto, Contractor may make a claim for an extension of time.

ARTICLE 7. CHANGES IN THE WORK

7.1 Without invalidating the Agreement and without notice to any surety, the TOWN may, at any time or from time to time, order additions, deletions or revisions to the Work by a Written Amendment or a Change Order. Upon receipt of any such document, the Contractor shall promptly proceed with the Work involved, which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

7.2 If the TOWN and Contractor are unable to agree as to the extent, if any, of an adjustment in the Contract Price or an adjustment of the Contract Times that should be allowed as a result of a Work Change Directive, a claim may be made there for.

7.3 Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any Work performed that is not required by the Contract Documents as amended, modified and supplemented except in the case of an emergency or in the case of uncovering Work.

7.4 The TOWN and Contractor shall execute appropriate Change Orders or Written Amendments recommended by TOWN covering:

7.4.1 Changes in Work which are (i) ordered by the TOWN, (ii) required because of acceptance of defective Work or correcting defective Work, or (iii) agreed to by the parties:

7.4.2 Changes in Contract Price or Contract Times which are agreed to by the parties; and

7.4.3 Changes in Contract Price or Contract Times, which embody the substance of any written decision rendered by the TOWN.

7.5 Agreement on any Change Order shall constitute a final settlement of all matters relating to the change in the Work which is the subject of the Change Order, including but not limited to all direct, indirect, and impact costs and time associated with such change and any and all adjustments to the Contract Price and the Contract Times. In the event a Change Order increases or decreases the Contract Price, Contractor shall include the Work covered by such Change Order in Applications for Payment as if such Work was originally part of the contract documents.

7.6 If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times) is required by the provisions of any Bond to be given to a surety, the giving of any such notice will be Contractor's responsibility, and the amount of each applicable Bond will be adjusted accordingly.

ARTICLE 8. CHANGE OF CONTRACT PRICE

8.1 Contract Price constitutes the total compensation (subject to authorized adjustments) payable to the Contractor for performing the Work. All duties, responsibilities and obligations assigned to or undertaken by the Contractor shall be at the Contractor's expense without change in the Contract Price.

8.2 Contract Price may only be changed by a Change Order or by a Written Amendment. Any claim for an adjustment in the Contract Price shall be based on written notice delivered to TOWN promptly (but in no event later than seven (7) days) after the start of the occurrence or event giving rise to the claim and stating the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered within ten (10) days after the start of such occurrence or event (unless TOWN allows additional time for claimant to submit additional or more accurate data in support of the claim) and shall be accompanied by a written statement that the adjustment claimed covers all known amounts to which the claimant is entitled as a result of said occurrence or event. If the TOWN and Contractor cannot otherwise agree on the amount involved.

8.3 The value of any Work covered by a Change Order or of any claim for an adjustment in the Contract Price will be determined as follows:

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

8.3.2 Where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit).

8.3.3 Where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under the preceding paragraph, on the basis of the Cost of the Work plus a Contractor's fee for overhead and profit.

8.4 **Cost of the Work:** The term Cost of the Work means the sum of all costs necessarily incurred and paid by Contractor in the proper performance of the Work. Under this Agreement, the cost of the work is covered entirely within the Contract Price. If costs are incurred that surpass the Contract Price, those costs could include the following:

8.4.1 Cost for labor.

8.4.2 Invoiced cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof. If materials used in performing the extra Work are taken from the Contractor's stock, then in lieu of invoices the Contractor shall furnish an affidavit, certifying that such materials were taken from its stock, that the quantity claimed was actually used in the Work, and that the price and transportation claimed represent the actual cost to the Contractor shall be submitted to the TOWN with the claim.

8.4.3 Payments made by Contractor to Subcontractors for Work performed or furnished by Subcontractors.

8.4.4 Costs of special consultants (including but not limited to engineers, architects, testing laboratories, and surveyors) employed for services specifically related to the Work.

8.4.5 Supplemental costs including the following:

8.4.5.1 The proportion of necessary transportation, travel and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

8.4.5.2 Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the site and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost less market value of such items used but not consumed which remain the property of Contractor.

8.4.5.3 Rental rates of all construction equipment and machinery and the parts thereof used for the Work.

8.4.5.4 Sales, consumer, use or similar taxes related to the Work, and for which Contractor is liable, imposed by laws and regulations.

8.4.5.5 Deposits lost for causes other than negligence of Contractor, any Subcontractor or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable.

8.4.5.6 Losses and damages (and related expenses) caused by damage to the work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance and furnishing of the Work (except losses and damages within the deductible amounts of property insurance), provided they have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of the TOWN. No such losses, damages and expenses

shall be included in the Cost of the Work for the purpose of determining Contractor's fee. If, however, any such loss or damage requires reconstruction and Contractor is placed in charge thereof, Contractor shall be paid for services a fee agreed to by the TOWN in writing.

8.4.5.7 Cost of utilities, fuel and sanitary facilities at the site.

8.4.5.8 Minor expenses such as telegrams, long distance telephone calls, telephone service at the site, expressage and similar petty cash items in connection with the Work.

8.5 The term "Cost of the Work" shall not include any of the following:

8.5.1 Payroll costs and other compensation of Contractor's officers, executives, principals (of partnership and sole proprietorships), 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 and not specifically included in the agreed upon schedule of job classifications referred to in paragraph 10.4.1 or specifically covered by paragraph 10.4.2—all of which are to be considered administrative costs covered by the Contractor's fee.

8.5.2 Expenses of Contractor's principal and branch offices other than Contractor's office at the site.

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

8.5.4 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.

8.5.5 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.

8.5.6 Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in paragraph 8.4.

8.6 The fee allowed to Contractor for overhead and profit shall be determined as a mutually acceptable fixed fee.

8.7 Whenever the cost of any Work is to be determined pursuant to paragraphs 8.3 and 8.4, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in form acceptable to the TOWN an itemized cost breakdown together with supporting data.

8.8 **Cash Allowances:**

8.8.1 It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be furnished and performed for such sums as may be acceptable to the TOWN. Contractor agrees that:

8.8.1.1 the allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the site, and all applicable taxes; and

8.8.1.2 Contractor's costs for unloading and handling on the site, labor, installation costs, overhead, profit and other expenses contemplated for the allowances have been included in the Contract Price and not in the allowances and no demand for additional payment on account of any of the foregoing will be valid.

8.8.2 Prior to final payment, an appropriate Change Order will be issued as recommended by the TOWN to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

ARTICLE 9. CHANGE OF CONTRACT TIMES

9.1 Contract Times may only be changed by a Change Order or a Written Amendment. Any claim for an adjustment of the Contract Times shall be based on written notice delivered by the party making the claim to the other party and to the TOWN promptly (but in no event later than seven (7) days) after the occurrence 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 ten (10) days after such occurrence (unless TOWN allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant has reason to believe it is entitled as a result of the occurrence of said event. No claim for an adjustment in the Contract Times will be valid if not submitted in accordance with the requirements of this paragraph.

9.2 **Liquidated damages**. The TOWN and the Contractor agree and recognize that time is of the essence for every time period set forth in the Contract Documents and that the TOWN will suffer financial loss if the Work is not substantially complete within the time set forth in the contract documents, plus any extensions thereof allowed in accordance with this Article. If the Contractor fails to perform the Work within the specified time set forth in the Contract Documents as adjusted pursuant to this Article, the TOWN and Contractor agree that as liquidated damages, and not as a penalty, for delay in performance the Contractor shall pay the TOWN in the amount stipulated below for each and every calendar day that expires after the time set forth in the Contract Documents for Substantial Completion of the Work until the same is finally complete and ready for Final Payment. The TOWN shall have the right to deduct liquidated damages from any amount due or that may become due to the Contractor, or to collect such liquidated damages from the Contractor or the Surety. The TOWN has the option to enforce liquidated damages or to waive such damages. The liquidated damages herein specified shall only apply to the Contractor's delay in performance. Liquidated damages are intended only to compensate the TOWN for additional TOWN personnel efforts in administering the Contract after normally scheduled completion dates, and for TOWN governmental and citizen inconvenience, lost opportunities, and lost confidence in government and morale of government when work is not completed on time. Such damages are uncertain in amount and difficult to measure and prove accurately. By executing this contract, the Contractor agrees that the liquidated damages specified herein are reasonable in amount and are not disproportionate to actual anticipated damages. Liquidated damages do not include any sums of money to reimburse the TOWN for extra costs which the TOWN may become obligated to pay on other contracts which are delayed or extended because of Contractor's failure to complete the Work within the time periods set forth in the Contract Documents. Liquidated damages are not intended to include litigation or attorneys' fees incurred by the TOWN, or other incidental or consequential damages suffered by the TOWN due to the Contractor's performance. If the TOWN charges liquidated damages to the Contractor, this shall not preclude the TOWN from commencing an action against the Contractor for other actual harm resulting from the Contractor's performance that is not due to the Contractor's delay in performance. In order to recover liquidated damages, the TOWN is under no obligation to prove the actual damages sustained by the TOWN due to the Contractor's delay in performance. The parties agree that liquidated damages shall be computed according to the following schedule of liquidated damages for each and every day that substantial completion of the work shall be delayed:

SCHEDULE OF LIQUIDATED DAMAGES

Original Contract Amount		Liquidated Damages
From	To and Including	Per Day
$ 0	25,000	$ 100.00
25,000	50,000	200.00
50,000	100,000	400.00
100,000	200,000	600.00
200,000	400,000	800.00
400,000	600,000	1,000.00
over 600,00		1,500.00

9.3 Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a claim is made there for as provided in this Article. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by the TOWN, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions or acts of God. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

ARTICLE 10. TESTS AND INSPECTIONS—CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

10.1 **Notice of Defects:** Prompt notice of all defective Work of which the TOWN has actual knowledge will be given to Contractor. All defective Work may be rejected, corrected or accepted as provided in this Article.

10.2 **Access to Work:** The TOWN, independent testing laboratories, and governmental agencies with jurisdictional interests will 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.

10.3 **Tests and Inspections:** Contractor shall give TOWN timely 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.

10.5 If laws or regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests or approvals, pay all costs in connection therewith, and furnish TOWN the required certificates of inspection, or approval. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests or approvals required for the TOWN's acceptance of materials or equipment to be incorporated in the Work, or of materials or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

10.6 If the Contractor covers any Work that is to be inspected, tested or approved without written concurrence of the TOWN, it must be uncovered for observation, if requested by the TOWN.

10.7 Uncovering Work shall be at Contractor's expense unless Contractor has given the TOWN timely notice of Contractor's intention to cover the same and TOWN has not responded with reasonable promptness.

10.8 If TOWN considers it necessary or advisable that covered Work be observed by TOWN or inspected or tested by others, Contractor, at TOWN's request, shall uncover, expose or otherwise make available for observation, inspection or testing as TOWN 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, Contractor shall pay all claims, costs, losses and damages caused by, arising out of or resulting from such uncovering, exposure, observation,

inspection and testing and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and the TOWN shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, may make a claim. If it is found that such Work is not defective, Town shall pay all claims, costs, losses and damages caused by, arising out of or resulting from such uncovering, exposure, observation, inspection and testing and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and the Contractor shall be entitled to an appropriate increase in the Contract Price, and, if the parties are unable to agree as to the amount thereof, may make a claim.

10.9 **The TOWN May Stop Work:** If Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work will conform to the contract documents, the TOWN may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of the TOWN to stop the Work shall not give rise to any duty on the part of the TOWN to exercise this right for the benefit of Contractor or any surety or other party.

10.10 **Correction or Removal of Defective Work:** If required by TOWN, Contractor shall promptly, as directed, either correct all defective Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by TOWN, remove it from the site and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses and damages caused by or resulting from such correction or removal (including but not limited to all costs of repair or replacement of work of others).

10.11 **Correction Period**

10.11.1 If within one year after the date of Final Payment or such longer period of time as may be prescribed by laws or regulations or by the terms of any applicable special guarantee required by the Contract Documents or by any specific provision of the contract documents, any Work is found to be defective, Contractor shall within seven (7) calendar days after receiving notice from the TOWN, without cost to the TOWN and in accordance with the TOWN's written instructions: (i) correct such defective Work, or if its has been rejected by the TOWN, remove it from the site and replace it with Work that is not defective, and (ii) satisfactorily correct or remove and replace any damage to other Work or the work of others resulting therefrom. If Contractor does not within seven (7) calendar days after receiving notice from the TOWN comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, the TOWN may have the defective Work corrected or the rejected Work removed and replaced, and all claims, costs, losses and damages caused by or resulting from such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

10.11.2 In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications or by Written Amendment.

10.11.3 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.

10.12 **Acceptance of Defective Work:** Instead of requiring correction or removal and replacement of defective Work, the TOWN may accept it. Contractor shall play all claims, costs, losses and damages attributable to the TOWN's evaluation of and determination to accept such defective Work (such costs to be approved by Project Manager as to reasonableness). 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 TOWN shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, the TOWN may make a claim therefor. If the acceptance occurs after such recommendation, the Contractor will pay an appropriate amount to the TOWN.

10.13 **The TOWN May Correct Defective Work:** If Contractor fails within a reasonable time after written notice from TOWN to correct defective Work or to remove and replace rejected Work as required by TOWN, or if Contractor fails to perform the Work in accordance with the contract documents, or if Contractor fails to comply with any other provision of the contract documents, the TOWN may, after seven (7) days' written notice to Contractor, correct and remedy any such deficiency. In exercising the rights and remedies under this paragraph the TOWN shall proceed expeditiously. In connection with such corrective and remedial action, the TOWN may exclude Contractor from all or part of the site and take possession of all materials for which the TOWN has already paid. Contractor shall allow the TOWN access to the site to enable the TOWN to exercise the rights and remedies under this paragraph. All claims, costs, losses and damages incurred or sustained by the TOWN in exercising such rights and remedies will be charged against Contractor and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and the TOWN shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, the TOWN may make a claim therefor. Such claims, costs, losses and damages will include but not be limited to all costs of repair or replacement of work of others destroyed or damaged by correction, removal or replacement of Contractor's defective Work. Contractor shall not be allowed an extension of the Contract Times (or Milestones) because of any delay in the performance of the Work attributable to the exercise by the TOWN of the TOWN's rights and remedies hereunder.

ARTICLE 11. PAYMENTS TO CONTRACTOR AND COMPLETION

11.1 **Application for Progress Payment:** At the end of each month, Contractor shall submit to TOWN for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the contract documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice or other documentation warranting that the TOWN has received the materials and equipment free and clear of all Liens, claims, security interests, or encumbrances and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect the TOWN's interest therein, all of which will be satisfactory to the TOWN. The amount retained with respect to progress payments will be as stipulated in the Agreement. With each application for payment the Contractor shall submit a waiver(s) of claim signed by the Contractor acceptable in form to the TOWN. The waiver of claim for payment for the work of the Contractor shall equal the amount of the previous payment distributed to the Contractor for work of the Contractor and the amount of the total previous payment distributed to the Contractor.

11.2 **Contractor's Warranty of Title:** Contractor warrants and guarantees that title to all Work, materials and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to the TOWN no later than the time of payment free and clear of all liens.

11.3 **Review of Applications for Progress Payment:** TOWN will, within fourteen (14) days after receipt of each Application for Payment, either make the payment or return the Application to Contractor indicating in writing TOWN’s reasons for refusing payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application. Unless refused pursuant to the contract documents, the amount recommended will become due fourteen (14) days after presentation of the Application for Payment to the TOWN and will be paid by the TOWN to Contractor when due.

11.4 The TOWN’s payment of an Application for Payment will constitute a representation based on on-site observations of the executed Work, review of the Application for Payment, and the accompanying data and schedules, that:

11.4.1 the Work has progressed to the point indicated;

11.4.2 the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion and to the results of any subsequent tests called for in the contract documents); and

11.4.3 the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled.

11.5 TOWN payments, including final payment, shall not mean that the TOWN is 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 Work, or for any failure of Contractor to perform or furnish Work in accordance with the contract documents.

11.6 In addition to the retainages set forth in the contract documents, the TOWN may retain one hundred percent (100%) of all progress payments for any unsatisfactory performance of the Work, including without limitation:

11.6.1 Defective work or failure to repair or replace defective work;

11.6.2 Claims filed against the Contractor, or reasonable evidence indicating probable filing of such claims;

11.6.3 Failure of the Contractor to make adequate or proper payments to subcontractors or suppliers for materials, equipment or labor;

11.6.4 Failure to obtain necessary permits or licenses, or to comply with applicable laws or regulations, unless such noncompliance is due to reasons beyond the control of the Contractor, or due to act of the TOWN;

11.6.5 Reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Price then unpaid;

11.6.6 Reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;

11.6.7 Persistent failure to carry out the Work in accordance with the contract documents;

11.6.8 As a set off for amounts due the TOWN on other items.

11.7 When the reason(s) for withholding payment are removed and corrected to the TOWN's satisfaction, the TOWN shall make payment to the Contractor the sums withheld, subject to the amounts required to be retained by the contract documents.

11.8 **Substantial Completion:** When Contractor considers the entire Work ready for its intended use Contractor shall notify the TOWN in writing, or verbally, that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that the TOWN issue a Certificate of Substantial Completion. Within a reasonable time thereafter, the TOWN shall inspect the Work to determine its status. If TOWN does not consider the Work substantially complete, it will notify Contractor in writing giving the reasons there for. If TOWN considers the Work substantially complete, it will complete a Certificate of Substantial Completion, which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment.

11.9 The TOWN shall have the right to exclude Contractor from the Work after the date of Substantial Completion, but the TOWN shall allow Contractor reasonable access to complete or correct items on the tentative list.

11.10 **Partial Use:** Use by the TOWN, at the TOWN's, option of any substantially completed part of the Work which: (i) has specifically been identified in the Contract Documents, or (ii) the TOWN and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by the TOWN for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, may be accomplished prior to Substantial Completion of all the Work subject to the following:

11.10.1 **Final Inspection:** Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, TOWN will make a final inspection and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

11.10.2 **Final Application for Payment:** After Contractor has completed all such corrections to the satisfaction of the TOWN and delivered in accordance with the Contract Documents all maintenance and operating instructions, schedules, guarantees, Bonds, certificates or other evidence of insurance required by the Contract Documents, certificates of inspection, marked-up record documents, and other documents. Contractor may make application for final payment following the procedure for progress payments. The final application for payment shall be accompanied (except as previously delivered) by: (i) all documentation called for in the Contract Documents, including but not limited to the evidence satisfactory to the TOWN of the continuation of completed operations insurance and any insurance coverage written on a claims-made basis at final payment and one year thereafter; (ii) the consent of surety to final payment and that the performance bond shall remain in effect throughout the guarantee period; (iii) complete and legally effective claim releases signed by all suppliers and subcontractors in the form provided in the Contract Documents certifying that all outstanding claims for payment have been paid. The Contractor shall not receive final payment due under the Agreement until the Contractor obtains and files the foregoing items (i), (ii), and (iii).

11.10.3 **Liens:** Colorado Statutes do not provide for any right of lien against public property. In lieu thereof, §38-26-107, Colorado Revised Statutes, as amended, provides adequate relief for any claimant having furnished labor, materials, rental machinery, tools, equipment, or services toward construction of the particular public work in that final payment may not be made to a Contractor until all such creditors have been put on notice by publication of such pending payment and given opportunity to stop payment to the Contractor in the amount of such claims. Pursuant to §38-26-107, C.R.S., any supplier may bring a suit and file a notice of lis pendens against the TOWN within ninety (90) days after the date set for final settlement. If any such supplier or person files any such claim and notice of lis pendens, the TOWN shall withhold retained amounts from final payments to the Contractor as are necessary to satisfy fully such claims. References to liens appearing in this Article shall be deemed as references to claims made pursuant to C.R.S §38-26-101 et seq. unless the context requires otherwise.

11.11 **Final Payment and Acceptance:** If the TOWN s satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, TOWN will, within fourteen (14) days after receipt of the final Application for Payment proceed to make payment by first ordering the publication of Notice of Final Payment as required by C.R.S. §38-26-107(1) and then making final payment in accordance with C.R.S. 38-26-107(3). Along with the Final Payment, the TOWN will also give written notice to the Contractor that the Work is acceptable. Otherwise, TOWN will return the Application to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application.

11.12 If, through no fault of Contractor, final completion of the Work is significantly delayed, the TOWN shall, upon receipt of Contractor's final Application for Payment make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by the TOWN for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required by the Contract Documents, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Project Manager with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

11.13 **Waiver of Claims:** The making and acceptance of final payment will constitute:

11.13.1 a waiver of all claims by Contractor against the TOWN other than those previously made in writing and still unsettled.

11.13.2 No Waiver of Rights. Neither the inspection by the TOWN or any of its officials, employees, or agents, nor any order by the TOWN of payment of money, or any payment for, or acceptance of, the whole or any part of the work by the TOWN, nor any extension of time, nor any possession taken by the TOWN or its employees shall operate as a waiver of any provision of this contract, or of any power herein reserved to the TOWN, or any right to damages herein provided, nor shall any waiver of any breach in this contract be held to be a waiver of any other or subsequent breach.

ARTICLE 12. SUSPENSION OF WORK AND TERMINATION

12.1 **The TOWN May Suspend Work:** At any time and without cause, the TOWN may suspend the Work or any portion thereof for a period of not more than ninety (90) days by notice in writing to Contractor and Project Manager which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be allowed an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes an approved claim.

12.2 **TOWN May Terminate Work:** Upon the occurrence of any one or more of the following events:

12.2.1 if Contractor persistently fails to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the progress schedule established under paragraph 2.7 as adjusted from time to time pursuant to paragraph 6.5;

12.2.2 if Contractor disregards laws or regulations of any public body having jurisdiction;

12.2.3 if Contractor otherwise violates in any substantial way any provisions of the Contract Documents.

12.3 The TOWN may, upon seven (7) days written notice to Contractor, without cause and without prejudice to any other right or remedy of the TOWN, elect to terminate the Agreement. In such case, Contractor shall be paid (without duplication of any items):

12.3.1 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 on such Work;

12.3.2 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;

12.3.3 for all claims, costs, losses and damages incurred in settlement of terminated contracts with Subcontractors, Suppliers and others; and

12.3.4 for reasonable expenses directly attributable to termination.

12.4 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.

12.5 **Contractor May Stop Work or Terminate.** If, through no act or fault of Contractor, the Work is suspended for a period of more than ten (10) days by the TOWN or under an order of court or other public authority, or Project Manager fails to act on any Application for Payment within thirty (30) days after it is submitted or the TOWN fails for thirty (30) days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days' written notice to the TOWN, and provided the TOWN does not remedy such suspension or failure within that time, terminate the Agreement and recover from the TOWN payment on the same terms as provided in paragraph 12.2. In lieu of terminating the Agreement and without prejudice to any other right or remedy, if Project Manager has failed to act on an Application for Payment within thirty days after it is submitted, or the TOWN has failed for thirty days to pay Contractor any sum finally determined to be due, Contractor may upon seven days' written notice to the TOWN stop the Work until payment of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from making claim under Articles 10 or 11 for an increase in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping Work as permitted by this paragraph.

ARTICLE 13 - BONDS AND INSURANCE

13.0 **Performance, Payment and Other Bonds.** Contractor shall furnish Performance and Payment Bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all Contractor's obligations under the Contract Documents. These Bonds shall remain in effect at least until one year after the date when final payment becomes due, except as provided otherwise by laws or regulations or by the Contract Documents. Contractor shall also furnish such other Bonds as are required by the Contract Documents. 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 sureties named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" 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 the agent's authority to act. The Contractor shall furnish the performance and payment bond in the form provided in the Contract Documents or approved by the TOWN, the earlier of ten (10) days after the TOWN has issued the notice of award or delivery of the executed Agreement. The TOWN reserves the right to exclude any Surety Company on any ground it deems appropriate. The cost of the bonds shall be included in the bid.

13.1 If the surety on any Bond furnished by Contractor is declared bankrupt, becomes insolvent, has its right to do business terminated in any state where part of the Project is located, or ceases to meet any of the requirements of the Contract Documents, Contractor shall within ten days thereafter substitute another Bond and surety, both of which must be acceptable to the TOWN.

13.2 **Licensed Sureties and Insurers; Certificates of Insurance**

0.2.1 All Bonds and insurance required by the Contract Documents to be purchased and maintained by Contractor shall be obtained from surety or insurance companies acceptable to the TOWN that are duly licensed to transact business in the State of Colorado and to issue Bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

0.2.2 Contractor shall deliver to the TOWN, with copies to each additional insured, certificates of insurance (and other evidence of insurance requested by the TOWN or any other additional insured) which Contractor is required to purchase and maintain in accordance with paragraph 5.3. The certificates shall be reviewed and approved by the TOWN prior to execution of the Agreement. The TOWN shall have the right to request and obtain copies of any insurance policies required under paragraph 5.3. The completed certificates of insurance shall be sent to the person and address specified in the Special Conditions.

13.3 **Contractor's Insurance Requirements**

13.3.1 The Contractor agrees to procure and maintain, at its own cost, the policy or policies of insurance required by these General Conditions, in addition to any other insurance requirements imposed by the Contract Documents or by law. The Contractor shall not be relieved of any liability, claims, demands, or other obligations assumed pursuant to the Contract Documents by reason of its failure to procure or maintain insurance, or by reason of its failure to procure or maintain insurance in sufficient amounts, durations, or types.

13.3.2 Contractor shall procure and maintain, and shall cause each Subcontractor or Supplier of the Contractor to procure and maintain (or shall insure the activity of Contractor's Subcontractors and Suppliers in Contractor's own policy with respect to), the minimum insurance coverages listed in the Agreement. Such coverages shall be procured and maintained with forms and insurers acceptable to the TOWN. All coverages shall be continuously maintained from the date of commencement of the Work. In the case of any claims-made policy, the necessary retroactive dates and extended reporting periods shall be procured to maintain such continuous coverage.

ARTICLE 14. MISCELLANEOUS

14.1 **Giving Notice:** 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.

14.2 **Computation of Times:** When any period of time is referred to in the Contract Documents by days, it will be computed to include the first and the last day of such period.

14.3 **Notice of Claim:** Should the TOWN or Contractor suffer injury or damage to person or property because of any error, omission or act of the other party or of any of the other party's employees or agents or others for whose acts the other party is legally liable, claim will be made in writing to the other party within a reasonable time of the first observance of such injury or damage. The provisions of this paragraph shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitations or repose.

14.4 **Cumulative Remedies:** The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and all of the rights and remedies available to the TOWN there under, are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by laws or regulations, by special warranty or guarantee or by other provisions of the contract documents, and the provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right and remedy to which they apply.

14.8 **Equal Opportunity Employer:** The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, age, sex, disability or national origin. The Contractor will take affirmative action to ensure that applicants are employed and that employees are treated during employment without regard for their race, color, religion, age, sex, disability or national origin. Such action shall include but not be limited to the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notice to be provided by an agency of the federal government, setting forth the provisions of the Equal Opportunity Laws.

14.9 The Contractor shall be in compliance with the appropriate provisions of the Americans with Disabilities Act of 1990 as enacted and from time to time amended and any other applicable federal regulation. A signed, written certificate stating compliance with the Americans with Disabilities Act may be requested at any time during the life of the Agreement by the TOWN.

14.10 **Assignment and Subcontracting:** The Contractor shall not assign by power of attorney or otherwise any of the money payable under this contract unless written consent of the TOWN has been obtained. No right under this contract, nor claim for any money due or to become due hereunder shall be asserted against the TOWN or persons acting for the TOWN by reason of any so-called assignment of this contract, or any part thereof, unless such assignment has been authorized by the written consent of the TOWN. In case the Contractor is permitted to assign moneys due or to become due under this contract, the instrument of assignment shall contain a clause subordinating the claim of the assignee to all prior liens for services rendered or materials supplied for the performance of the work.

14.11 Should any subcontractor fail to perform the Work in a satisfactory manner, the Contractor shall immediately terminate the subcontractor upon notice from the TOWN. Contractor shall be as fully responsible and accountable to the TOWN for the acts and omissions of subcontractors and of persons either directly or indirectly employed by Contractor. Nothing contained in this contract shall create any contractual relationship between any subcontractor and the TOWN.

14.12 **Arbitration:** Except as may otherwise be provided by law, or agreed to by stipulation of the TOWN, no claims, disputes, or other disagreements arising out of Work under the contract shall be decided by arbitration. If at any time during the performance of the work the TOWN agrees to submit a dispute to arbitration, if the arbitrator or arbitration panel adopts the TOWN's legal position with respect to the claim, dispute, or other disagreement, the Contractor shall reimburse the TOWN for reasonable attorneys' fees and other costs incurred by the TOWN in going to arbitration and the prevailing rate in the TOWN for any services rendered by the TOWN Attorney and employees consultants assisting the TOWN Attorney and discovery and litigation costs. However, if the Contractor prevails in the arbitration, the TOWN shall reimburse the Contractor for such costs. Unless otherwise agreed in writing, the Contractor shall carry on the work and maintain its progress during the arbitration proceedings, and the TOWN shall continue to make payments to the Contractor in accordance with the contract documents.

SECTION 00800

SUPPLEMENTARY CONDITIONS

TABLE OF CONTENTS

Article 1 – Definitions 2
SC-1.01 Defined Terms 2

Article 2 – Preliminary Matters 2
SC-2.02 Copies of Documents.....2

Article 4 – Availability of Lands; Subsurface and Physical Conditions; Reference Points 2
SC-4.02 Subsurface and Physical Conditions.....2
SC-4.06 Hazardous Environmental Condition at Site 3

Article 5 – Bonds and Insurance.....3
SC-5.01 Performance, Payment and Other Bonds.....3
SC-5.02 Licensed Sureties and Insurers 3
SC-5.04 Contractor's Insurance 4
SC-5.06 Property Insurance.....6
SC-5.07 Waiver of Rights.....6
SC-5.09 Acceptance of Bonds and Insurance; Option to Replace.....6

Article 6 – Contractor's Responsibilities 6
SC-6.06 Concerning Subcontractors, Suppliers, and Others 6
SC-6.10 Taxes.....6
SC-6.17 Shop Drawings and Samples 7
SC-6.20 Indemnification.....7

Article 10 – Changes In the Work; Claims.....8
SC-10.03 Execution of Change Orders.....8
SC-10.05 Claims.....8

Article 12 – Change of Contract Price; Change of Contract Times 8
SC-12.01 Change of Contract Price.....8
SC-12.03 Delays 9

Article 13 – Tests and Inspections; Correction, Removal or Acceptance of Defective Work 10
SC-13.07 Correction Period.....10

Article 14 – Payments to Contractor and Completion.....10
SC-14.02 Progress Payments 10
SC-14.07 Final Payment 11
SC-14.09 Waiver of Leins 11

Article 16 – Dispute Resolution.....11
SC-16.01 Methods and Procedures.....11

Article 17 – Miscellaneous 11
SC-17.07 Addresses of Owner, Engineer, Contractor 11
SC-17.08 Cross-Referencing 12

SECTION 00800

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, EJCDC C-700 (2007 Edition). All provisions which are not so amended or supplemented remain in full force and effect.

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

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

ARTICLE 1 – DEFINITIONS

SC-1.01A.19 Add the following sentence at the end of Paragraph 1.01.A.19:

The title of Architect as used in the Contract Documents also refers to the Engineer.

SC-1.01.A.29 Add the following sentence at the end of paragraph 1.01.A.29:

The terms “Owner” or “District” as used in all of the Contract Documents shall refer to the Pueblo West Metropolitan District.

SC-1.01A.34 Add the following sentence at the end of Paragraph 1.01.A.34:

The Project Manual also includes the bidding requirements, Contract Forms, Conditions of the Contract and Specifications.

SC-1.01A.50 Add the following sentence at the end of Paragraph 1.01.A.50:

Work shall also include the materials and equipment provided by Contractor or equipment as provided by Owner for installation by Contractor.

ARTICLE 2 – PRELIMINARY MATTERS

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

Owner shall furnish to Contractor four (4) complete sets of the Contract Documents for use in the execution of the Work. Additional copies will be furnished, upon request, at the cost of the reproduction.

ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; REFERENCE POINTS

SC-4.02 Add the following new subparagraph immediately after subparagraph 4.02.A.2:

3. Geotechnical reports are included in Section 01020-Geotechnical Report of the Project Manual.

SC-4.06 Delete Paragraphs 4.06.A and 4.06.B in their entirety and insert the following:

A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner.

B. Not Used.

ARTICLE 5 – BONDS AND INSURANCE

SC-5.01 Add the following new paragraph immediately after Paragraph 5.01.C:

D. In addition to the performance bond specified in the General Conditions, Contractor shall furnish Labor and Material Payment Bonds and Insurance Certificates. District and Engineer reserve the right to reject surety providing performance and payment bonds or other bonds as specified in the Contract Documents. Contract Agreement will not be executed until surety is acceptable to District and Engineer.

SC-5.02.A Delete Paragraph 5.02. A in its entirety and insert the following:

A. All bonds and insurance required by the Contact Documents to be purchased and maintained by the Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the State of Colorado and must be countersigned by an agent who is a resident of the State of Colorado and must be accompanied by a certified copy of the authority to act for the surety and authority to transact business in the State of Colorado.

SC-5.04 Add the following new paragraphs immediately after Paragraph 5.04.B:

C. The limits of liability for the insurance required by Paragraph 5.04 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

1. Workers' Compensation and related coverages under Paragraphs 5.04.A.1and A.2 of the General Conditions:

a. State of Colorado: Statutory

b. Applicable Federal: Statutory

c. Employer's Liability: $100,000 each accident $500,000 disease, policy limit $100,000 disease, each employee

2. Contractor's General Liability under Paragraphs 5.04.A.3 through A.6 of the General Conditions which shall include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of Contractor:

a. General Aggregate: $1,000,000

b. Products Completed Operations Aggregate $1,000,000

c. Personal and Advertising Injury $500,000

d. Each Occurrence (Bodily Injury and Property Damage) $500,000

e. Property Damage liability insurance will provide Explosion, Collapse, and Under-ground coverages where applicable.

f. Excess or Umbrella Liability
Bodily Injury and Property Damage $2,000,000
Retention $10,000

3. Automobile Liability under Paragraph 5.04.A.6 of the General Conditions:

a. Combined Single Limit of $2,000,000

SC-5.06.A Delete Paragraph 5.06.A in its entirety and insert the following in its place:

A. Contractor shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof. Contractor shall be responsible for any deductible or self-insured retention. This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, Engineer, and the officers, directors, partners, employees, agents and other consultants and subcontractors of any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or loss payee;

2. be written on a Builder's Risk "all-risk" policy form that shall at least include insurance for physical loss and damage to the Work, temporary buildings, false work, and materials and equipment in transit and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by these Supplementary Conditions.

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

4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;

6. include testing and startup;

7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other loss payee to whom a certificate of insurance has been issued; and

8. comply with the requirements of Paragraph 5.06.C of the General Conditions.

SC-5.06.B Delete Paragraph 5.06.B and replace with the following:

B. Contractor shall purchase and maintain equipment breakdown insurance and any other additional property insurance required by Laws and Regulations, which insurance will include the interest of Owner, Contractor, Subcontractors, and Engineer, and the officers, directors,

partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.

SC-5.07.B.1 Delete subparagraph 5.07.B.1 in its entirety and insert the following in its place:

1. loss due to business interruption, loss of use or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner, but the foregoing shall not apply to liquidated damages Owner may claim as provided in the Agreement; and

SC-5.09.A Delete Paragraph 5.09.A in its entirety and insert the following in its place:

A. If the Owner has any objection to the coverage afforded by or other provisions of the Bonds or insurance required to be purchased and maintained by the Contractor in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the Owner shall so notify the Contractor in writing within 10 days after receipt of the certificates (or other evidence requested) required by paragraph 2.01.B. Contractor shall provide to the Owner such additional information in respect of insurance. If Contractor does not purchase or maintain all of the Bonds and insurance required of Contractor by the Contract Documents, Contractor shall notify the Owner in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the Owner may elect to obtain equivalent Bonds or insurance to protect the Owner's interests at the expense of the Contractor and a Change Order shall be issued to adjust the Contract Price accordingly.

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

SC-6.06 Add the following new paragraph immediately after Paragraph 6.06.G:

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

SC-6.10.A Delete Paragraph 6.10.A in its entirety and insert the following in its place:

A. Owner is exempt from Colorado State Sales and Use Taxes on materials and equipment to be incorporated in the Work (said taxes shall not be included in the Contract Price or modifications to the Contract Price). Prior to purchase of any materials to be incorporated in the Work, the Contractor and any Subcontractor shall apply to the Colorado Department

of Revenue for an exemption to be used for all materials and work done under this Contract (Form DR-0172 (09/21/06)). All purchases for the Work shall use the exemption from Sales and Use Taxes.

SC-6.10 Add the following new paragraph immediately after Paragraph 6.10.A:

B. Owner's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to supplies or materials not incorporated into the Work.

SC-6.17 Delete paragraphs 6.17.A, B, C, D, and E in their entirety and replace with the following:

A. Contractor shall furnish required submittals with sufficient information and accuracy in order to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing subsequent submittals of Shop Drawings, Samples, or other items requiring approval and Contractor shall reimburse Owner for Engineer's charges for such time.

B. In the event that Contractor requests a change of a previously approved item, Contractor shall reimburse Owner for Engineer's charges for its review time unless the need for such change is beyond the control of Contractor.

SC-6.20.A Delete Paragraph 6.20.A in its entirety and replace with the following:

A. The Contractor agrees to indemnify and hold harmless Owner, its officers, employees, insurers, and self-insurance pool, from and against all liability, claims, and demands, on account of injury, loss, or damage, including without limitation claims arising from bodily injury, personal injury, sickness, disease, death, property loss or damage, or any other loss of any kind whatsoever, which arise out of or are in any manner connected with this contract, if such injury, loss, or damage is caused in whole or in part by, or is claimed to be caused in whole or in part by, the act, omission, error, professional error, mistake, negligence, or other fault of the Contractor, any subcontractor of the Contractor, or any officer, employee, representative, or agent of the Contractor or of any subcontractor of the Contractor, or which arise out of any workmen's compensation claim of any employee of the Contractor or of any employee of any subcontractor of the Contractor. The Contractor agrees to investigate, handle, respond to, and to provide defense for and defend against, any such liability, claims, or demands at the sole expense of the Contractor. The Contractor also agrees to bear all other costs and expenses related thereto, including court costs and attorney fees, whether or not any such liability, claims, or demands alleged are groundless, false, or fraudulent.

SC-6.20 Add the following new paragraph immediately after Paragraph 6.20.C:

D. Governmental Immunities Act. The Owner is relying on, and does not waive or intend to waive by any provision of this Agreement, the monetary limitations or any rights, immunities and protection provided by the Colorado Governmental Immunities Act (C.R.S. § 24-10-101 et seq.) as from time to time amended, or otherwise available to the District, its officers, agents, employees, attorneys, engineers, planners, indemnifiers and insurers.

ARTICLE 10 - CHANGES IN THE WORK; CLAIMS

SC-10.03.A.4. Add the following new paragraph immediately after Paragraph 10.03.A.3:

4. At the time of execution of a Change Order or Written Agreement, Owner and Contractor expressly acknowledge that said Change Order or Written Agreement provides for a fair and equitable adjustment in Contract Price and/or Contract Time for the additions, deletions, or revisions in the Work as authorized by said Change Order or Written Agreement. Owner and Contractor further expressly acknowledge that later claims for adjustments to the Contract Price and/or Contract Time associated with said Change Order or Written Agreement are not valid.

SC-10.05.G Add the following new paragraphs immediately after Paragraph 10.05.F:

G. Should Contractor cause damage to the Work or property of any separate contractor or subcontractor at the site, or should any claim arising out of Contractor's performance of the Work at the site be made by any separate contractor against the Contractor, Owner, or Engineer, the Contractor shall promptly attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by arbitration.

Contractor shall to the fullest extent permitted by Laws and Regulations, indemnify and hold Owner or Engineer harmless from and against all claims, damages, losses and expenses (including, but not limited to, fees of engineers, architects, attorneys and other professionals and court and arbitration costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any separate contractor against Owner or Engineer.

ARTICLE 12 - CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

SC-12.01.A Add the following language at the end of the last sentence of Paragraph 12.01A:

Changes in the Contract Price or Contract Time, which are agreed to by the parties by an appropriate, duly executed Change Order or Written Amendment shall constitute a full and final change or amendment to the Contract for any and all changes of which the Contractor is, or should have been, aware as of the date of the executed Change Order.

Accordingly, execution of a Change Order or Written Amendment by the Contractor shall constitute a waiver on the part of the Contractor of any further claims for changes in the Contract Price or Contract Time, which occurred or may have occurred up through the date of any executed Change Order, whether such changes were expressly set forth in the executed change Order or not.

SC-12.03 Add the following new paragraph immediately after Paragraph 12.03.E:

F. Any and all claims for delay damages pursuant to this Article shall be made based on written notice submitted by party making the claim to the Engineer and the other party to the Contract in accordance with provisions of Article 10. Such claims shall be made as such delays are affecting Work and shall not be deemed "cumulative." Failure to raise any such claims on a timely basis shall be construed as a waiver of such claims, individually.

SC-12.03 Add the following new paragraph immediately after Paragraph 12.03.G:

H. The Owner and Contractor are both aware that a portion of the construction may be conducted during winter weather conditions, and that extremely variable and severe weather conditions are typical for the site of the Work. The Contractor expressly agrees that the Contract Price is based on completion of the Work within the times specified in the Agreement and under weather conditions typically encountered during the contemplated construction period at the site of the Work. For purposes of evaluating requests for extensions of time due to unusually severe weather conditions, the following conditions, and no others, will be considered unusually severe:

1. Precipitation exceeding the historical mean for the months of the construction period by more than one standard deviation;

2. For winter construction, average temperature less than the historical mean for the months of the construction period by more than one standard deviation;

3. For winter construction, number of days below freezing exceeding the historical mean for the months of the construction period by more than one standard deviation;

4. Isolated abnormal weather occurrences of a severely destructive nature, which in fact, cause such destruction at the site of the Work.

5. For the purpose of determining mean conditions, all available data contained in the records of the National Weather Service for reporting from, as well as data available from the State Climatologist for the same areas. The Contractor further agrees that should a request for time extension due to unusually severe weather conditions be made, the Contractor shall submit all necessary historical and detailed daily data during the construction period to support the claim.

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

SC-13.07 Add the following new paragraph immediately after Paragraph 13.07.E:

F. Nothing in the General Conditions concerning the correction period shall establish a period of limitation with respect to any other obligation, which Contractor has under the Contract Documents. The establishment of a time period relates only to the specific obligations of the Contractor to correct the Work, and has no relationship to the time within which his obligations under the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish his liability with respect to his obligations other than to specifically correct the Work.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

SC-14.02.A.1 Add the following as the last sentence of subparagraph 14.02.A.1:

1. Payment for materials and equipment not incorporated in the Work, but delivered and suitably stored, shall be based only upon the actual cost of such materials to Contractor, and shall not include any overhead or profit to Contractor.

SC-14.02.C.1 Delete Paragraph 14.02.C.1 in its entirety and replace with the following:

1. Thirty (30) days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount

recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

SC-14.02.D.3 Delete subparagraph 14.02.D.3 in its entirety and replace with the following:

3. Upon a subsequent determination that the Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1, as amended, and subject to interest as provided in the Agreement from the date of said determination, to the date of payment.

SC-14.07.C.1 Delete subparagraph 14.07.C.1 in its entirety.

SC-14.09 Delete paragraph 14.09 in its entirety.

ARTICLE 16 – DISPUTE RESOLUTION

SC-16.01 Delete Paragraph 16.01 A, B and C in their entirety.

ARTICLE 17 – MISCELLANEOUS

SC-17.07 Add the following new paragraphs immediately after Paragraph 17.06:

A. Owner is Town of Telluride and their duly authorized agents. All notices, letters and communication directed to Owner shall be addressed and delivered to JVA Incorporated, who is designated representative (below).

JVA, Incorporated
Attn: Josh McGibbon, P.E.
1319 Spruce Street
Boulder, CO 80302

B. All duties and responsibilities assigned to Engineer in the Contract Documents, with the corresponding rights and authority will be assumed by JVA, Incorporated and their duly authorized agents. All notices, letters and communication directed to Engineer shall be addressed and delivered to JVA, Inc. 1319 Spruce Street, Boulder, CO 80302, Attention: Josh McGibbon, P.E., with a copy to Owner.

C The business addresses of Contractor given in contract for the work and Contractor's office at the site of the Work are hereby designated as the places to which all notices, letters, and other communication to Contractor will be delivered

D. Either Owner, Engineer, or Contractor may change his address at any time by an instrument in writing delivered to the other parties.

SC-17.08 Add the following new paragraph immediately after Paragraph 17.07:

The cross-referencing or specification sections under the heading "Related Sections" and elsewhere within each specification section is intended as an aid to the Contractor and shall not relieve the Contractor from his responsibility to coordinate the Work under the Contract Documents. Listings of cross-references are not intended to be comprehensive. The omission of a cross-reference to an additional or related requirement shall not relieve the Contractor of his obligation to provide a complete Project.

END OF SECTION

Work Change Directive

No. _____

Date of Issuance: _____ Effective Date: _____

Project:	Owner:	Owner's Contract No.:
Contract:		Date of Contract:
Contractor:		Engineer's Project No.:

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

Item No.	Description

Attachments (list documents supporting change):

_____

_____

Purpose for Work Change Directive:

Authorization for Work described herein to proceed on the basis of Cost of the Work due to:

- ☐ Nonagreement on pricing of proposed change.
- ☐ Necessity to expedite Work described herein prior to agreeing to changes on Contract Price and Contract Time.

Estimated change in Contract Price and Contract Times:

Contract Price $_____ (increase/decrease) Contract Time _____ (increase/decrease) days

Recommended for Approval by Engineer:	Date
Authorized for Owner by:	Date
Received for Contractor by:	Date
Received by Funding Agency (if applicable):	Date:

CHANGE ORDER #_____

DATE: _____

TO: _____

PROJECT: **2015 Raw Lift Station Improvement Project**

TOWN: Town of Telluride, Colorado

You are hereby requested to comply with the following changes from the contract plans and specifications:

Description of Changes Supplemental Plans & Specs Attached	DECREASE Contract Price	INCREASE Contract Price
	$	$
TOTALS	$	$
NET CHANGE IN CONTRACT PRICE:	$ _____	$ _____

JUSTIFICATION:

_____
_____
_____
_____
_____

The amount of the Contract will be (decreased) (increased) by the sum of _____ dollars. The Contract Total including this and previous change orders will be _____ dollars. The Contract Period provided for completion will be (increased) (decreased) (unchanged) _____ days.

This document will become a supplement to the Contract and all provisions will apply hereto:

RECOMMENDED:
PROJECT MANAGER

BY: _____

ACCEPTED:
CONTRACTOR

BY: _____

Field Order

No. _____

Date of Issuance:	Effective Date:	
Project:	Owner:	Owner's Contract No.:
Contract:		Date of Contract:
Contractor:		Engineer's Project No.:

Attention:
You are hereby directed to promptly execute this Field Order issued in accordance with General Conditions Paragraph 9.04.A, for minor changes in the Work without changes in Contract Price or Contract Times. If you consider that a change in Contract Price or Contract Times is required, please notify the Engineer immediately and before proceeding with this Work.

Reference: _____ _____
(Specification Section(s)) (Drawing(s) / Detail(s))

Description:

Attachments:

	Engineer:

Receipt Acknowledged by Contractor:	Date:

Copy to Owner

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Work covered by contract documents

B. Work by others

C. Contractor use of site and premises

D. Work sequence

E. Easements and right-of-way

F. Protection of public and private property

G. Maintenance of traffic

H. Barricades and lights

I. Lines and grades

J. Regulatory requirements

K. Cutting and patching

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of this Contract consists all necessary labor, supervision, equipment, tools, and materials for construction of the headworks building, installation of a new screen, washer compactor, and conveyance system, minor improvements to existing wet well, process piping, and ancillary improvements at the existing WWTF. Providing and installation of all electrical conduit and wiring, motor control centers, programmable logic controllers, and controls. Work to include all associated site work related to the project.

B. Furnish and pay for all materials, equipment, supplies, appurtenances; provide all construction equipment and tools; and perform all necessary labor and supervision

C. Coordinate the progress of the Work including coordination between trades, subcontractors, suppliers, public utilities and subsequent building contractor performing work on site and Owner to insure the progress of Work

D. It is the intent of this contract that Work proceed in the most expeditious manner possible.

E. Construct the Work under contract indicated in the Bid Form

1.3 WORK BY OTHERS

A. Systems Engineering Group, programming and integration.
   1. Refer to Section 16951 Control Narratives

B. Town manned plant operating times
   1. 8AM to 4:30PM, 5 days per week

1.4 CONTRACTOR USE OF SITE AND PREMISES

A. Contractor shall limit use of the premises for Work and will use the designated staging area for field offices, equipment, and material storage. Areas have been designated for contractor's use.

B. Coordinate use of premises under direction of Engineer and/or Owner

C. Assume full responsibility for the protection and safekeeping of equipment and products stored on site under this Contract

D. Contractor may use only those areas indicated on the Drawings for storage and such additional areas as Engineer may designate

E. Contractor should plan for normal work days, Monday through Friday, within the hours of 7:00 am to 6:00 pm. Other work hours and days may be allowed by the Town and Engineer upon 48 hours written notice.

1.5 WORK SEQUENCE

A. Construction Sequencing: Work efforts, commissioning and decommission of the work herein described will include a critical sequence of work. CONTRACTOR shall take into account this sequence when preparing bid and the successful bidder shall include this sequence in the construction schedule. Coordination of work necessary to meet the construction sequence as discussed below is the responsibility of the CONTRACTOR. The ENGINEER and OWNER shall be updated prior to start and completion of each phase.

B. This project is the addition of a new Headworks building prior to the influent wet well and pumps for the existing WWTF and, as such, the current operations must be maintained throughout construction. Temporary short-term shutdowns of individual processes are possible. All shutdowns shall be coordinated with the Owner with a minimum 48-hour notice. The actual startup process, sequencing and procedure shall be discussed and coordinated with the Engineer and Owner a minimum of 14 days prior to CONTRACTOR'S desired startup date.

C. The CONTRACTOR shall develop its own sequence of work to minimize construction time, site disturbances and interruptions of existing plant operations. Testing and Startup

schedule and sequence shall be thoroughly discussed and coordinated with ENGINEER and OWNER. A suggested general sequence of work is outlined as follows:

1. Pothole existing utilities, including the 24" influent line, 14" force main, 8" drain line, potable water line, gas line and electrical power lines. Notify Engineer and Owner of any utility conflicts or discrepancies from the plans.
2. Relocate the existing power lines around the new Headworks building. Coordinate all work with the Town and San Miguel Power.
3. Reroute the pedestrian/bike path during construction. Coordinate path route and signage with the Town.
4. Remove 8" forcemain drain line from the existing valve to the lift station. Grout the existing opening.
5. Temporarily relocate the existing compressor and shed until it can be relocated to its final location.
6. Begin excavation and construction of the new Headworks building. The existing 24" influent line shall remain in operation and shall not be diverted until the influent diversion vault is constructed and all equipment is installed and fully operational.
7. Leak test all channels, vaults, gates, etc.
8. Complete headworks building including masonry, roofing, stairs, monorail, hoists, grating, grout, mechanical and electrical equipment.
9. Install new screening and washing compactor equipment as it arrives onsite.
10. Perform start-up testing on the new screening and washing compactor equipment and provide equipment training to the WWTF staff.
11. Perform required SCADA, instrumentation and controls integration.
12. It is anticipated bypass pumping will only have to occur once for a period of two days during construction of the influent and effluent channel structures. Bypass pumping shall take place from the manhole directly upstream of the new Headworks building to the manhole directly upstream from the WWTF. The bypass lines shall be trenched under the existing access roads.
13. During the bypass pumping the influent and effluent channel structures shall be constructed. The existing 24" influent lines shall be bulkheaded and the new 8" forcemain drive line shall be completed.
14. Perform grading, seeding and mulching around new headworks building as weather permits and during the first growing season.
15. Achieve Substantial Completion and commissioning of all improvements by **September 4th, 2015**. Confirm the equipment is fully functional and operational and complete all leak tests. Only after these steps have been completed, the Contractor will be allowed to introduce wastewater to the new headworks channels and equipment.
16. Achieve Final Completion by **October 30th, 2015**.

D. Procedures and methods other than those specified will be considered by ENGINEER and OWNER, provided they afford equivalent continuity of operations.

E. Provide open access for Owner to property at all times during construction. Maintain minimum width clearance for access of Town and Contractor personnel and emergency vehicles at all times

F. Power outages
   1. Schedule each outage with Engineer and Owner
      a. Number of outages to be kept to a minimum

1.6 EASEMENTS AND RIGHT-OF-WAY

A. The majority of the Work will be performed in the dedicated street Right-of-Way and on Owner's property.

B. Confine construction operations to the immediate vicinity of the location indicated on drawings and use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies, so as to cause the least possible damage to property

C. On Private Property
   1. Do not enter for material delivery or occupy for any purpose with personnel, tools, equipment, construction materials, or excavated materials, any private property outside the designated construction easement without written permission of the owner.

D. Within Street Right-of-Way
   1. Perform all work and conduct all operations of Contractor, his employees, and his subcontractors in accordance with the requirements of Town of Telluride and San Miguel County

1.7 PROTECTION OF PUBLIC AND PRIVATE PROPERTY

A. Protect, shore, brace, support, and maintain underground conduits, drains, and other underground construction uncovered or otherwise affected by construction operations

B. Contractor shall be responsible for all damage to streets, roads, highways, shoulders, street lighting and/or signage, embankments, culverts, location or character, which may be caused by transporting equipment, materials, or personnel to or from the Work or any part or site thereof, whether by him or his subcontractors

C. Make satisfactory and acceptable arrangements with the Owner of, or the agency or authority having jurisdiction over, any damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage

1.8 MAINTENANCE OF TRAFFIC

A. Conduct Work to interfere as little as possible with Town and public travel, whether vehicular or pedestrian
   1. Whenever it is necessary to cross, close, or obstruct private roads, driveways and walks, provide and maintain suitable and safe detours, or other temporary expedients for accommodation of private travel

1.9 BARRICADES AND LIGHTS

A. Protect streets, roads, highways, and other public thorough fares which are closed to traffic by effective barricades with acceptable warning and directional signs

B. Locate barricades at the street intersecting public thoroughfare on each side of the blocked section

C. Provide suitable barriers, signs, and lights to the extent required to adequately protect the public

D. Provide similar warning signs and lights at obstructions such as material piles and equipment

E. Illuminate barricades and obstructions with warning lights from sunset to sunrise

F. Store materials and conduct work to cause the minimum obstruction to the other contracts

1.10 LINES, GRADES AND SURVEY

A. Construct all Work to the lines, grades, and elevations indicated on the Drawings
   1. Contractor is responsible for correcting all incorrect grades or grades not meeting specified tolerances

B. Engineer has established basic horizontal and vertical control points in the Drawings
   1. Use these points as datum for the Work
   2. Provide such competent personnel and tool, stakes, and other materials as Engineer may require in establishing or designating control points, in establishing construction easement boundaries, or in checking layout survey, and measurement work performed by Contractor

C. Provide all additional survey, layout, and measurement work required
   1. Work performed by a qualified professional engineer or registered land surveyor acceptable to Engineer
   2. Locate and protect control points prior to starting site work, and preserve all permanent reference points during construction
      a. Make no changes or relocations without prior written notice to Engineer
      b. Report to Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations
      c. Require surveyor to replace Project control points which may be lost or destroyed
      d. Establish replacements based on original survey control
   3. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means
      a. Temporary project benchmark
      b. Stakes for grading, fill and topsoil placement
      c. Utility slopes and invert elevations
   4. From time to time, verify layouts by the same methods
   5. Maintain a complete, accurate log of all control and survey work as it progresses

6. On request of Engineer, submit documentation to verify accuracy or field engineering work

1.11 REGULATORY REQUIREMENTS

A. Comply with all federal, state, and local laws, regulations, codes, and ordinances applicable to the Work

B. References in the Contract Document to local codes shall mean the codes in effect in the Town of Telluride and San Miguel County according to the jurisdiction in which the Work is performed.

C. Other standards and codes which apply to the Work are designated in the specific technical specifications

1.12 CUTTING AND PATCHING

A. Contractor shall be responsible for all cutting, and patching, including attendant excavation and backfill, required to complete the Work or to
   1. Uncover portions of the Work to provide for installation of ill-timed work
   2. Remove and replace defective work
   3. Remove and replace work not conforming to requirements of Contract Documents
   4. Remove samples of installed work as specified for testing

B. Provide products as specified or as required to complete cutting and patching operations

C. Inspection
   1. Inspect existing conditions of the Project, including elements subject to damage or to movement during cutting and patching
   2. After uncovering work, inspect the conditions affecting the installation of products, or performance of the work
   3. Report unsatisfactory or questionable conditions to the Engineer in writing; do not proceed with the work until the Engineer has provided further instructions

D. Preparation
   1. Provide devices and methods to protect other portions of the Project from damage
   2. Provide protection from the elements for that portion of the Project which may be exposed by cutting and patching work, and maintain excavations free from water
   3. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes
   4. Restore work which has been cut or removed; install new products to provide completed Work in accord with requirements of Contract Documents

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01035

MODIFICATION PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing contract modifications.

1.2 MINOR CHANGES IN THE WORK

A. The Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or Contract Time, on a JVA Field Order Form.

B. The Contractor may request additional information or clarification by using and submitting a “Request for Information” (RFI).

1.3 PROPOSAL REQUEST (PR) OR QUOTATION REQUEST (QR)

A. Owner-Initiated Quotation Request: The Engineer will issue a detailed Quotation Request Form indicating any changes in the Work that will require adjustment to the Contract Sum or Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. The Quotation Request Form issued by the Engineer is for information only. Do not consider them as an instruction either to stop work in progress or to execute the proposed change.
   2. Within 7 days of receipt of a Quotation Request Form, submit an estimate of cost necessary to execute the change to the Engineer for the Owner's review.
      a. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include a statement indicating the effect the proposed change in the Work will have on the Contract Time.

B. Contractor-Initiated Proposals: When latent or unforeseen conditions require modifications to the Contract, the Contractor may propose changes by submitting a Contractor request for a change form to the Engineer,
   1. Include a statement outlining the reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and Contract Time.

2. Include a list of quantities of products required and unit costs, with the total amount of purchases to be made. Where requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Comply with requirements under General Conditions in Section 6.05 Substitutes and "Or-Equals" if the proposed change requires substitution of one product or system for a product or system specified.

C. There will be no Contractor initiated Change Orders, the Contractor may only request additional information or clarification by using and submitting a "Request for Information" (RFI), on the Contractor's RFI form. Additional forms may be obtained from the Engineer, and Contractor-Initiated Proposals may also be provided.

1.4 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: When the Owner and the Contractor disagree on the terms of a Change Order, the Engineer may issue a Construction Change. The Construction Change Directive instructs the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. The Construction Change Directive contains a complete description of the change in the Work. It also designates the method to be followed to determine change in the Contract Sum or Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
   1. After completion of the change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

1.5 CHANGE ORDER PROCEDURES

A. Upon the Owner's and the Engineer's approval and signature from the Contractor the Change Order Form becomes valid

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01039

COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General requirements

B. Coordination

C. Field engineering

D. Alteration project procedures

E. Preconstruction conference

F. Progress meetings

G. Requests for information

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

B. Section 01340 - Shop Drawings and Product Data

C. Section 01700 - Contract Closeout

1.3 GENERAL REQUIREMENTS

A. Refer to General Conditions for Owner meetings and other requirements

B. Engineer will schedule and administer pre-construction meeting according to agenda
   1. Prepare agenda for meetings including items required by Owner and Contractor
   2. Notify Contractor and Owner 4 days in advance of meeting date
   3. Preside at meeting

C. Contractor will schedule and administer site mobilization and weekly progress meetings. Contractor will also be responsible for coordination, field engineering, alteration, project procedures, cutting and patching procedures outlined herein. If work progress does not warrant a meeting, all parties can mutually agree to postpone meeting.
   1. Arrange for the attendance of Contractor's agents, employees, subcontractors, and suppliers as appropriate to the agenda
   2. Record the minutes; include all significant proceedings and decisions
   3. Reproduce and distribute copies of minutes within one week after each meeting
      a. To all participants in the meetings

b. To Engineer
c. To Owner

4. Owner and other inspecting parties such as the geotechnical engineer/technician as well as plant operators may attend meetings
5. Engineer will attend weekly meetings either via phone or on site

D. Representatives of contractors, subcontractors, and suppliers attending the meetings shall be qualified and authorized to act on behalf of the entity each represents

1.4 COORDINATION

A. Coordinate scheduling, submittals, and Work of the various Sections of specifications to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later by others.

B. Verify that utility requirement characteristics of operating equipment are compatible with available utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment, and coordinate preparation of grading and other requirements for installation utility work by others.

C. Coordinate completion and clean up of Work of separate Sections in preparation for final completion and for portions of Work designated for Owner’s use

D. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.5 FIELD ENGINEERING

A. Employ a Land Surveyor registered in the State of Colorado and acceptable to the Engineer and Owner.

B. Contractor will locate and protect survey control and reference points.

C. Control datum for survey is that established by Owner provided survey and shown on Drawings.

D. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

1.6 ALTERATION PROJECT PROCEDURES

A. Materials: As specified in product Sections; match existing products and work for patching and extending work.

B. Where new work abuts or aligns with existing, perform a smooth and even transition. Patched work to match existing adjacent work in texture and appearance.

C. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Engineer.

D. Where a change of plane of 1/4 inch or more occurs, submit recommendation for providing a smooth transition for Engineer review.

E. Patch or replace portions of existing surfaces, which are damaged, lifted, or showing other imperfections.

F. Finish surfaces as specified in individual product sections.

1.7 PRECONSTRUCTION CONFERENCE

A. Engineer will schedule a conference after Notice of Award

B. Location: On site

C. Attendance
1. Owner's Representative
2. Engineer and his professional consultants
3. Geotechnical Engineer
4. Contractor's Project Manager
5. Contractor's Superintendent
6. Major Subcontractors
7. Others as Appropriate

D. Agenda:
1. Execution of Owner Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of subcontractors and suppliers, list of products, Schedule of Values, and Construction Project Schedule in critical path format.
5. Designation of personnel representing the parties in Contractor, Owner, and the Engineer.
6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, cost proposal requests, Change Orders and Contract closeout procedures.
7. Construction scheduling and updates.
8. Scheduling activities of Geotechnical Engineer, equipment manufacturers representatives, and other field tests
9. Critical work sequencing
10. Major equipment deliveries and priorities
11. Procedures for maintaining Record Documents
12. Construction facilities, controls and construction aids
13. Temporary utilities provided by Owner
14. Safety and first-aid procedures
15. Security and housekeeping procedures

16. Procedures for testing

1.8 PROGRESS MEETINGS

A. Contractor will schedule and administer meetings throughout progress of the Work at weekly intervals. If work progress does not warrant meeting, all parties can mutually agree to postpone the weekly meeting.

B. Location of the Meetings: The project field office of the Contractor, or other locations arranged for by Contractor, convenient to all parties

C. Contractor will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within one week to Contractor, Owner, participants, and those affected by decisions made.

D. Attendance
   1. Owner's Representative
   2. Engineer, and his professional consultants as needed
   3. Contractor's Superintendent
   4. Subcontractors as appropriate to the agenda
   5. Suppliers as appropriate to the agenda
   6. Others, as appropriate

E. Suggested Agenda
   1. Review Minutes of Previous meetings.
   2. Review Unresolved issues from Last Meeting.
   3. Review of Work Progress.
   4. Field Observations, Problems, Conflicts and Decisions.
   5. RFI Review
   6. Review of Submittals Schedule and Status of Submittals
   7. Schedule
      a. General Schedule Issues
      b. Review of off-site fabrication and delivery schedules
      c. Planned progress during succeeding work period (3-week “Look ahead”)
      d. Maintenance of construction project schedule
      e. Corrective measures to regain project schedules
   8. Maintenance of Quality and Work Standards
   9. Change Orders
   10. New PR’s or CCR’s
   11. Accepted Change Orders
   12. Pay Requests
   13. Other Business

1.9 REQUESTS FOR INFORMATION (RFI)

A. The Contractor shall prepare and submit an RFI upon the discovery of the need for interpretation of the Contract Documents or additional information.
   1. Only the Contractor shall submit RFIs to the Engineer.

2. RFIs shall be submitted on Engineer's RFI form. Engineer will provide a template for the Contractor upon request.

B. RFI shall include:
1. Project Name
2. Engineer Job Number
3. Date
4. Name of Contractor
5. Name of Engineer
6. RFI number, numbered sequentially
7. Related specification section number, title, and related paragraphs, as needed
8. Drawing number and detail references, as needed
9. Field conditions
10. Contractor's proposed solution. If the Contractor's solution(s) affect contract times or contract price, Contractor shall state the effects on the RFI.
11. Contractor's signature
12. Relevant attachments including but not limited to drawings, descriptions, measurements, photos, product data, and shop drawings

C. Electronically Submitted RFIs
1. Contractor shall submit one (1) complete RFI file in Adobe Acrobat PDF format

D. Engineer's Response
1. Engineer will review each RFI, determine action required, and respond.
2. Engineer will review and respond to each RFI within seven (7) working days
3. If Engineer receives an RFI after 1:00 P.M. local time, the RFI will be considered as received the following working day.
4. Engineer will not respond to RFIs requesting approval of submittals, approval of substitutions, coordination and information already indicated in Contract Documents, adjustment in contract time or contract amount, or erroneous RFIs.
5. Engineer may respond to RFIs on related issues with a single response.
6. If Engineer requests additional information as a result of the RFI, any further action or RFIs submitted by the Contractor will restart a new seven (7) day review period.
7. Contractor shall submit any request for change of contract time or contract price utilizing proper Change Order forms.

E. Contractor shall log and track all RFIs submitted organized by RFI number.
1. RFI log shall be submitted at each progress meeting
2. RFI log shall include:
   a. Project name
   b. Name, address, and phone number of Contractor
   c. Contractor representative name
   d. RFI number
   e. RFI description
   f. RFI submittal date
   g. RFI response date
   h. Related Change Order number, as needed

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01080

IDENTIFICATION SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Color coding, lettering, and tagging of all new exposed pipe and electrical equipment

1.2 RELATED SECTIONS

A. Section 09900 – Painting

B. Section 16050 – Basic Electrical Materials and Methods

1.3 REFERENCES

A. ANSI 13.1 – Scheme for the Identification of Piping Systems

PART 2 PRODUCTS

2.1 MATERIALS

A. Paint: As specified in Section 09900

B. Nameplates: Plastic, two colors for surface and core

PART 3 EXECUTION

3.1 LOCATION OF IDENTIFICATION

A. Lettering and flow direction arrows
   1. Near equipment served
   2. Close to valve or flanges
   3. Adjacent to branches, tees and changes in direction of pipeline
   4. At intervals of not more than 20 feet on straight runs, unless otherwise indicated by Engineer

3.2 LETTERING

A. Lettering to be provided by:
   1. Paint, stencil
   2. Cylindrically coiled printed plastic sheets meeting ANSI A13.1-2007
      a. Seton, Setmark Pipe Markers
      b. Or accepted equal

B. Letter size as follows:

Outside Diameter of Pipe Or Covering (inch)	Minimum Height of Letters (inch)
¾ Through 4	¾
>4 to <8	1 1/4
8 or larger	2 1/2

3.3 NAME PLATES

A. Provide nameplates on all electrically powered equipment and electrical enclosures
   1. Size: Approximately 3-inch wide by 2-inch high, on red plastic surface engraved through to a yellow core
   2. Label: "Danger" in capital ½ inch letters on top line. The balance of sign in 3/8 inch capital letters reading: "Do not perform any equipment maintenance until main power disconnect is turned off and padlocked"
   3. Provide additional electrical nameplates of the size and colors indicated in the individual specification sections
   4. Install in prominent location agreed to by the Engineer and Owner

B. Provide nameplate at all non-potable water outlets
   1. Size: approximately 3- inch wide by 2-inch high, on red plastic surface engraved through to a white core
   2. Label: "Non-Potable Water" top line and "Do Not Drink" second line in ½ inch capital letters
   3. Securely attach to wall (if possible) or attach with stainless steel chain

3.4 SCHEDULED COLOR CODING

A. All 24-inch pipe and smaller

B. Bands where scheduled: 6 inch wide, at 5 foot intervals

C. Provide only bands of color on un-insulated steel and PVC, elsewhere natural finish

3.5 PIPING NOT SCHEDULED

A. Paint to match wall or ceiling, unless otherwise directed by Engineer

B. Appropriately identify and place arrows

C. Un-insulated stainless steel and PVC
   1. Natural finish

3.6 SCHEDULE

A. Paint and letter colors

Letters	**Color of Pipe**	**Color of Letters**
Raw Water Influent	Match Existing	White
Water Process Piping	Match Existing	Black
Potable Water Piping	Match Existing	White
Backwash Water	Match Existing	Black
Non-potable Water Piping	Match Existing	White
Air Piping - instrument	Match Existing	White
Air piping – low pressure	Match Existing	Black
Natural Gas Line	Match Existing	White

B. For piping not specified above refer to "Ten State Standards-Water Works, 2012 Edition" and/or the CDPHE "Design Criteria for Potable Water Systems, March 1997" as well as consult with Engineer

C. Specifically paint the following items:
   1. Valve hand-wheels and levers: Red
   2. Hoist Hooks, blocks, monorail beams: Match existing

END OF SECTION

SECTION 01200

PAYMENT PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

B. This information is supplemental to the requirements as stated in the General Conditions.

1.2 SUMMARY

A. This Section includes additional administrative and procedural requirements necessary to prepare and process Applications for Payment. Refer to General Conditions for most requirements of the Owner.
   1. Schedule of Values assisting in processing Applications for Payment
   2. Unit Prices for administrative requirements governing use of unit prices
   3. State Revolving Loan Fund project administrative requirements
   4. Construction Progress Schedules

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 PROCEDURES FOR THE SCHEDULE OF VALUES

A. Coordination: coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
   1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with Continuation Sheets
      b. Submittals Schedule
      c. O&M Manuals Schedule
   2. Submit the Schedule of Values to Engineer at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment
   3. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: include the following Project identification on the Schedule of Values:
   a. Project name and location
   b. Name of Engineer
   c. Engineer's project number.
   d. Contractor's name and address
   e. Date of submittal
2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
   a. Related Specification Section or Division.
   b. Description of the Work.
   c. Change Orders (numbers) that affect value.
   d. Dollar value.
   e. Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.
6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders result in a change in the Contract Sum.

1.5 APPLICATION FOR PAYMENTS

A. General
   1. Submit itemized payment request as required in General Conditions together with Schedule of Values and other submittals as specified herein

2. Contractor shall not "project" work completed beyond the date of Application for Payment submittal for the purpose of payment request

B. Each Application for Payment shall be consistent with previous applications and payments as certified by the Architect and paid for by the Owner.
   1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements

C. Payment Application Times: Each progress payment date is as indicated in the Agreement. The period of construction Work covered by each Application or Payment is the period indicated in the Agreement

D. Application Preparation: Complete every entry on the form, including notarization and execution by person authorized to sign legal documents on behalf of the Owner. Incomplete applications will be returned without action.
   1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions have been made.
   2. Include amounts of Change Orders issued prior to the last day of the construction period covered by the application

E. Transmittal
   1. Submit copy of each Application for Payment to the Engineer by means ensuring receipt within 24 hours
   2. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to the Engineer

F. Initial Application for Payment
   1. Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:
      a. List of subcontractors
      b. List of principal suppliers and fabricators
      c. Schedule of Values
      d. Contractor's Construction Schedule (preliminary if not final)
      e. Schedule of principal products
      f. List of Contractor's staff assignments
      g. Copies of building permits
      h. Copies of authorizations and licenses from governing authorities for performance of the Work
      i. Certificates of insurance and insurance policies
      j. Performance and payment bonds, if required

G. Application for Payment at Substantial Completion
   1. Following issuance of the Certificate of Substantial Completion, submit an Application for Payment. This application shall reflect any Certificates of Partial

Substantial Completion issued previously for Owner occupancy of designated portions of Work

a. Administrative actions and submittals that shall precede or coincide with this application include:
   i) Occupancy permits and similar approvals
   ii) Warranties (guarantees) and maintenance agreements
   iii) Test/adjust/balance records
   iv) Maintenance instructions
   v) Meter readings
   vi) Start-up performance reports
   vii) Change-over information related to Owner's occupancy, use, operation and maintenance
   viii) Final cleaning
   ix) Application for reduction of retainage, and consent of surety
   x) Advice on shifting insurance coverages
b. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion

H. Application for Final Payment
1. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Price, previous payments, and sum remaining due.
2. Application for Final Payment will not be considered until the following have been accomplished:
   a. Completion of Project closeout requirements
   b. Completion of items specified for completion after Substantial Completion
   c. Assurance that unsettled claims will be settled
   d. Assurance that Work not complete and accepted will be completed without undue delay
   e. Transmittal of required Project construction records to Owner
   f. Proof that taxes, fees and similar obligations have been paid
   g. Removal of temporary facilities and services
   h. Removal of surplus materials, rubbish and similar elements

1.6 PROCEDURES FOR STATE REVOLVING FUND (SRF) LOAN PROJECTS

A. Coordination: coordinate preparation of the SRF forms and reports with preparation of Contractor’s Construction Schedule and Pay Applications
1. Correlate line items in the Project Schedule with other required administrative forms and schedules, including the following:
   a. Certifications regarding debarment (General and Subcontractors)
   b. Certified payrolls (Davis-Bacon wage determination)
   c. Disadvantaged Business Enterprise (DBE) Procurement
2. Make required submittals to the Engineer on a timely basis based on monthly and quarterly reporting requirements

1.7 PROCEDURES FOR THE CONSTRUCTION PROGRESS SCHEDULE

A. Coordination: coordinate preparation and updates of Contractor's Construction Schedule with the preparation of Schedule of Values.
   1. Correlate line items in the Construction Schedule with required project tasks, including the following:
      a. Mobilization/demobilization
      b. Permits and regulatory requirements
      c. Submittals
      d. Equipment
      e. O&M Manuals
      f. Work breakdown of major project work
      g. Major subcontractors work
      h. Startup and commissioning
      i. Training
      j. Substantial completion
      k. Final completion
      l. Milestones and operational shutdown requirements

B. Utilize the Critical Path Method (CPM) type construction schedule to establish preliminary progress schedule and track Work progress
   1. After acceptance by Engineer of preliminary Progress Schedule submitted per requirements of General Conditions, set preliminary Progress Schedule as the Construction Baseline Schedule
   2. Update and submit the construction progress schedule on a monthly basis with the pay application
      a. Monthly submittal should indicate progress of tasks, changes to baseline schedule logic, work additions such as change orders, milestone and contract date changes
      b. Submit two (2) color print copies, 11" x 17" size, and one Adobe pdf copy
      c. Upon request provide copy of project schedule CPM data file

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01340

SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submission of all shop drawings and product data as required by the Contract Documents for all equipment and materials to be furnished under this contract unless specifically indicated otherwise

1.2 RELATED SECTIONS

A. Section 01600 – Materials and Equipment

B. Section 01730 – Operations and Maintenance Data

C. Specification Divisions 2 thru 16

1.3 SUBMITTALS

A. Definitions
   1. Technical submittals: Shop drawings, product data and samples prepared by Contractor, subcontractors, suppliers, or manufacturers
      a. Shall be submitted by the Contractor to Engineer for approval for the use of Equipment and Materials to complete the Work or as needed to describe the following:
         i) Operation and maintenance
         ii) Technical properties
         iii) Installation
      b. Shop drawings: Custom prepared data for the Project and Work including performance and capacity curves, diagrams, bills of material, instructions, and other information
      c. Product data: Non-custom prepared printed information for the Project and Work on materials and products
      d. Samples: Fabricated and non-fabricated tangible samples of products and material
         i) Used for visual inspection and testing and analysis
   2. Informational submittals: Reports, administrative informational submittals, certification and guarantees not including and defined as shop drawings, samples and product data
      a. Reports: Include laboratory reports and tests, technical procedures and records and design analysis
      b. Administrative informational submittals: Submittals necessary for administrative records such as construction photographs, work records, schedules, standards, record project data, safety data, and similar information submittals
      c. Certification: Includes manufacturer or supplier certificates and guarantees

B. General Requirements
   1. Quality
      a. Shall be of suitable quality for legibility and reproduction purposes
      b. Shall be useable for reproduction yielding legible hard copy
      c. Submittals not conforming to specified requirements herein and as specified in Divisions 2 through 16 shall be subject to rejection by Engineer and upon Engineer request, Contractor shall resubmit documents that are in conformance
   2. Dimensions
      a. English units shall be provided on submittals
      b. Metric units are acceptable in addition to English units
      c. English units shall govern
   3. Form of submittals
      a. Submittals shall be transmitted in electronic format as specified herein
      b. Scanned submittals are acceptable
      c. Electronic project documents and submittals shall be transmitted in the following format:
         i) Native electronic format, nonproprietary
         ii) Adobe PDF produced from native electronic format
      d. Filename:
         i) Shall be consistent for the initial and any subsequent submission revisions for a single submittal
         ii) Contractor shall use a consistent naming convention for all submittals
            a) Use number of original submittal followed directly by a capital letter corresponding to the number of times a submittal is resubmitted (i.e., #001, #001A, #001B, etc.)
   4. Non-conforming submittals shall be subject to rejection by Owner and/or Engineer
   5. Submittal completion requirements
      a. Submittals shall include design criteria, dimensions, construction materials and all other information specified for a complete submittal to facilitate Engineer review of the submittal information adequately
      b. In the event various drawings are included a submittal for a class of Equipment, Contractor shall annotate clearly which parts apply to furnished Equipment
         i) Information not pertaining to the submittal shall be clearly annotated. Highlighting of such information will cause rejection of the submittal by the Engineer
      c. Contract Drawings
         i) Copies or portions thereof will not be allowed as acceptable fabrication or erection drawings
         ii) In the event Contract Drawings are used by the Engineer for erection drawings to annotate information on erection or identify reference details, Engineer title block and professional seal shall be removed and replaced with the Contractor's title block on the Contract Drawing(s). Contractor shall revise such erection drawings for subsequent revisions by the Engineer to Contract Drawings

C. Preparation
   1. Shop Drawings

a. Drawings shall be presented in a clear and thorough manner:
b. Identify details by reference to sheet and detail, schedule or room numbers shown on Contract Drawings
c. Identify equipment by reference to equipment name and tag number shown on Contract Drawings
d. Scale and Measurements: Make drawings accurate to a scale with sufficient detail to show the kind, size, arrangement and function of component materials and devices
e. Minimum sheet size: 8.5" by 11"
f. Fabrication drawing size: 11" by 17" or 24" by 36"

2. Product Data
   a. Clearly mark each copy to identify pertinent products or models submitted for review
   b. Identify equipment by reference to equipment name and P&ID number
   c. Catalog cut sheets: Cross-out or hatch irrelevant data

D. Technical Submittals: Shop Drawings and Product Data Submittal Requirements
1. Shop Drawings and Product Data shall include the following, at a minimum:
   a. Specifications of manufacturer(s)
   b. Equipment parts and catalogs
   c. Bills of materials, material lists, and schedules
   d. Shop erection and fabrication drawings
   e. Drawings shall include equipment dimensions, weights, installation location requirements, plates required, main components, support details, anchor bolt details/sizes/locations, support base sizes, baseplate sizes, spacing and clearance requirements for installation, erection, operation and maintenance disassembly
   f. Electrical requirements:
      i) Shall include schematic diagrams including one-line diagrams, terminal block numbers, internal wiring diagrams, external connections, controls, and any other information as requested in individual specification sections
   g. List of spare parts
   h. Instruction and Operation and Maintenance (O&M) manuals
      i) As specified herein and in Specification Section 01730
   i. Manufacturer’s performance testing of equipment
   j. Concrete mix design data and information
   k. Performance characteristics and capacities
   l. External connections, anchorages, and supports required
   m. Other drawings, parts, catalogs, specifications, samples, or data necessary for the Engineer to determine conformance with Contract Documents
2. Samples – Office samples shall be of sufficient size and quantity to clearly illustrate:
   a. Functional characteristics of the product, with integrally related parts and attachment devices
   b. Full range of color, texture and pattern
   c. Comply with requirements identified in individual specification sections

E. Construction Schedule: Designate in the construction schedule, or in a separate coordinated shop drawing schedule, the dates for submission and the dates that reviewed Shop Drawings and Product Data will be needed, if accelerated review is requested

F. Field samples and Mock-ups:
   1. Contractor shall erect, at the Project Site, at a location acceptable to the Engineer and Owner
   2. Size or area: as specified in the respective specification section
   3. Fabricate each sample and mock-up complete and finished
   4. Remove mock-ups at conclusion of Work or when acceptable to Engineer

1.4 CONTRACTOR RESPONSIBILITIES

A. Review shop drawings and product data prior to submission for accuracy and completeness of each submission

B. Approve and stamp each submission before submitting to Engineer

C. Determine and verify:
   1. Field measurements
   2. Field construction criteria
   3. Catalog numbers and similar data
   4. Conformance with specifications and identification of all deviations
   5. Confirm assignment of unit responsibility

D. Prior to each submission, carefully review and coordinate all aspects of each item being submitted

E. Verify that each item and the corresponding submittal conform in all respects with specified requirements of the Work and of the Contract Documents with respect to means, methods, techniques, sequences, and operations of construction, and safety precautions and programs incidental thereto

F. Make submissions promptly in accordance with Construction Schedule, and in such sequence as to cause no delay in the Work or in the work of any other Contractor

G. Limit requirement for accelerated submittal review by Engineer to no more than 10% percent of total number of submittals
   1. Accelerated submittal review period: less than 14 calendar days

H. Notify Engineer in writing, at time of submission, of any deviations in the submittals from Contract Document requirements:
   1. Identify and tabulate all deviations in transmittal letter
   2. Indicate essential details of all changes proposed, including modifications to other facilities that may be a result of the deviation
   3. Include required piping and wiring diagrams

1.5 SUBMISSION REQUIREMENTS

A. Make submissions far enough in advance of scheduled dates for installation to provide time required for reviews, for securing necessary approvals, for possible revisions and resubmissions, and for placing orders and securing delivery

B. In scheduling, allow fourteen (14) calendar days for review by Engineer following receipt of submission in Engineer's office:
   1. Time required to mail submissions or resubmissions is not considered a part of review period

C. Submittal Naming and Numbering
   1. Assign a unique number to include all shop drawings, product data and other information required for individual specification sections, beginning with #001.
   2. Resubmissions shall have the original number with a letter, starting with "A". If the first submittal required resubmission, it would be labeled #001A.
   3. Each specification section may still have more than one submittal number for later submissions (i.e., Preliminary O&M Manuals, Final O&M Manuals, etc.)
   4. Contractor shall use a consistent naming convention for all submittals

D. Quantity of Submittals Required
   1. Shop Drawings and Product Data:
      a. Initial submittal:
         i) Electronic – One (1) copy to Engineer
      b. Resubmittal:
         i) Electronic – One (1) copy to Engineer
      c. Final Submittal for Distribution
         i) Paper hard copy - Maximum of two (2) copies for Contractor's use, plus a maximum of three (3) copies which will be distributed by Engineer when approved. Do not submit more than five (5) copies
         ii) One (1) electronic copy to Engineer
      d. As –constructed document submittals
         i) Paper hard copy – Maximum of two (2) copies for Contractor's use, plus a maximum of three (3) copies which will be distributed by Engineer when approved. Do not submit more than five (5) copies
         ii) Electronic – One (1) copy to Engineer and one (1) copy to Owner
   2. Samples
      a. Initial submittal:
         i) Submit three (3) of each sample unless specified otherwise in individual specification section
      b. Resubmittal:
         i) Submit three (3) to Engineer
      c. One (1) sample of approved sample submittal will be returned to Contractor
   3. Informational submittals
      a. Technical reports and administrative submittals
         i) Electronic – One (1) copy to Engineer
         ii) Paper: Three (3) copies to Engineer
      b. Certificates and guarantees:

i) Electronic – One (1) copy to Engineer
ii) Paper: Three (3) copies to Engineer

c. Test reports
i) Paper
a) Owner: Two (2) copies
b) Engineer: One (1) copy
c) Contractor: Two (2) copies
d) Manufacturer/supplier: One (1) copy

4. Instruction and O&M manuals
a. In accordance to Specification Section 01730
5. At no additional cost to the Owner and whether or not submittals are copyrighted, the Owner may copy and use for staff training and/or internal operations any submittals approved for final distribution as well as required by this Contract

E. Submittal Transmittal Requirements
1. Accompany each submittal with a letter of transmittal showing all information required for identification and checking
2. Shall include:
a. Drawing numbers and titles
b. Revision number
c. Electronic filename
d. Deviations from Contract Documents: As specified herein
e. Submittals unidentifiable will be returned for proper identification
f. Date

F. Submittals Requirements
1. Submittal number
2. Date of submission and dates of any previous submissions
3. Project title and number
4. Owner Contract identification number if applicable
5. Names of:
a. Contractor
b. Supplier
c. Manufacturer
6. Identification of the product, with the specification section number
7. Field dimensions, clearly identified as such
8. Relation to adjacent or critical features of the Work or materials
9. Applicable standards, such as ASTM or Federal Specification numbers
10. Identification of deviations from Contract Documents:
a. If Contractor proposes to provide material or equipment of Work which deviates from the Project Manual, Contractor shall indicate so under “deviations” on the transmittal form accompanying the submittal copies
b. Identify all requested deviations as specified and on the copies of Specifications and Drawings required by paragraph below.
11. Confirmation of compliance with Contract Documents and, if applicable, identification of deviations from Contract Documents:

a. Provide the following documents to demonstrate compliance with the contract specifications:
   i) A copy of the relevant Drawing(s) with all addendum updates that apply to the equipment in various Divisions marked to show specific changes necessary for the equipment proposed in the Contractor's submittal
      a) If no changes are required, the Drawing(s) shall be clearly marked "No Changes Required"
      b) Failure to include copies of relevant Drawing(s) with the submittal, whether changes are required or not, shall be cause for rejection of the entire submittal with no further review by Engineer
      c) Relevant Drawing(s) include as a minimum the control diagrams, process and instrumentation diagrams (P&IDs), and Process (P) drawings.
   ii) A copy of each pertinent specification section with all addendum updates included, all referenced and applicable specifications sections, with their respective addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate the requested deviations from the specification requirements:
      a) If deviations from the specifications are indicated and, therefore requested, by the Contractor, the submittal shall be accompanied by a detailed, written justification for each deviation
      b) Failure to include a copy of the marked up specification sections, along with justification for any requested deviations to the specification requirements, with the submittal shall be cause for rejection of the entire submittal with no further review by Engineer

12. Identification of revisions on resubmissions
13. An 8" by 4" blank space for Contractor's and Engineer's stamps
14. Stamp cover sheet of each submittal as identified in letter of transmittal
15. Contractor's stamp: Initialed or signed, certifying review and approval of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the Work and of Contract Documents. Use stamp to include wording similar to the following:

> This submittal has been reviewed by [*Name of Contractor*] and approved with respect to the means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incidental thereto. [*Name of Contractor*] also warrants that this submittal complies with contract documents and comprises no deviations thereto:
> Section No:_____ Submittal No:
> Date:_____ By:

G. For equipment that is provided directly by manufacturer without specification provide:
   1. Shop drawings: Illustrate complete assembly of products; foundation, installation and anchor requirements; dimensions and total weights of each, electrical wiring diagrams

2. Product data: Provide manufacturer’s literature including general assembly, materials of construction, model and type, detailed data describing parts and accessories, sufficient data to verify compliance with specifications
3. Manufacturer’s installation instructions: Provide detailed connection requirements and startup instructions
4. Manufacturer’s field report: Indicate personnel present and actual start-up procedures that were performed by manufacturer’s representative
5. Field report and test results shall be submitted to the Engineer by the Contractor

H. Submittal Log:
1. Maintain an accurate submittal log for duration of the Work showing current status of all submissions
2. Show submittal number, section number, section title, submittal description, dates and disposition of submittal
3. Make submittal log available to Engineer for Engineer's review upon request

I. Unless specified otherwise, make submissions in groups to facilitate efficient review and approval:
1. Include all associated items from individual specification sections to assure that all information is available for checking each item when it is received
2. Submit a complete initial submittal including all components when an item consists of components from several sources
3. Partial submittals may be rejected as not complying with provisions of the Contract
4. Engineer will not be held liable for delays due to poorly organized or incomplete submissions
5. Do not include items from more than one specification section for any one submittal number

J. Contractor may require subcontractors to provide drawings, setting diagrams and similar information to help coordinate the Work, but such data shall remain between Contractor and his subcontractors and will not be reviewed by Engineer unless specifically called for within the Contract Documents

K. All submittals for each component of multi-component systems shall be compiled and submitted through the Contractor to the Engineer by the manufacturer having System Responsibility

1.6 DISPOSITION OF SHOP DRAWINGS, PRODUCT DATA, AND INFORMATION SUBMITTALS

A. "No Exceptions Taken": Approved with No Corrections Noted
1. One copy sent to Owner
2. One copy sent to Resident Project Representative
3. One copy retained in Engineer's file
4. Remaining copies returned to Contractor for his use
   a. One copy to be kept on file at Contractor's office at job site
   b. Remaining copies for Contractor's office file, suppliers, or subcontractors

5. No corrections or comments noted on the submittal or on a Submittal Response Summary Sheet
6. Issues or miscellaneous comments pertaining to other related items of the Work may be included in transmittal letter
7. Resubmission not required

B. "Exceptions Noted": Approved with Corrections Noted
1. One copy sent to Owner
2. One copy sent to Resident Project Representative
3. One copy retained in Engineer's file
4. Remaining copies returned to Contractor for his use
   a. One copy to be kept on file at Contractor's office at job site
   b. Remaining copies for Contractor's office file, suppliers or subcontractors
   c. Copies of submittal data in operation and maintenance manuals to be revised according to corrections
5. Comply with corrections or comments as noted on the submittal or on a Submittal Response Summary Sheet
6. Resubmission not required

C. "Revise And Resubmit": Incorrect information provided or Significant Information Still Required
1. One copy sent to Resident Project Representative
2. One copy retained in Engineer's file
3. All remaining copies returned to Contractor for revision and re-submittal
4. Copy of transmittal letter and/or Submittal Response Summary Sheet sent to Owner. A "No Exceptions Taken" or "Exceptions Noted" submittal it will be forwarded to Owner after review per above disposition requirements
5. Submittal is either: incorrectly annotated; specific comments need to be addressed and incorporated in re-submittal; and/or additional information may be required as noted on the submittal or on a Submittal Response Summary Sheet
6. Submitted information may not include or address specific item required per the specification as identified on the submittal or on a Submittal Response Summary Sheet
7. Specific information related to identified item may be required for final approval of submittal
8. Resubmission of entire submittal may be required or resubmission of specific item may be required as identified on the submittal or on a Submittal Response Summary Sheet

D. "Rejected": Returned for Correction
1. One copy sent to Resident Project Representative
2. One copy retained in Engineer's file
3. All remaining copies returned to Contractor
4. Copy of transmittal letter and/or Submittal Response sent to Owner
5. Contractor required to resubmit complete submittal package in accordance with Contract Documents
6. Submittal does not comply with provisions of Contract Documents as noted on the submittal or on a Submittal Response Summary Sheet

7. Resubmission required

E. “Receipt Acknowledged”: For Reference Purposes Only, or for Record Copy:
1. Applicable to manufacturer or Contractor provided calculations and other miscellaneous documentation no subject to Engineer review and approval
2. One copy sent to Resident Project Representative
3. One copy retained in Engineer's file
4. One copy returned to Contractor
5. Copy of transmittal letter sent to Owner
6. Remaining submittal copies destroyed
7. Detailed review and comment by Engineer not required
8. Resubmission not required

1.7 DISPOSITION OF SAMPLES

A. "No Exceptions Taken": Approved with No Corrections Noted
1. One sample sent to Owner
2. One sample sent to Resident Project Representative
3. One sample retained in Engineer's file
4. Acknowledgement: Copy of transmittal letter sent to Contractor
5. Resubmission not required

B. "Exceptions Noted": Approved with Corrections Noted
1. One sample sent to Owner
2. One sample sent to Resident Project Representative
3. One sample retained in Engineer's file
4. Acknowledgement: Copy of transmittal letter sent to Contractor
5. Work performed or products furnished to comply with exceptions noted in acknowledgement
6. Resubmission not required

C. "Rejected": Returned for Correction
1. One sample retained in Engineer's file
2. Remaining samples sent to Contractor for resubmittal and compliance with the Contract Documents as noted in transmittal letter
3. Copy of transmittal letter sent to Owner
4. Resubmission required

1.8 RESUBMISSION REQUIREMENTS

A. Make any corrections or changes in submittals required by Engineer and resubmit until approved

B. Transmit each resubmission under new letter of transmittal. Use number of original submittal followed directly by a capital letter corresponding to the number of times a submittal is resubmitted (i.e., #001, #001A, #001B, etc.)

C. Shop Drawings and Product Data

1. Revise initial drawings or data and resubmit as specified for the initial submittal
2. Indicate any changes which have been made other than those requested by Engineer

D. Samples: Submit new samples as required for initial submittal

E. Reimbursement of Resubmission Review Costs:
1. Review of first submittal and one resubmittal will be performed by Engineer at no cost to Contractor
2. Cost for review of subsequent resubmissions will be directly paid by Contractor
3. Engineer will document work-hours required for review and costs for Engineer review will be deducted from payments due Contractor as Change Order deducts
4. Charges for review of resubmissions will include Engineer at maximum rate of $150 per hour and administrative staff at maximum rate of $75 per hour

1.9 PROJECT RECORD SUBMITTALS

A. After completion of the Work and prior to final payment, Contractor shall furnish record documents and final approved shop drawings and samples (as-constructed shop drawings and samples) in the number of copies specified herein.
1. Contractor shall provide additional copies of final approved shop drawings and samples for insertion in Equipment instruction and O&M manuals as required
2. All copies shall be clearly marked “Project Record”

1.10 ENGINEER'S DUTIES

A. Review submittals with reasonable promptness and in accordance with approved submission schedule provided that each submittal has been called for by the Contract Documents and is stamped by Contractor as indicated above
1. No extensions of time are allowed due to Engineer’s delay in reviewing submittals unless all the following criteria are met:
   a. Contractor has notified Engineer in writing that timely review of particular submittal in question is critical to the progress of the Work and Contractor has identified the requested submittal return date.
   b. Engineer has failed to return submittal within 21 days of receipt of the submittal or receipt of said notice, whichever is later
   c. Contractor demonstrates that delay in progress of the Work was directly attributable to Engineer’s failure to return submittal within 21 days
2. No extensions of time are allowed due to delays in progress of the Work caused by rejection and subsequent resubmission of data, including multiple resubmissions
3. Engineer’s review shall not extend to means, methods, techniques, sequences, construction operations, and safety precautions and programs incidental thereto. No information regarding these items will be reviewed whether or not included in submittals
4. In the event that Engineer will require more than 21 calendar days to perform review, Engineer shall so notify Contractor

B. Review drawings and data submitted only for general conformity with Contract Documents

1. Engineer's review of drawings and data returned marked No Exceptions Taken or Exceptions Noted does not indicate a thorough review of all dimensions, quantities, and details of material, equipment device or items shown
2. Engineer's review does not relieve Contractor of responsibility for errors, omissions or deviations nor responsibility for compliance with the Contract Documents

C. Assume that no shop drawing or related submittal comprises a deviation to the Contract Documents unless Contractor advises Engineer otherwise in writing which is acknowledged by Engineer in writing:
   1. Consider and review only those deviations from the Contract Documents clearly identified as such on the submittal and tabulated on the Contractor's transmittal sheet.

D. Review informational submittals for indications of Work or Material deficiencies and will respond to Contractor regarding such deficiencies

E. Return submittals to Contractor for distribution or for resubmission

F. Transmit, unreviewed, to Contractor all copies of submittals received directly from suppliers, manufacturers and subcontractors

G. Transmit, unreviewed, to Contractor all copies of submittals not called for by the Contract Documents or which have not been approved by Contractor

H. Engineer will not review uncalled-for shop drawings or product data except by special arrangement

I. Affix stamp and indicate approval for submittal or resubmission requirements with the following stamp:

☐ NO EXCEPTIONS TAKEN ☐ EXCEPTIONS NOTED
☐ REVISE & RESUBMIT ☐ REJECTED

This review was performed only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Modifications or comments made on the shop drawings and product data during this review do not relieve Contractor from responsibility for compliance with the requirements of the plans and specifications. Contractor is responsible for: dimensions and quantities; information that pertains solely to the fabrication processes or to the means, methods, of construction; coordination of the work of all trades.

JVA, Inc.

Date_____ By_____

1.11 SUBMITTAL SCHEDULE

A. Unless indicated otherwise, provide all submittals required by individual sections of the Contract Documents to establish compliance with the specified requirements.

B. Contractor to produce schedule of submittals for Engineer review

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Construction record photographs prior to commencing and during the course of the Work

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 01700 – Contract Closeout: Project Record Documents

1.3 PHOTOGRAPHY REQUIRED

A. Take photographs of the existing conditions prior to commencing work to document existing conditions

B. Take photographs on the date on which each scheduled Application for Payment is due. Intent is for digital photos to be kept as project record

C. CD of Digital photos become the property of Owner

1.4 COSTS OF PHOTOGRAPHY

A. Pay all costs for specified photography and printing
   1. Parties requiring additional photography or prints will pay for them directly

1.5 DELIVERY OF PHOTOS

A. Submit digital photos to the Engineer with monthly pay requests or within 20 days of photo date

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 TECHNIQUE

A. Factual Presentation

B. Correct Exposure and Focus
   1. High resolution and sharpness
   2. Maximum depth-of-field

3. Minimum distortion

3.2 VIEWS REQUIRED

A. Photograph from locations to adequately illustrate the condition of construction and the state of the Project
   1. Photographic survey of the existing site
      a. Show all areas to be modified
      b. Show all areas in which Contractor will conduct operations or store equipment
   2. Weekly photographs
      a. Minimum of eight (8) views weekly until final acceptance
      b. Views as designated by the Engineer or Owner

3.3 PHOTOGRAPH REQUIREMENTS FOR PROGRESS SITE PHOTOGRAPHS

A. Responsibility
   1. Site photographs for Owner record of construction progress shall be the responsibility of the Contractor
   2. Contractor shall be responsible for site photographs including the existing and progress of Work

B. Photographs shall include, but not limited to, the following:
   1. Existing site: Photographs of existing site conditions before site work commences
      a. Number of views shall be sufficient to cover the existing site conditions
   2. Progress of work: Shall include photographs from clearing throughout construction
      a. Number of views shall be sufficient to cover progress in Work and shall include a minimum of eight (8) different views
   3. After completion of Work: Shall be sufficient to show completed and finished Work

C. Digital images
   1. Provide images in uncompressed JPEG format
   2. Minimum resolution: 1500 x 2200
   3. Submitted digital images shall not be cropped

D. Identify each digital image file
   1. Name of project
   2. Orientation and description of view
   3. Date and time of exposure

3.4 ADDITIONAL PHOTOGRAPHS

A. Contractor shall provide additional photographs upon the request of the Engineer

B. Additional photographs may include, but not limited to, the following:
   1. Publicity photographs
   2. Special events at Project site
   3. Major phase of Work
   4. Substantial Completion
   5. Follow-up investigations for on-site events such as construction damage or losses

6. Additional record photographs during final acceptance

3.5 PROJECT RECORD

A. Submit CD of all photos, grouped by date

B. Engineer will distribute, after review
   1. One copy of each view to Owner
   2. One copy of each view to Engineer's file
   3. One copy of each view returned to Contractor for inclusion in Project Record Document

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance/Control of installation

B. Inspection and testing laboratory services

C. Qualification of laboratory

D. Laboratory duties

E. Limitations of authority of testing laboratory

F. Contractor's responsibilities

G. Field testing

H. Testing and services schedule

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

B. Section 01340 - Shop Drawings, Product Data, and Samples

C. Section 01600 - Material and Equipment

1.3 REFERENCES

A. Conform to reference standard by date of issue current on date of Contract Documents

B. Obtain copies of standards when required by Contract Documents

C. Where specified reference standards conflict with Contract Documents, request clarification for Engineer before proceeding

D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Provide copies of written reports for materials, equipment or systems as scheduled at the end of this section. Reference each report by respective section number.

C. Laboratory Test Reports: Provide written reports of each test and inspection to Engineer. Each report shall include:
   1. Date issued
   2. Project title and number
   3. Testing laboratory name, address and telephone number
   4. Name and signature of laboratory inspector
   5. Date and time of sampling or inspection
   6. Record of temperature and weather conditions
   7. Date of test
   8. Identification of product and specification section
   9. Location of sample or test in the Project
   10. Type of inspection or test
   11. Results of tests and compliance with Contract Documents
   12. Interpretation of test results when requested by Engineer

D. Shop Test Reports: Provide reports detailing results of tests and certification from manufacturer to verify compliance with specifications

E. Field Test Reports: Provide reports detailing results of the tests. Indicate compliance or non-compliance with Contract Documents. Identify corrective action for materials and equipment which fails to pass field tests.

1.5 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship to produce Work of specified quality

B. Comply fully with manufacturer's instructions, including each step in sequence

C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship

E. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement

F. Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities: Conditions of the Contract

G. Certification of products: Respective sections of specifications

H. Laboratory tests required and standards for testing: Respective sections of specifications

1.6 INSPECTION AND TESTING LABORATORY SERVICES

A. Owner will employ and pay for the services of an independent testing laboratory to perform specified laboratory testing of materials where the technical specifications specifically obligate the Owner to provide the services
   1. Contractor shall cooperate with the laboratory to facilitate the execution of its required services
   2. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the Work of the Contract
   3. Contractor shall employ and pay for the services of an independent testing laboratory to perform all specified services and testing not specifically identified in the technical specifications to be provided by Owner related to the design of mixes, products and equipment, to Engineer's review of proposed materials and equipment before, during and after incorporation in the Work and to retest materials and equipment which fail original tests

B. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Engineer. Payment for retesting will be charged to the Contractor by deducting inspection or testing charges from the Contract Sum/Price

1.7 QUALIFICATION OF LABORATORY

A. Meet "Recommended Requirements for Independent Laboratory Qualification", published by American Council of Independent Laboratories

B. Meet basic requirements of ASTM E 329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction" as applicable

C. Authorized to operate in the State in which the Project is located

1.8 LABORATORY DUTIES

A. Cooperate with Engineer and Contractor; provide qualified personnel after due notice

B. Perform specified inspections, sampling, and testing of materials and methods of construction
   1. Comply with specified standards
   2. Ascertain compliance of materials with requirements of Contract Documents

C. Promptly notify Engineer and Contractor of observed irregularities or deficiencies of work or products

1.9 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory Is Not Authorized To
   1. Release, revoke, alter or enlarge on requirements of Contract Documents

2. Approve or accept any portion of the Work
3. Owner employed laboratory shall not perform any duties of the Contractor

1.10 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory and testing personnel and provide access to Work

B. Secure and deliver to the laboratory adequate quantities of representative samples of materials proposed to be used and which require testing

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete and other material mixes which require control by the testing laboratory

D. Furnish copies of product test reports as required

E. Furnish Incidental Labor and Facilities
1. To provide access to Work to be tested
2. To obtain and handle samples at the project site or at the source of the product to be tested
3. To facilitate inspections and tests
4. For storage and curing of test samples

F. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested
1. Notify Engineer and independent firm 24 hours prior to expected time for operations requiring services to allow for scheduling of tests and laboratory assignment of personnel
2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use

1.11 FIELD TESTING

A. Owner shall pay all costs associated with standard field testing of materials as detailed in these specifications. Contractor shall pay all costs for testing of piping and equipment as detailed in these specifications. Owner's independent firm will take concrete samples, cure and break samples and report results. Owner's independent firm will also provide compaction testing and proctors for backfill operations. Contractor shall pay for all retesting due to tests indicating failed conditions.

B. Provide all required materials, labor, equipment, water, and power required for testing

C. Perform all tests in presence of Engineer and provide one copy of field test results to Engineer same day of tests

D. Repair with no additional compensation all materials and equipment which fail during testing

E. Field testing shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment, or System	Owner (O) or Contractor (C) Provided
02300	Earthwork	O
02740	Asphalt	O
03000	Concrete	O
05120	Structural Steel Framing	O
05400	Cold Formed Steel Framing	O
15060	Pipe and Pipe Fittings	C

1.12 TESTING AND SERVICES SCHEDULE

A. Testing laboratory services shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment, or System	Owner (O) or Contractor (C) Provided
02300	Earthwork	C
02740	Asphalt Mixes	C
03000	Concrete Mixes	C

1.13 SHOP TESTING

A. Shop testing shall be provided for the following:

Specification Section	Type of Material, Equipment, or System	Owner (O) or Contractor (C) Provided
Division 11	Refer to individual specifications for SHOP testing requirements by manufacturer	C

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, heating, ventilating, telephone service, water and sanitary facilities

B. Temporary Controls: Barriers, enclosures and fencing, protection of the Work, and water control.

C. Construction Staging Facilities: Access roads, parking areas, progress cleaning, project signage, storage and temporary buildings.

1.2 GENERAL REQUIREMENTS

A. Furnish, install and maintain all temporary utilities to assure continuous service required for the Work, except as allowed herein, and remove on completion of Work. Modify and extend systems, as work progress requires.

B. Furnish, install and maintain all construction aids required for the Work, except as allowed herein, and remove on completion of the Work

C. Furnish, install and maintain fences and barriers as required for protection of the public, property and the Work

D. Contractor may use existing roadways for access and parking only where designated by Owner.

E. Provide a field office for the use of the Contractor's Superintendent, Owner's Representatives, and Engineer in the designated staging area

F. Products may be new or used, but must be serviceable, adequate for the intended purpose, and must not violate the requirements of any applicable codes or standards

G. Clean and repair damage caused by temporary installations or use of temporary facilities. Grade and seed all disturbed areas not detailed on the drawings for other treatment

H. Provide contractor information sign posted at accessible location with contractor name and emergency phone contact information. Provide and post necessary information related to SRLF requirements.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies

1. Comply with applicable Federal and State rules and regulations, local codes and ordinances
2. Comply with utility company requirements

1.4 TEMPORARY ELECTRICITY

A. Contractor shall pay all costs associated with power service to the field offices and pay all costs for energy used.

B. Arrange for and pay all costs associated with temporary power service either from the local utility or a portable engine-generator

C. Provide power outlets for construction operations, with branch wiring and distribution boxes located at the site. Provide flexible power cords as required

D. Provide main service disconnect and over current protection at convenient location

E. Pay all costs for installation and removal of temporary electrical service

1.5 TEMPORARY LIGHTING

A. Provide and maintain lighting to exterior staging and storage areas after dark for security purposes as required

B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required

C. Maintain lighting and provide routine repairs

1.6 TELEPHONE SERVICE

A. Provide, maintain and pay for all telephone service to field offices at time of project mobilization.

B. Provide one direct line instrument in Field Office for telephone service
1. To field office, one direct line
2. Other direct lines at Contractor's option

C. Pay all costs for removal of telephones

1.7 TEMPORARY WATER SERVICE

A. Potable water does exist on the site. Provide and pay for all temporary potable water piping and hoses to bring to Contractor’s construction facilities and drinking water stations. Install a meter at a location approved by the Owner.

B. Provide all drinking water required by construction personnel and Owner's representatives. Pay all costs for temporary water service.

1.8 TEMPORARY SANITARY FACILITIES

A. Provide sanitary facilities at staging area
   1. As required by laws and regulations
   2. Not less than 1 facility

B. Service, clean and maintain facilities and enclosures

1.9 CONSTRUCTION AIDS

A. Provide construction aids and equipment required by personnel and to facilitate the execution of the Work: scaffolds staging, ladders, stairs, ramps, runways, platforms, railways, hoists, cranes, chutes and other such facilities and equipment

B. Relocate construction aids as required by progress of construction, by storage or work requirements, and to accommodate legitimate requirements by Owner

C. Completely remove temporary materials, equipment, and services at completion of the Project

D. Clean, repair damage caused by installation or by use of temporary facilities
   1. Remove foundations and underground installations for construction aids
   2. Grade the areas for the site affected by temporary installations to required elevations and slopes and clean the area and seed unless specified as shown on the drawings to be different

1.10 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition

B. Provide suitable barriers as required for public protection of Owner's employees

C. Protect non-owned vehicular traffic, stored materials, site and structures from damage

D. Install facilities of a neat and reasonable uniform appearance, structurally adequate for the required purposes

E. Relocate barriers as required by progress of construction

F. Completely remove barriers, including foundations, when construction has progressed to the point that they are no longer needed

G. Clean and repair damage caused by installation, fill and grade the areas of the site to required elevations and slopes and clean the area

1.11 TEMPORARY FENCING

A. Construction: Commercial grade chain link fence

B. Provide additional fencing to protect stored materials & products or to insure public safety and the safety of Owner's employees

C. Provide Owner two (2) keys to lock(s)

D. The site of the work is fenced

1.12 STORMWATER MANAGEMENT

A. Refer to SWMP in the drawings and comply with all conditions of CDPHE Stormwater Discharge Permit. Contractor responsible for both permit filing and any required reporting.

B. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment as necessary.

C. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

D. Perform work in phases and restore areas where work is complete.

1.13 FUGITIVE DUST PERMIT

A. Comply with all conditions of CDPHE Fugitive Dust Permit. Contractor responsible for both permit filing and any required reporting.

B. Contractor to pay for all metered water used in dust abatement

1.14 CONSTRUCTION DEWATERING

A. Comply will all conditions and requirements of CDPHE Construction Dewatering Permit. The Contractor shall be responsible for any permit filing and reporting necessary.

1.15 EROSION AND SEDIMENT CONTROL

A. Install sediment control fencing at site perimeter where necessary to prevent erosion and sedimentation from occurring off site.

B. During and after site grading, maintain a roughened surface on all disturbed areas to minimize erosion potential.

C. Construct and maintain drainage swales with staked straw bale barriers to control drainage patterns and minimize erosion.

D. Provide and maintain gravel sediment traps at inlets to prevent siltation.

E. Provide and maintain rock check dams if required.

F. Soils can be stockpiled on site as directed by Owner. Rock to be hauled off not crushed and stockpiled onsite.

1.16 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification Sections

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage

C. Protect finished driving surfaces, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects

D. Prohibit construction traffic from entering future landscaped areas after grades have been established and topsoil restored

1.17 SECURITY

A. Provide security and facilities to protect Work from unauthorized entry, vandalism, or theft

B. Coordinate with Owner's security program

1.18 ACCESS ROADS

A. Maintain existing roads accessing public thoroughfares to construction staging area.

B. Extend and relocate as Work progress requires. Provide detours necessary for unimpeded traffic flow

C. Provide and maintain access to existing fire hydrants free of obstructions

D. Provide means of removing mud from vehicle wheels before entering public paved streets as required by SWMP and Owner

1.19 PARKING

A. Paved and unpaved surfaces adjacent to the staging area can accommodate construction personnel until the designated building staging area has been established

B. If staging area space is not adequate, provide additional off-site parking at location designated by Owner

1.20 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition

B. Remove waste materials, debris, and rubbish from site periodically and dispose off-site in accordance with local and state regulations. Due to high winds experienced at the site, waste removal must be done immediately after it is generated

1.21 FIELD OFFICES AND SHEDS

A. Construction
   1. Structurally sound, weather-tight, with floors raised above ground
   2. Temperature transmission resistance: Compatible with occupancy and storage requirements
   3. At Contractor's option, portable or mobile buildings modified for office use may be used
   4. Fill and grade sites for temporary structures to provide surface drainage
   5. Construct temporary field offices and storage sheds on proper foundations, provide connections for utility services
      a. Secure portable or mobile buildings for winds to 110 mph
      b. Provide steps and landings at entrance door
   6. Mount thermometer at convenient outside location, not in direct sunlight
   7. Provide periodic maintenance and cleaning for temporary structures, furnishings, equipment and services
   8. Remove temporary field offices, contents, and service at a time they are no longer needed
   9. Remove storage sheds when they are no longer needed
   10. Remove foundations and debris; grade the site to required elevations and clean the areas

B. Contractor's Office and Facilities (not mandatory)
   1. Size: As required for general use and to provide space for project progress meetings
   2. Telephone: One direct line instrument, one fax
   3. Furnishings in meeting area
      a. Conference table and chairs for at least 12 persons
      b. Racks and files for project record documents in, or adjacent to, the meeting area
      c. Engineer and Owner will have use of meeting area and telephone when on site. Meeting area: 200 square feet minimum, minimum dimension 8 feet
   4. Other furnishings: Contractor's option
   5. One 10-inch outdoor-type thermometer

C. Existing facilities at the site shall may be used for field offices

D. Fire protection equipment. Contractor shall provide and maintain fire extinguishers and active fire hydrants where indicated, maintain fire lanes to hydrants, and provide other

equipment as necessary for proper fire protection during construction. Such equipment shall be for fire protection only.

1.22 REMOVAL OF TEMPORARY UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Final Application for Payment

B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated

C. Clean and repair damage caused by installation or use of temporary work

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01550

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies administrative and procedural requirements for cutting and patching

B. Work included in this Section
   1. Cutting and patching not required to be performed as part of the work of other sections
   2. Cutting and patching existing work altered or disturbed to accommodate new construction
   3. Cutting and patching existing work damaged or defaced during new construction as required to restore to existing or better condition at the time of award of Contract
   4. Cutting and patching required to
      a. Install or correct non-coordinated work
      b. Remove and replace defective and non-conforming work
      c. Remove samples of installed work for testing

C. Contractor shall be responsible for all cutting, and patching, including attendant excavation and backfill, required to complete the Work or to:
   1. Uncover portions of the Work to provide for installation of ill-timed work
   2. Remove and replace defective work
   3. Remove and replace work not conforming to requirements of Contract Documents
   4. Remove samples of installed work as specified for testing

1.2 DEFINITIONS

A. Cutting includes cutting into nominally completed or existing construction including, but not limited to, the following, in order to provide for the coordination of Work, installation of Work, uncovering of other facilities and structures for access or inspection, or obtaining samples for testing or other similar purposes
   1. Concrete
   2. Steel
   3. Wood
   4. Miscellaneous metal structures
   5. Piping and pavement

B. Patching includes the repair required to restore cut materials to original or better condition

C. Submittals

1. Submit a proposal describing procedures in advance of the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
    a. Extent: For each occurrence, describe the cutting and patching required, show how it will be performed and indicate the reason(s) it cannot be avoided
    b. In-place construction changes: Describe anticipated results and include changes to structural elements and operating components in addition to changes in building's appearance and other significant visual elements
    c. Products: List products to be used and firms or entities that will perform the Work
    d. Dates: Indicate when cutting and patching will be performed
    e. Utility services and mechanical and electrical systems:
        i) List services and systems that cutting and patching procedures will disturb or affect
        ii) List services and systems that will be relocated and that will be temporarily out of service
        iii) Indicate how long services and systems will be disrupted
    f. Structural elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with the original structure
    g. Approval by Engineer:
        i) Obtain approval of cutting and patching proposal before cutting and patching
        ii) Approval does not waive right to later require removal and replacement of unsatisfactory work

D. Quality Assurance
1. Structural work requirements: Do not cut and patch structural elements in a manner that would reduce their load-carrying or load-deflection ratio
    a. Obtain Engineer approval of cutting and patching proposal before cutting and patching the following structural elements:
        i) Bearing and retaining walls, foundation construction, and structural concrete and structural steel
        ii) Lintels
        iii) Timber and primary wood framing
        iv) Structural decking and stair systems
        v) Equipment supports, piping, ductwork, vessels, and equipment
        vi) Miscellaneous structural metals
2. Operational limitations: Do not cut and patch operating elements or safety related components in a manner that would result in reducing their capacity to perform as intended, or result in increased maintenance or decreased operational life or safety
    a. Obtain Engineer approval of cutting and patching proposal before cutting and patching the following operating elements or safety related systems:
        i) Primary operational systems and equipment
        ii) Air, smoke, water, moisture, or vapor barriers
        iii) Membrane and flashings
        iv) Fire protection, control, communication, or electrical wiring systems
        v) Noise and vibration control elements and systems

3. Visual requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces, in a manner that would, in the Engineer's opinion, reduce the building's aesthetic qualities, or result in visual evidence of cutting and patching
    a. Retain the original installer or fabricator throughout construction phases to cut and patch the following categories of exposed work, if possible, or if it is not possible to engage the original installer or fabricator, engage another recognized experienced and specialized firm:
        i) Concrete finishes
        ii) Pre-formed metal panels
        iii) Painting
        iv) Wall covering
        v) HVAC enclosures, cabinets, or covers
        vi) Firestopping

E. Warranty
1. For existing warranties, Contractor shall replace, patch, and repair material and/or surfaces cut and/or damaged by methods and with materials in order to not void any warranties required or existing

PART 2 PRODUCTS

A. Materials
1. Use materials identical to existing materials unless not available
    a. If identical materials are not available or cannot be used where exposed surfaces are involved, use materials matching existing adjacent surfaces to the fullest extent possible with regard to visual effect
    b. Before proceeding, Contractor shall obtain approval of the Engineer
    c. Use materials whose installed performance will equal or surpass that of existing materials

PART 3 EXECUTION

3.1 INSPECTION

A. Inspect existing conditions of the Project, including elements subject to damage or to movement during cutting and patching. Take corrective action before proceeding, if unsafe or unsatisfactory conditions are encountered

B. After uncovering work, inspect the conditions affecting the installation of products, or performance of the work

C. Report unsatisfactory or questionable conditions to the Engineer in writing; do not proceed with the work until the Engineer has provided further instructions

3.2 PREPARATION

A. Provide devices and methods to protect other portions of the Project from damage

B. Provide temporary support of Work to be cut where required

C. Provide protection from the elements for that portion of the Project which may be exposed by cutting and patching work, and maintain excavations free from water
   1. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations

D. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas

E. Take all precautions necessary to avoid cutting existing pipe, conduit or ductwork serving the building, but scheduled to be removed or relocated until provisions have been made to bypass them

F. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes

G. Restore work which has been cut or removed; install new products to provide completed Work in accordance with requirements of Contract Documents

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay

B. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition
   1. Cutting: Cut existing construction using methods least likely to damage elements to be retained or adjoining construction. Where possible review proposed procedures with the original installer; comply with the original installer's recommendations
      a. In general, where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use
      b. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces
      c. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill
      d. By-pass utility services such as pipe or conduit, before cutting, where services are shown or required to be removed, relocated or abandoned. Cut-off pipe or conduit in walls or partitions to be removed. Cap, valve or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting
      e. Provide fire-safe seals to maintain fire rating at all penetrations
   2. Patching: Patch with durable seams that are as invisible as possible. Comply with specified tolerances

a. Where feasible, inspect and test patched areas to demonstrate integrity of the installation
b. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing
c. Where removal of walls or partitions extends one finished area into another, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary to achieve uniform color and appearance
d. Where patching occurs in a smooth painted surface, extend final paint coat over entire unbroken containing the patch, after the patched area has received primer and second coat
e. Patch, repair or re-hang existing ceilings as necessary to provide an even plane surface of uniform appearance
f. Replace concrete walkways to nearest construction joint

3. Plaster Installation: Comply with manufacturer's instructions and install thickness and coats as indicated

3.4 CLEANING

A. Thoroughly clean areas and spaces where cutting and patching is performed or used as access. Remove completely paint, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore damaged pipe covering to its original condition

END OF SECTION

SECTION 01600

MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Administrative and procedural requirements governing Contractor's selection of products for use in Project and for Work including, but not limited to, the following:
   1. Definitions
   2. General Requirements for Materials and Equipment
   3. Environmental Conditions
   4. Submittals
   5. Quality Assurance and Qualifications
   6. System Responsibility
   7. Transportation and Shipment
   8. Delivery, Storage and Handling
   9. Maintenance Materials
   10. Warranty
   11. Equipment and Product Selection and Identification
   12. Examination, Installation, Adjusting and Cleaning

1.2 RELATED SECTIONS

A. Section 00315 – Pre-Selected Equipment

B. Section 01010 – Summary of Work

C. Section 01340 – Shop Drawings, Product Data, and Samples

D. Section 01400 – Quality Control

E. Section 01650 – Starting of Systems

F. Section 01730 – Operation and Maintenance Data

G. Section 03000 – Concrete

H. Section 15100 – Valves, Cocks, and Hydrants

I. Section 15835 – Exhaust Fans

J. Section 15850 – Air Outlets and Inlets

1.3 REFERENCES

A. AFBMA Std 9-90-Load Ratings and Fatigue Life for Ball Bearings

B. AFBMA Std 11-90-Load Ratings and Fatigue Life for Roller Bearings

C. AGMA-American Gear Manufacturer Association

D. ANSI B1.1-89-Unified Screw Threads

E. ANSI B 1.20. 1-83-Pipe Threads, General Purpose (Inch)

F. ANSI B16.1-89-Cast Iron Pipe Flanges and Flanged Fittings, Class 125

G. ANSI B18.2.1-81-Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Log Screws

H. ANSI B18.2.2-87-Square and Hex Nuts

I. NSF/ANSI 60-2012 Drinking Water Treatment Chemicals – Health Effects

J. NSF/ANSI 61-2012 Drinking Water System Components – Health Effects

K. Hazardous (Classified) Locations: Conform to requirements of NFPA70 Articles 500 through 504

1.4 DEFINITIONS

A. Definitions used in this specification section are not intended to change the meaning of other terms used in the Contract Documents, such as “specialties,” “systems,” “structure,” “finished,” “accessories,” and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry

B. Products: Items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term “product” includes the terms “material”, “equipment”, “system”, and terms of similar intent

C. Named products: Items identified by manufacturer’s product name, including make or model number of other designation, shown or listed in the manufacturer’s published product literature that is current as of date of Contract Documents

D. Foreign products: Distinguished from “domestic products” are items substantially manufactured (50 percent or more of value) outside of the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50 percent) by persons who are not citizens or, nor living within, the United States and its possessions are also considered to be foreign products

E. Materials: Products substantially shaped, cut, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed to form a part of the Work

F. Equipment: Product with operational parts, whether motorized or manually operated, that requires service connections, such as wiring or piping

G. Special tools, instruments, devices, or accessories: Any tools, instruments, devices or accessories required for repair, adjustment or maintenance of equipment which are designed especially for the equipment in question or which are not normally kept in stock by local tool suppliers

H. Responsible manufacturer: Unless otherwise specified, responsible manufacturer shall be manufacturer of driven equipment. Agents, representatives or other entities who are not a direct component of manufacturing corporation will not be acceptable as a substitute for manufacturer's corporation in meeting this requirement

1.5 GENERAL REQUIREMENTS

A. The section applies to all equipment provided under this contract

B. The requirements of detailed specifications take precedence over this section in the event of an apparent conflict

C. Provide all new Equipment and Materials, except as specified or required by testing

D. Equipment and Materials removed from existing structure: Do not use in completed Work except where specifically indicated or specified

E. Contractor to coordinate equipment with other parts of the Work, including verification or compatibility of structures, piping, wiring and equipment components

F. Contractor is responsible for all alterations in the Work to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Drawings or specifications:
   1. The arrangement of equipment shown on the Drawings is based upon information available to the Owner at the time of the design and is not intended to show exact dimensions unique to a specific manufacturer
   2. More than one manufacturer has been used for mechanical layout and design to accommodate all named manufacturer's
   3. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual equipment installation requirements as provided by the Contractor
   4. Structural supports, foundations, connected piping, valves and electrical conduit specified may have to be altered as coordinated by the Contractor during the submittal process to accommodate the actual equipment provided by the Contractor
   5. No additional payment will be made to the Contractor for such revisions and alterations

G. Do not use any material or equipment for any purpose other than that for which is designed or specified

H. Equipment lists presented in these specifications and as specified on the drawings are included for the convenience of the Engineer and Contractor and are not to be considered as complete listings of all equipment, devices and material to be provided under this

contract:

1. Contractor prepare his own material and equipment take-off lists as necessary from the contract drawings, addenda and this project manual to meet the requirements of this project

1.6 ENVIRONMENTAL CONDITIONS

A. Project is a wastewater treatment facility where dilute concentrations of corrosive chemicals, gasses, fuels, high humidity, and other constituents may be expected to be present

B. Various corrosive or explosive mixtures of liquids including; oxidizers (chlorine and chlorine dioxide), solvents, grease, gasoline and other hazardous materials may be present

C. Minimum Design Criteria:
   1. Altitude: 8,650 feet above mean sea level

1.7 SUBMITTALS

A. Provide submittals in accordance with Section 01340

B. Submittals for products are specified in Section 01340 and in Divisions 2 through 16

C. All submittals for each component of multi-component systems shall be compiled and submitted through the Contractor to the Engineer by the manufacturer having System Responsibility

D. Provide a copy of this specification section with all addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate the requested deviations from the specification requirements.

E. Provide Certificate of System Responsibility

F. Tanks, ventilation duct and other equipment mounted outdoors with anchorage and mounting product data for reference purposes:
   1. Include wind loads
   2. Include snow loads

G. Manufacturer's certified data showing location of critical speeds in relation to operating speeds

H. Inverter duty motors: Include motor manufacturer's certification that motor is compatible with variable frequency controllers (drives) to be used with motor as specified in Section 16150 and Section 16200

1.8 QUALITY ASSURANCE AND QUALIFICATIONS

A. Source limitations and interchangeability: To the fullest extent possible, provide products of the same kind from a single source

B. Nameplates: Except for required labels and operating data, do not attach or imprint manufacturer's or producer's nameplate or trademarks on exposed surface of products that will be exposed to view in occupied spaces or on the exterior
   1. Labels: Locate required product labels and stamps on concealed surfaces, or where required for observation after installation, on inconspicuous, accessible surfaces.
   2. Equipment nameplates: Provide a permanent nameplate on each item of service – connected or power-operated equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. Nameplate shall contain, but not limited to, the following information and other essential operating data:
      a. Name of product and manufacturer
      b. Model and serial number
      c. Capacity
      d. Speed
      e. Ratings
      f. Operating and power characteristics
      g. Labels of tested compliance with codes and standards
   3. Refer to additional requirements specified in Divisions 2 through 16

C. Installers Qualifications:
   1. Equipment and material: Installed and placed in service by or under guidance of qualified personnel having knowledge and experience necessary for proper results
   2. Where Contractor's or subcontractor's employees are not properly qualified, use personnel such as factory authorized field representative of equipment supplier

1.9 SYSTEM RESPONSIBILITY

A. Equipment systems made up of two or more components shall be provided as a single system by the responsible manufacturer. Unless otherwise specified, the Contractor shall assign system responsibility to, and obtain each system from the manufacturer of the driven equipment. The manufacturer shall design and provide all components of the system to enhance proper operation, compatibility of all components, ease of construction and efficient maintenance. The responsible manufacturer shall coordinate selection and design of all system components such that all equipment is compatible and operates properly to achieve the performance requirements specified. The Contractor is responsible to the Owner for performance of all systems as provided in the General and Special Conditions.

B. Nothing in this provision shall be construed as relieving the Contractor of overall responsibility for the Work of this Contract and the performance of all systems as specified under paragraphs 00700-Article 13

1.10 TRANSPORTATION AND SHIPMENT

A. Shipment preparation: Contractor shall require manufacturers and suppliers to prepare Equipment and Materials for shipment in a manner to facilitate unloading and handling,

and to protect against damage or unnecessary exposure in transit and storage, for contractor supplied equipment. Provisions for protection shall include the following:

1. Crates or other suitable packaging materials
2. Covers and other means to prevent corrosion, moisture damage, mechanical, injury, and accumulation of dirt in motors, electrical equipment, and machinery
3. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel
4. Grease packing or oil lubrication in all bearings and similar items

B. Marking

1. Each item of Equipment and Material shall be tagged or marked as identified in the delivery schedule or on submittals
2. Complete packing lists and bills of material shall be included with each shipment.
3. Each piece of every item need not be marked separately, provided that all pieces of each item are packed or bundled together and the packages or bundles are properly tagged or marked

1.11 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. Arrange deliveries of Equipment and Materials in accordance with construction schedules, in ample time to facilitate inspection prior to installation and to avoid delay of Work. Coordinate to avoid conflict with work and conditions at the site
2. Deliver products in undamaged condition, in manufacturer's sealed, weather tight, original container or packaging, with identifying labels intact and legible, all in accordance with manufacturer's instructions and recommendations using means and methods that will prevent damage, deterioration, and loss, including theft
3. Control delivery schedules to minimize long-term storage at the Site and to prevent overcrowding of construction spaces. Coordinate delivery and installation to ensure minimum holding or storage times for items known or recognized to be flammable hazardous, easily damaged, or sensitive to deterioration, theft, and other sources of loss
4. Products delivered to Work site shall be in undamaged condition, in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing
5. Mark deliveries of component parts of equipment to identify the equipment, to permit easy accumulation of parts, and to facilitate inspection and measurement of quantity or counting of units
6. Immediately on delivery, inspect shipment to ensure:
   a. Product complies with requirements of Contract Documents and reviewed Submittals
   b. Quantities are correct
   c. Containers and packages are intact and labels are legible
   d. Equipment and Materials are properly protected and undamaged
7. Include complete packing lists and bills of material with each shipment including Equipment Identification number assigned by Drawings and Specifications of this Contract

8. Deliver anchor bolts together with templates sufficiently early to permit setting when structural concrete is placed

B. Storage
1. There is no interior space available from the Owner for storage of delivered equipment and material at the project site:
   a. Provide adequate facilities for storage in accordance with Section 01500
   b. Provide off-site storage and protection when site does not permit on-site storage or protection and if acceptable to Owner in accordance with the General Conditions
2. Submit and maintain insurance for Equipment and Materials at off-site storage
3. Requests for payment of stored Equipment and Materials by the Contractor may be rejected if storage facilities do not conform to these specifications or manufacturer's written recommendations.
4. Store Equipment and Materials immediately on delivery, and protect until completion of the Work. Store in accordance with manufacturer’s instructions with seals and labels intact and legible
5. Store Equipment and Materials in a manner that will not endanger the supporting construction
6. Store Equipment and Materials that are subject to damage by elements in weathertight enclosures
7. Maintain temperature and humidity within ranges required by manufacturer
8. Protect motors, electrical equipment, plumbing fixtures, and machinery of all kinds against corrosion, moisture deteriorations, mechanical injury, and accumulation of dirt or other foreign matter
9. Protect electrical equipment, controls, and insulation against moisture, water, and dust damage
10. Immediately after delivery and inspection, connect and operate continuously all space heaters furnished in electrical equipment
11. Protect exposed-machined surfaces and unpainted iron and steel as necessary with suitable rust-preventive compounds
12. Protect bearings and similar items with grease packing or oil lubrication
13. Handle and store steel plate, sheet metal, and similar items in a manner to prevent deformation
14. Exterior storage:
    a. Provide substantial platforms, blocking, or skids to support fabricated products aboveground and to prevent soiling or staining. Cover products subject to discoloration or deterioration from exposure to elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation
    b. Store loose granular materials on solid surface areas to prevent mixing with foreign matter
    c. Provide surface drainage to prevent flow or ponding of rainwater
15. Equipment and Materials shall not show any pitting, rust, decay or other deleterious effects of storage prior to final acceptance of Work

16. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure products are maintained under specified conditions and free from damage or deterioration
    a. Prepare stored materials lists with schedules of maintenance activities and frequency of activities required to maintain the quality of the equipment and the warranty from the manufacturer
    b. List dates and activities of storage requirements such as rotating moveable parts
    c. Update lists weekly and include in progress meeting agenda
17. Protect painted surfaces against impact, abrasion, discoloration or other damage:
    a. Repaint any damaged areas with manufacturer provided touch-up paint
18. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation
19. Installed products stored prior to start-up:
    a. Equipment and materials shall not show any pitting, rust, decay or other deleterious effects of storage when installed in the Work
    b. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations, dust, dirt, water and paint. Remove when no longer needed

C. Handling
1. Provide equipment and personnel necessary to unload and handle Equipment and Materials, by methods to prevent damage or soiling to Equipment and Materials or packaging
2. Handle by methods to prevent bending or overstressing. Where lifting points are designated, lift components only at those points
3. Provide additional protection to surrounding surfaces as necessary to prevent damage

D. Maintenance of storage
1. Inspect stored Equipment and Materials on a scheduled basis
2. Verify that storage facilities comply with manufacturer's product storage requirements, including environmental conditions continually maintained
3. Verify that surfaces of products exposed to elements are not adversely affected; that any weathering of finishes is acceptable under requirements of Contract Documents
4. For mechanical and electrical equipment in long-term storage, provide manufacturers service instructions to accompany each item, with notice of enclosed instructions on exterior of package. Service Equipment on a regularly scheduled basis.

E. Protection after installation
1. Provide substantial coverings as necessary to protect installed Equipment and Materials from damage from subsequent construction operations
2. Remove when no longer needed or as specified

1.12 MAINTENANCE MATERIALS

A. Spare Parts:
1. Store spare parts, wherever required by detailed technical specification sections, in accordance with the provisions of this paragraph

2. Tag all spare parts with permanent, labeled tags or packaging by equipment designation number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate)
3. Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping
4. Unless otherwise specified, spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box:
   a. Provide box with a hinged wooden cover and locking hasp
   b. Hinges to be strap type
   c. Paint the box and identify with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts"
5. Prepare and provide a neatly typed inventory of spare parts taped to the underside of the box cover

1.13 WARRANTY

A. Warranty all Equipment and Materials against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, leakage, breakage or other failure

B. Unless otherwise specified, for all Equipment and Materials provide manufacturer's warranty for a period of 2 years from the date of Final Completion

C. Warranties that begin at the time of shipment, delivery or within a limited time period from date of shipment or delivery or any other qualification that does not conform to the definition of Substantial Completion are not acceptable

D. Cost of all manufacturer warranties are considered as part of the Bid price

PART 2 PRODUCTS

2.1 MATERIALS

A. Suitable for the intended service conditions

B. Structural and miscellaneous fabricated steel in equipment shall conform to AISC standards, except as otherwise specified

2.2 FABRICATION

A. Design, fabricate, and assemble in accordance with the best modern manufacturing and shop practices

B. Manufacture parts to standard sizes and gages

C. Two or more items of the same type shall be identical by the same manufacturer and interchangeable

2.3 EQUIPMENT AND PRODUCT SELECTION

A. General product requirements: Provide products that comply with the Contract Document, are undamaged, and unless otherwise indicated or specified, are new at time of installation
   1. Provide produces complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect
   2. Standard products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects
   3. Continued availability: Where, because of the nature of its application, the Owner is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair or replacement, provide standard, domestically produced product for which the manufacturer has published assurances that the product and its parts shall be available to the Owner at a later date. A reasonable doubt regarding such future availability will be grounds for rejection of products other than named products
   4. As specified in each applicable Specification Sections, Drawings, codes, standards, and regulatory agencies
   5. Fabricated products:
      a. Design, fabricate, and assemble products in accordance with best engineering and shop practices
      b. Manufacture like parts of duplicate units to standard interchangeable sizes and gauges. Two or more items of same kind shall be identically made by the same manufacturer
      c. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically accepted in writing by Owner
      d. Ensure that material or equipment are not used for any purpose other than that for which it is designed or is specified
      e. Labels and nameplates shall be provided where required by regulatory agencies or in accordance to state identification and essential operation data
   6. Provide products of the same kind from a single source to the fullest extent possible

2.4 EQUIPMENT AND PRODUCT IDENTIFICATION

A. Nametags: Identify all valves, instruments, devices, with the equipment tag designation numbers and prefix and suffix letters as specified and/or shown on the Process and Instrumentation Drawings (P&IDs). Identification shall also be in accordance with Section 01080

B. Nameplates: Identify all pumps and equipment with the equipment tag designation numbers and prefix and suffix letters as specified and/or shown on the Process and Instrumentation Drawings (P&IDs):

1. Provide engraved or machine stamped non-corrosive metal nameplate fastened to the pump or equipment base plate with screws or drive pins of the same material
2. Nameplate material shall not corrode or discolor in moist or salt water spray atmosphere
3. Name plates indicate the following:
    a. Manufacturer
    b. Date of manufacture
    c. Name of product
    d. Model and size
    e. Serial Number
    f. Capacity: Rating in gpm or SCFM (if a fan or blower) and feet of head or inches water column
    g. Impeller or wheel diameter (if a fan)
    h. Impeller diameter
    i. Operating and power characteristics
    j. As specified herein and in Divisions 2 through 16
4. Motor Nameplates:
    a. All motors for pumps and other equipment having motors shall be identified as specified elsewhere under this Section and in Divisions 2 through 16

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install any equipment showing such effects. Replace damaged equipment with identical new equipment

3.2 INSTALLATION

A. Install all equipment, accessories and materials in accordance with the manufacturer's written recommendations unless otherwise specified in the individual equipment detailed technical specifications

B. Each product shall be securely anchored in place except as required for proper movement and performance

C. Each product shall be located and aligned with other Work

D. Manufacturer’s Instructions
    1. Contractor shall obtain and distribute hard copies and electronic copies of manufacturer’s instructions and recommendations to parties involved in installation including a copy to Engineer
    2. Maintain one (1) set of complete instructions at job site during installation and until completion
    3. Handle, install, connect, clean, conditions, and adjust products in accordance with such instructions and in conformity with specified requirements

3.3 ADJUSTING

A. Perform all required adjustment tests, operation checks, and other startup activities required

3.4 CLEANING

A. Perform under provisions of Section 01700

B. Repaint all painted surfaces which are damaged prior to final equipment acceptance to Owner's satisfaction

C. Clean exposed surfaces and protect as necessary and required to prevent any damage or deterioration at the time of Substantial Completion

END OF SECTION

SECTION 01650

STARTING OF SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Starting systems

B. Demonstration, instructions, and training

C. Testing, adjusting, and balancing

1.2 RELATED SECTIONS

A. Section 01730 - Operation and Maintenance Data

1.3 STARTING SYSTEMS

A. Provide Engineer with start-up and training schedule at least 14 days prior to the startup of the equipment

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage

C. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer

D. Verify wiring and support components for the equipment are complete and tested

E. Execute start-up under supervision of responsible manufacturer's representative in accordance with manufacturers' instructions

F. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and supervise placing equipment or system in operation

G. Submit a written report certifying that equipment or system has been properly installed and is functioning correctly

1.4 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner's personnel within 7 days prior to date of Substantial Completion

B. Utilize Operation and Maintenance Manuals as basis for instruction. Review contents of

manual with Owner's personnel in detail to explain all aspects of operation, maintenance, and troubleshooting

C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled times, at equipment location

D. Prepare and insert additional data in Operations and Maintenance Manuals when need for additional data becomes apparent during instruction

E. The amount of time required for instruction on each item of equipment and system is that specified in individual sections

F. Owner may videotape training sessions. Contractor and manufacturer's trainer to cooperate with videotaping

1.5 TESTING, ADJUSTING, AND BALANCING

A. Contractor will employ and pay for services of an independent firm to perform testing, adjusting, and balancing as required by individual specification sections or on the Drawings

B. Reports will be submitted by an independent firm to the Engineer, through the Contractor, indicating observations and results of tests and indicating compliance or non-compliance with specified or regulatory requirements and with the requirements of the contract

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Substantial completion

B. Final acceptance

C. Project record documents

D. Closeout procedures

E. Final cleaning

F. Final adjustment of accounts

G. Final application for payment

1.2 RELATED SECTIONS

A. Section 00700 – General Conditions

B. Section 01500 – Construction Facilities and Temporary Controls

C. Section 01340 – Shop Drawings and Product Data

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Prior to requesting inspection for certification of Substantial Completion, complete the following and list exceptions in the request:
   1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100% completion for the portion of the Work claimed as Substantially Complete
      a. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price
      b. If 100% completion cannot be shown, include a list of incomplete items, the value of incomplete Work, and reasons the Work is not complete. All items remaining outstanding on the Contractor's punch list shall include a projected date of completion and/or correction with an explanation of why such item is not presently completed
   2. Advise Owner of pending insurance changeover requirements
   3. Submit specific warranties, workmanship Bonds, maintenance agreements, final certifications, and similar documents

4. Obtain and submit releases enabling Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases
5. Submit record drawings, instruction books and operating manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information
6. Deliver tools, spare parts, extra stock, and similar items
7. Make final changeover of permanent locks and transmit keys to Owner. Advise Owner's personnel of changeover in security provisions
8. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes

B. Inspection Procedures: On receipt of a request for inspection, Engineer will either proceed with inspection or advise Contractor of unfilled requirements. Engineer will prepare the Certificate of Substantial Completion following inspection or advise Contractor of construction that must be completed or corrected before the certificate will be issued
   1. Engineering will repeat inspection when requested and assured by Contractor that the Work is Substantially Complete.
   2. Results of the completed inspection will form the basis of requirements for final acceptance

1.4 FINAL ACCEPTANCE

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
   1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required
   2. Submit an updated final statement, accounting for final additional changes to the Contract Price
   3. Submit a certified copy of Engineer’s final inspection list of items to be completed or corrected, endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by Engineer.
   4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the Date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work
   5. Submit consent of surety to final payment
   6. Submit evidence of final, continuing insurance coverage complying with insurance requirements

B. Reinspection Procedure: Engineer will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to Engineer.
   1. Upon completion of reinspection, Engineer will prepare a certificate of final acceptance. If the Work is incomplete, Engineer will advise Contractor of Work that

is incomplete or of obligations that have not been fulfilled but are required for final acceptance

2. If necessary, reinspection will be repeated, but at the expense of the Contractor who will reimburse the Owner for these services by the Engineer

1.5 PROJECT RECORD DOCUMENTS

A. General
   1. Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours
   2. Maintain on site, one set of the following record documents; record actual revisions to the Work:
      a. Contract Drawings
      b. Specifications
      c. Addenda
      d. Change Orders and other Modifications to the Contract
      e. Reviewed shop drawings, product data, and samples
      f. Field test reports
      g. Construction photographs
   3. Store Record Documents and samples separate from documents used for construction
      a. Provide files and racks for storage of documents
      b. Provide locked cabinet or secure storage space for samples

B. Record Drawings
   1. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings
   2. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown
   3. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings
   4. Give particular attention to concealed elements that would be difficult to measure and record at a later date
      a. Record information concurrently with construction progress
      b. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work. Mark each document "Project Record" in neat, large, printed letters
      c. Mark new information that is important to Owner but was not shown on Contract Drawings or Shop Drawings
      d. Note related Change Order numbers where applicable
      e. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set
      f. Upon completion of the Work, submit record drawings to Engineer for Owner's records
   5. Contract Drawings and approved Shop Drawings: Legibly mark each item to record actual construction, including:

a. Measured depths of elements of foundation in relation to finish grade or first floor datum
b. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvement
c. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction.
d. Field changes of dimensions and details
e. Changes made by Addenda or Change Order(s), if any
f. Details not on original Contract Drawings
g. References to related Shop Drawings and Modifications

C. Record Specifications: Maintain one complete copy of the Project Manual including addenda. Include with the Project Manual one copy of other written construction documents, such as Change Orders and Modifications issued in printed form during construction
1. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications.
2. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
3. Note related record drawing information and product data.
4. Upon completion of the Work, submit record Specifications to Engineer for Owner's records

D. Record Product Data: Maintain one copy of each product data Submittal. Note related Change Orders and markup of record drawings and specifications.
1. Mark record documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the Site and from the manufacturer's installation instructions and recommendations.
2. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation.
3. Upon completion of markup, submit complete set of record product data to Engineer for Owner's records
4. Legibly mark and record at each Product section description of actual Products installed, including the following:
a. Manufacturer's name, product model, number, trade name and supplies
b. Product substitutions or alternates utilized
c. Changes made by Addenda, field order or change order

E. Record Samples Submitted: Immediately prior to Substantial Completion, Contractor shall meet with Engineer and Owner's personnel at the Project Site to determine which Samples are to be transmitted to Owner for record purposes. Comply with Owner's instructions regarding packaging, identification, and delivery to Owner.

F. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record keeping and Submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records, and place in good order. Identify miscellaneous records properly

and bind or file, ready for continued use and reference. Submit to Engineer for Owner's records
1. For electrical refer to Section 16900

G. Maintenance Manuals: Contractor shall organize operation and maintenance data as specified in Section 01730

H. Submit documents to Engineer with claim for final Application for Payment

I. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes

J. Make documents and samples available at all times for inspection by Engineer

K. Label each document "Project Record" in neat, large printed letters

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 CLOSEOUT PROCEDURES

A. General
1. Comply with requirements stated in the Owner's General Conditions of the Contract and in these specifications for administrative procedures in closing out the Work
2. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection
3. Provide submittals to Engineer/Owner that are required by governing or other authorities
4. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due

B. Operation and Maintenance Instructions: Arrange for each installer of Equipment that requires regular maintenance to meet with Owner's personnel at Project Site to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
1. Maintenance manuals
2. Record documents
3. Spare parts, materials and tools
4. Lubricants and fuels
5. Identification systems
6. Control sequences
7. Hazards, hazardous chemicals data sheets
8. Cleaning
9. Warranties and bonds

10. Maintenance agreements and similar continuing commitments

C. As part of instruction for operating Equipment, demonstrate the following procedures:
   1. Startup
   2. Shutdown
   3. Emergency operations
   4. Noise and vibration adjustments
   5. Safety procedures
   6. Economy and efficiency adjustments
   7. Effective energy utilization

3.2 FINAL CLEANING

A. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
   1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion
      a. Remove labels that are not permanent labels
      b. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition
      c. Wipe surfaces of mechanical and electrical Equipment. Remove excess lubrication and other substances
   2. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction
   3. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the Site and dispose of lawfully.
      a. Where extra materials of value remaining after completion of associated Work become Owner's property. Dispose of these materials as directed by Owner

3.3 CONTRACTOR'S CLOSEOUT SUBMITTALS

A. Evidence of Payment and Release of Liens: As specified in the General Conditions

B. Final inspection reports by all regulatory agencies demonstrating the agencies' final approval

C. At Contract close-out, deliver Record Documents to Engineer for the Owner

D. Accompany Submittal with Transmittal Letter in Duplicate, Containing
   1. Date
   2. Project title and number
   3. Contractor's name and address
   4. Title and number of each Record Document
   5. Signature of Contractor or his authorized representative

3.4 FINAL ADJUSTMENTS OF ACCOUNTS

A. Submit a Final Statement of Accounting to Engineer

B. Statement Shall Reflect All Adjustments to the Contract Sum
   1. The original Contract Sum
   2. Additions and deductions resulting from
      a. Previous Change Orders
      b. Deductions for uncorrected Work
      c. Deductions for liquidated damages
      d. Deductions for reinspection payments
      e. Other adjustments
   3. Total Contract Sum, as adjusted
   4. Previous payments
   5. Sum remaining due

3.5 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the General Conditions of the Contract

END OF SECTION

SECTION 01730

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittals

B. Format

C. Content of each volume

D. Manual for equipment and systems

E. Instruction of Owner's personnel

1.2 QUALITY ASSURANCE

A. Preparation of data shall be done by personnel
   1. Trained and experienced in maintenance and operation of the described products
   2. Completely familiar with requirements of this section
   3. Skilled as a technical writer to the extent required to communicate essential data
   4. Skilled as a draftsman competent to prepare required drawings

B. Manuals for equipment systems shall be prepared by the equipment manufacturer or system supplier

C. Compile product data and related information appropriate for Owner's maintenance and operation of products furnished under the Contract

D. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent sections of Specifications

1.3 SUBMITTALS

A. Submit under provisions of Section 01340

B. Manuals for equipment and systems
   1. Submit 3 preliminary copies prior to the date of shipment of the equipment or system
      a. Engineer will review
      b. If acceptable, 1 copy will be returned to Contractor, 1 copy sent Owner, and 1 copy retained in Engineer's file

c. If unacceptable, 2 copies will be returned to Contractor with Engineer's comments for revision and 1 copy retained in Engineer's file. Resubmit 3 revised preliminary copies for Engineer's review
d. No partial payments will be made for equipment and systems on hand or installed until preliminary manuals are submitted and acceptable
e. See Section 01340 for electronic submittal requirements, for the preliminary copy of the O&M manual an electronic submittal is allowable

C. Submit 3 final copies no less than 30 days prior to putting the equipment or system in service. If final manuals differ from accepted preliminary manuals, submit 2 copies of any necessary supplemental material with instructions for insertion for conforming Engineer's and Owner's copies of preliminary manuals to final manuals
1. Engineer will compare with accepted preliminary manual
2. If identical or otherwise acceptable, Contractor will be so notified. Two copies will be transmitted to Contractor, 3 copies will be held for later transmittal to Owner
3. If not acceptable, 4 copies will be returned to Contractor for revision or retained by Engineer and the necessary revision data requested from Contractor at Engineer's option
4. No portion of the Work is substantially complete until final equipment and system manuals relating to that portion of the Work are accepted by Engineer
5. Submit 3 copies of any revisions found desirable during instruction of Owner's personnel with instructions for insertion for revising Owner's and Engineer's copies of manual

D. Manual for materials and finishes
1. Submit 2 preliminary copies 15 days prior to request for final inspection
a. Engineer will review
b. One copy will be returned to Contractor with comments, 1 retained in Engineer's file
c. No final inspection shall be conducted until preliminary manuals are submitted
2. Submit 3 final copies, revised in accordance with Engineer's comments, within 10 days after final inspection
a. One copy will be transmitted to Contractor and 2 copies retained by Engineer for later transmittal to Owner
b. No final payment shall be made until final manuals are submitted
3. Additional requirements for specialized instruction of Owner's personnel are given in the detailed equipment specifications

1.4 FORMAT

A. Prepare data in the form of an instructional manual for use by Owner's personnel

B. Presentation of Information
1. Size: 8 ½" by 11"
2. Paper: 20 lb weight minimum, white, for typed pages
3. Text: Manufacturer's printed data or neatly typewritten

4. Drawings
    a. Provide reinforced punched binder tab, bind in with text
    b. Reduced to 11" by 17" and folded to 8 ½" by 11"
    c. Where reduction is impractical, folded and placed in 8 ½" by 11" envelopes bound in text
    d. Suitably identified on drawings and envelopes
5. Provide flysheets for each separate product or each piece of operating equipment
    a. Provide typed description of product and major component parts of equipment
    b. Provide indexed tabs, may be in color
6. Spine and cover: identify each volume with typed or printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" preceded by the word. "PRELIMINARY" or "FINAL" as applicable. Final manuals to list information on the cover and the spine. List the following:
    a. Title of project, reference Owner and project location as applicable
    b. Identity of separate structure as applicable
    c. Identity of general subject matter covered in manual and specification section number
7. As much as possible, assemble and bind material in the same order as specified

C. Binders
1. Preliminary manuals: Commercial quality permanent 3-ring or 3 post binders with durable, cleanable, hard plastic covers. GBC bound manual may be accepted upon review by Engineer
2. Final manuals: Commercial quality permanent 3-ring or 3 post binders with durable, cleanable, hard plastic covers with clear plastic cover and spine pockets suitable for title and cover inserts. Manufacturer's pre-printed binder may be accepted upon review by Engineer. "Deluxe Round Ring View Binder" as manufactured by Wilson Jones or accepted substitution
3. Final electronic manual: Provide one copy in digital format, all documents to be in native file format (Word, Excel, AutoCAD, pdf) or converted from native file format into Adobe pdf. Provide one copy on an electronic disk, CD or DVD

D. Arrange content by systems under section numbers and sequence of table of contents of this Project Manual

E. Provide tabbed flyleaf for each separate product and system, with typed description of product and major component parts of equipment

F. Electronic Manual: Compile in an electronic book format with Chapter bookmarks (equal to tabbed fly leafs) and OCR (optical character recognition) to allow for document searches.

1.5 CONTENTS OF EACH VOLUME

A. Neatly typewritten table of contents for each volume, arranged in a systematic order
1. Contractor, name of responsible principal, address and telephone number

2. A list of each product required to be included, indexed to the content of the volume
3. List, with each product, the name, address and telephone number of
    a. Subcontractor or installer
    b. Maintenance contractor, as appropriate
    c. Identify the area of responsibility of each
    d. Local source of supply for parts and replacement
4. Identify each product by product name and other identifying symbols as set forth in Contract Documents

B. Product Data
1. Include only those sheets which are pertinent to the specific product
2. Annotate each sheet to
    a. Clearly identify the specific product of part installed
    b. Clearly identify the data applicable to the installation
    c. Delete references to inapplicable information

C. Drawings
1. Supplement product data with drawings as necessary to clearly illustrate
    a. Relations of component parts of equipment and systems
    b. Control and flow diagrams
2. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation
3. Do not use Project Record Documents as maintenance drawings

D. Written text, as required to supplement product data for the particular installation
1. Organize in a consistent format under separate headings for different procedures
2. Provide a logical sequence of instructions for each procedures

E. Copy of each warranty, bond and service contract issued
1. Provide information sheet for Owner's personnel, give
    a. Proper procedures in the event of fracture
    b. Instances which might affect the validity of warranties or bonds

1.6 MANUALS FOR EQUIPMENT AND SYSTEMS

A. Provide an operation and maintenance manual for each item of equipment or system listed in the schedule of manuals in the quantity listed in the submittal schedule

B. Content for each of equipment and system as appropriate
1. Description of unit and component parts
    a. Function, normal operating characteristics and limiting conditions
    b. Performance curves, engineering data and tests
    c. Complete nomenclature and commercial number of all replaceable parts
2. Operating procedures
    a. Startup, break-in, routine and normal operating instructions
    b. Regulation, control, stopping, shutdown and emergency instructions

c. Summer and winter operating instructions, as applicable
d. Special operating instructions

3. Maintenance procedures
   a. Routine operations
   b. Guide to "trouble-shooting"
   c. Disassembly, repair and reassembly
   d. Alignment, adjusting and checking
4. Servicing and lubrication schedule
   a. List of lubricants required
5. Manufacturer's printed operating and maintenance instructions
6. Description of sequence of operation by control manufacturer
7. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance
   a. Predicted life of parts subject to wear
   b. Items recommended to be stocked as spare parts
8. As-installed control diagrams by controls manufacturer
9. Each contractor's coordination drawings
   a. As-installed color coded piping diagrams
10. Charts of valve tag numbers with the location and function of each valve
11. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage
12. Other data as required under pertinent sections of specifications

C. Content for each electric and electronic item or system, as appropriate
   1. Description of system and component parts
      a. Function, normal operating characteristics and limiting conditions
      b. Performance curves, engineering data and tests
      c. Complete nomenclature and commercial number of replaceable parts
   2. Circuit directories of panelboards
      a. Electrical service
      b. Controls
      c. Communications
   3. As-installed color coded wiring diagrams
   4. Operating procedures
      a. Routine and normal operating instructions
      b. Sequences required
      c. Special operating instructions
   5. Maintenance procedures
      a. Routine operations
      b. Guide to "trouble-shooting"
      c. Adjustment and checking
   6. Manufacturer's printed operating and maintenance instructions
   7. List of original manufacturer's spare parts, manufacturer's current prices and recommended quantities to be maintained in storage
   8. Other data as required under pertinent sections of specifications

D. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel

E. Additional requirements for Operation and Maintenance Data: The respective sections of specifications

1.7 INSTRUCTIONS OF OWNER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in the operation, adjustment and maintenance of all products, equipment and system

B. Operation and maintenance manual constitutes the basis of instruction
   1. Review contents of manual with personnel in full detail to explain all aspects of operations and maintenance

1.8 Additional requirements for specialized instruction of Owner's personnel are given in the detailed equipment specifications

A. Equipment and systems Operation and Maintenance manuals shall be prepared for each of the following

Specification Section	Type of Equipment or System
11272	Mechanical Fine Screen
11275	Shafted Screw Conveyor

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 02220

DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Demolition, removal, salvage and disposal of existing site features, piping, structures and materials where indicated on the drawings and as specified in this section

B. Demolition and removal of concrete foundations, concrete and asphaltic paving

C. Demolition of concrete knockouts for backwash waste sumps

1.2 RELATED SECTIONS

A. Section 01500 – Construction Facilities and Temporary Controls

B. Section 02300 – Earthwork

1.3 SUBMITTALS

A. Permits and Certificates.
   1. Permits and notices authorizing building demolition
   2. Certificates of severance of utility service
   3. Permit for transport and disposal of debris

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 specifications

B. Accurately record actual locations of capped utilities and subsurface obstructions

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable State and local codes for demolition of structures, safety of adjacent structures, dust control, and disposal

B. Obtain required permits from authorities

C. Notify affected utility companies before starting work and comply with their requirements

D. Do not close or obstruct roadways, sidewalks, or hydrants without written permission from Owner

E. Conform to applicable regulatory procedures when discovering hazardous or contaminated materials

1.6 SCHEDULING

A. Schedule and submit under provisions of Division 1 specifications

B. Provide detailed descriptions for demolition and removal procedures

C. Notify Engineer and Owner of any demolition work one (1) week prior to commencement

D. Coordinate all demolition work with Engineer and Owner

PART 2 PRODUCTS

2.1 SALVAGE OF MATERIALS

A. Remove and return to Owner the following Equipment and Materials:
   1. Two (2) 90 degree elbows from the existing lift station

B. All existing construction and items not salvaged to Owner shall be considered waste and shall become the property of Contractor for off-site disposal

C. Remove and reinstall as indicated on Drawings and herein the following Equipment and Materials:
   1. Treatment unit catwalk grating and stairs

2.2 HANDLING AND STORAGE

A. Contractor shall carefully disassemble Equipment and Materials that are to be reused and returned to Owner in such a way to avoid any damage. Contractor shall store such Equipment and Materials in such a way to avoid any damage, corrosion, or staining

2.3 FILL MATERIALS

A. Fill Material: Use on site fill material under provisions of Section 02300 and in accordance with Geotechnical recommendation

PART 3 EXECUTION

3.1 INSPECTION

A. Verify areas to be demolished are unoccupied and discontinued in use

B. Do not commence work until conditions are acceptable to Engineer and Owner

C. Existing conditions of Equipment and Materials, structures, surfaces, or properties that could be misinterpreted as damaged as a result of demolition work shall be photographed and filed with Owner and Engineer prior to commencement of Work

3.2 PREPARATION

A. Provide, erect, and maintain temporary barriers, enclosures, security fences and shoring at demolition locations in accordance with Division 1 and other related specifications to protect personnel

B. Protect existing structures and utilities which are not to be demolished

C. Provide temporary wiring and connections to maintain existing telephone, electrical, instrumentation and control systems in service during construction

D. Protect existing electrical and controls equipment and cabinets from dust and debris intrusion. Set up temporary barriers to preclude dust from being introduced into cabinets and equipment. Additionally seal all cabinets and equipment while demolition is occurring. Control and or turn off existing heating and ventilation systems that will introduce or distribute dust and debris from the demolition operations.

E. Mark location of existing utilities

3.3 GENERAL REQUIREMENTS

A. Sprinkle Work with water to minimize dust where applicable. Provide hoses and water connections for this purpose.

B. Do not use water to extent causing flooding, contaminated runoff, or icing

C. Remove demolished material from the site

D. Repair damage to adjacent structures

E. Remove existing exposed piping and electrical wiring and conduit to be abandoned to structural surface, cut flush, and finish to match existing surfaces

F. Remove buried piping, wiring, and conduit to be abandoned as required for the Work. Plug the remainder flush.

3.4 DISPOSAL

A. Do not store or burn waste materials on-site

B. Transport demolition debris to designated off-site disposal area

C. If hazardous materials are encountered during demolition work, Contractor shall comply with applicable regulations and laws regarding the removal, handling, and protection of environment and human health

3.5 CONNECTION TO EXISTING CONSTRUCTION

A. Cut and remove portions of existing construction as necessary to allow for proper installation of new construction Equipment and Materials

B. Shore and brace existing structures to maintain safe structure conditions and until permanent structures and supports are completed
   1. Contractor shall repair all damage in result of installation of shoring and bracing

C. Cap, seal or abandon pipe and cable as indicated on Drawings and specified herein

3.6 CLEANUP AND REPAIR

A. Contractor shall remove tools, equipment and demolished materials from Site upon completion of demolition work
   1. Remove protections
   2. Interior areas shall be broom clean
   3. Inspect and clean all electrical control cabinets, interior and exterior, exposed to dust and debris during the demolition process

B. Contractor shall repair demolition performed in excess of that required or indicated
   1. Surfaces and structures to remain shall be repaired to the existing conditions prior to commencement of demolition work

3.7 SITE DEMOLITION

A. Disconnect, remove, cap and identify designated utilities within demolition area

B. Remove asphalt paving, parkway, and other concrete work to facilitate construction. Remove concrete to nearest joint beyond demolition area.

C. Remove storm sewer items where shown on the Drawings.

D. Backfill areas excavated caused as a result of demolition, in accordance with Section 02300

E. Rough grade and compact areas affected by demolition to maintain site grades and contours as shown on drawings

F. Remove demolished materials from site

G. Do not burn or bury materials on site, unless otherwise directed by Owner. Leave site in clean condition.

3.8 ELECTRICAL DEMOLITION

A. General:
   1. Remove, relocate and extend existing installation to accommodate new construction.

3.9 BUILDING DEMOLITION

A. Remove and dispose of concrete knockouts for backwash waste sumps in filter building where indicated on the Drawings

B. Remove and dispose of portions of chlorine room as indicated on Drawings

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, and Division 1 and other related specification sections apply to work of this section

1.2 SECTION INCLUDES

A. Clearing, grubbing and site preparation

B. Removal and disposal of debris

C. Handling, storage, transportation, and disposal of excavated material

D. Sheeting, shoring, bracing and protection work

E. Pumping and dewatering as required, if necessary

F. Backfilling

G. Pipe embedment

H. Construction of fills and embankments

I. Excavation for buildings and structures

J. Pavement subgrade preparation

K. Trench stabilization

L. Final grading

M. Slope stabilization

N. Erosion control

O. Appurtenant work

1.3 RELATED SECTIONS

A. Section 01020 – Geotechnical Report

B. Section 02220 – Demolition

C. Section 02740 – Asphaltic Concrete Paving

D. Section 03000 – Concrete

1.4 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
   2. D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12-Inch Drop
   3. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil
   4. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
   5. D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
   6. D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Council of American Building Officials/American National Standards Institute (CABO/ANSI)
   1. A117.1 – Accessible and Useable Buildings and Facilities Standards

C. Occupational Safety and Health Administration (OSHA)
   1. Part 1926 – Safety and Health Regulations for Construction

1.5 SUBMITTALS

A. Submit under provisions of Division 1 Specifications

B. Product Data: Submit on all products or materials supplied herein

C. Test Reports: Indicate supplier, sieve analysis, optimum moisture content and density in accordance with ASTM D698 if appropriate for crushed rock or gravel, pipe embedment and material for fills and embankment

D. When excavation, trenching, and shoring in compliance with local, state, or federal safety regulations such as OSHA Part 1926 or successor regulations, require design by a registered professional engineer, submit copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems prepared by or under the supervision of a professional engineer legally authorized to practice in the jurisdiction where the Project is located

1.6 REGULATORY REQUIREMENTS

A. Burning will not be allowed on-site. Comply with all State and County codes, regulations, and laws

B. Obtain and comply with all requirements of Town of Telluride, San Miguel County, and CDPHE Stormwater and/or Groundwater Discharge Permits, as required

1.7 ENVIRONMENTAL REQUIREMENTS

A. Protect adjacent structures and surrounding areas from damage during excavation, filling, and backfilling

B. Protect work from erosion or other similar types of damage until the project has been completed. Do not backfill or construct fills or embankments during freezing weather. Backfill or construct fills or embankments only when temperature is 35°F and rising

C. Do not use frozen materials, snow, or ice in any backfill, fill, or embankment area

D. Do not backfill or construct fill or embankments on frozen surfaces, protect excavated material from becoming frozen

E. Do not backfill or construct fills or embankments during periods of heavy rainfall when soil moisture conditions will not allow proper compaction to be achieved

F. Do not remove trees from outside excavation or fill areas unless authorized by the Owner; protect from permanent damage by construction activities

G. Provide temporary bridges for roadways, walkways, driveways, etc.

1.8 QUALITY ASSURANCE

A. All imported material to be free of hazardous and organic wastes, “clean” as defined by EPA, and approved for its intended use by the Owner or project geotechnical engineer

B. Comply with applicable requirements of CABO/ANSI A117.1 for access requirements related to walks, ramps, and curb ramps

C. Obtain and comply with all requirements of Town of Telluride, San Miguel County, and CDPHE Stormwater and/or Groundwater Discharge Permits, as required

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Soil materials, whether from sources on or off the site must be approved by the Geotechnical Engineer as suitable for intended use and specifically for required location or purpose

B. Classification of Excavated Materials:
   1. Remove and handle all excavated materials regardless of its type, character, composition, condition, or depth. All material that is not classified as rock excavation at described in Paragraph 2.1.B.2 Rock Excavation is included herein
   2. Rock excavation is classified as removal of solid material that by actual demonstration, in the Engineer's opinion, cannot be reasonably loosened or ripped by either a single-tooth, hydraulically operated ripper mounted on a crawler tractor in

good condition rated at a minimum 300 flywheel horsepower or excavated with a minimum 325 flywheel horsepower hydraulic excavator in good condition equipped with manufacturer's standard boom, two rippers and rock points, or

a. Material that for convenience or economy is loosened by drilling, or the use of pneumatic tools, is not considered rock excavation
b. Removal of boulders larger than 1/2 cubic yard will be classified as rock excavation, if drilling or breaking them apart with power operated hammer, hydraulic rock breaker, expansive compounds, or similar means is both necessary and actually used for their removal
c. Contractor to inform engineer when rock excavation is required prior to performing Work
d. Contractor to provide accurate records of excavated rock to confirm quantity of rock excavated

3. Transport and properly dispose of any rubble and waste materials found in excavation off the Owner's property
   a. When dealing with excavation of transite or asbestos containing materials, Contractor shall comply with special handling requirements

C. Fills and Embankments
1. Use excess earth from on-site excavation for fills and embankments if practical
2. Obtain additional material from Owner designated borrow areas if necessary
3. Free from rocks or stones larger than 12 inches in greatest dimension and free from brush, stumps, logs, roots, debris, and organic and other deleterious materials
4. No rocks or stones larger than 6 inch in upper 18 inches of fill or embankment. Where allowed, distribute rocks and stones through the fill to not interfere with compaction.
5. Fill and embankment material must be acceptable to Geotechnical Engineer
6. Import fill: free of vegetation and debris, non expansive and maximum plasticity index of 15 (when tested using ASTM D4318)

Sieve Size (Inch)	**Percent Passing by Weight**
4	100
2.5	85-100
No. 4	70-100
No. 200	10-50

D. Structural Fill
1. Imported structural fill, such as a minus ½-inch CDOT Class 6 Aggregate Road Base, for one foot layer at backwash basins and two feet at drying beds over recompacted subgrade under structures conforming to the following:
   a. Gradation: 1" – 100% passing (percent finer by weight ASTM C136), No. 8 Sieve – 20-85% passing, and No. 200 Sieve – 20% (maximum)
   b. Liquid Limit: 35 (maximum), Plasticity Index: 15 (maximum), R-Value: 50 (min)

E. Topsoil

1. Topsoil is defined as friable (easily crumbled) clay loam surface soil, with high organic content, found in a depth of less than 4 inches below existing grade. Excavate acceptable material further to provide all topsoil necessary for project needs
2. Clean topsoil, free of plants and seed will be spread to 4 inches minimum depth, or as specified by plans, whichever is greater.
3. Reuse grubbing and surface topsoil containing plants and seeds in designated revegetation areas only.
4. Stockpile of all remaining topsoil which is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of rocks, stumps, stones larger than 2" in any dimension, and other extraneous or toxic matter harmful to plant growth for areas to be seeded or planted.

F. Pipe Embedment: Graded gravel
1. Washed rock - 1½ inch minus

Sieve Size (Inch)	**Percent Passing by Weight**
2	100
1½	95-100
1	80-95
¾	30-45
½	10-25
3/8	<1

2. Squeegee

Sieve Size	**Percent Passing by Weight**
3/8”	100
No. 4	85-100
No. 8	30-70
No. 16	5-40
No. 30	0-15
No. 50	0-10
No. 100	0-5
No. 200	<1

G. Drain gravel
1. Crushed rock, granular material with a maximum size of 1-1/2"
2. Minimum 50 percent passing No. 4 sieve; maximum 5 percent retained on No. 200 sieve

H. Compacted Trench Backfill
1. Job excavated material finely divided, free of debris, organic material, and stones larger than 3 inch; without moist, stiff clay, or topsoil
2. Graded gravel: As specified or shown on Drawings for pipe embedment

I. Trench Cover
1. Free of brush, debris and roots

2. In upper 18 inch no rock or rock excavated detritus, larger than 6” except with specific approval of Geotechnical Engineer
3. No stones larger than 3 inch in greatest dimension within 3 feet of top of pipe

J. Controlled Low Strength Material (Flow Fill)
1. Product shall be a lean, sand-cement slurry, “flowable fill” or similar material with a 28-day unconfined compressive strength between 50 and 200 psi

K. Coarse Base Rock
1. Granular material, maximum 3"; less than 10% passing 1" sieve
2. Shall be free of trash, clay or dust
3. Compaction as specified by Geotechnical Engineer

L. Road Base
1. Shall meet ASTM specification for Class II aggregate base and CDOT Class 6 gradation

Sieve Size	**Percent Passing by Weight**
1”	100
3/4	900-100
#4	35-55
#30	10-30
#200	2-9

2.2 ACCESSORIES

A. Silt Fence Fabric: woven polypropylene
1. Mirafi 100X, "Envirofence"
2. Or accepted substitution

PART 3 EXECUTION

3.1 EXAMINATION

A. Field verify the location of all underground utilities, pipelines and structures prior to excavation

B. Maintain service to pipelines indicated on Drawings during construction

3.2 PERFORMANCE – GENERAL

A. Perform work in a safe manner with appropriate precautions against hazard

B. Provide adequate working space and clearances for work performed within excavations and for installation and removal of utilities

C. Contain all construction activity on the designated site and within limits of work. Cost of restoration off site will be borne by the Contractor

3.3 SITE PREPARATION

A. Clearing and Grubbing
   1. Clear site areas to be occupied by permanent construction of grasses, roots, brush, and other material and debris
   2. Clean and strip subgrade for fills and embankments of surface vegetation, sod, tree stumps and organic topsoil
   3. Work shall be conducted such that damage to property is prevented and safety of employees implemented
   4. Remove and dispose of tree stumps and roots over 3 inches in diameter to a minimum depth of 18 inches below the natural surface or 5 feet below finished surface level, whichever is lower
   5. Remove debris, all trees, underbrush, stumps, roots and other combustible materials from site daily and dispose of off-site
      a. On-site burning is not permitted
   6. Backfill all excavated depressions including grub holes with approved material

B. Tree Protection
   1. Do not remove trees outside fill or excavated areas, except as authorized by Owner
   2. Protect trees left standing from permanent damage by construction operation
   3. Protect trees, trunks, and roots of existing trees on site which are to be retained

C. Topsoil Stripping
   1. Strip on-site material meeting the topsoil definition to a minimum depth of 4 inches from areas to receive grading as shown on Drawings
   2. Stockpile topsoil in areas designated by Owner and indicated on Drawings where it will not interfere with construction operations and activities and existing facilities
   3. At the completion of work in each area, place and grade topsoil to maintain gradient as indicated and required. Roughen surface for erosion control

D. Waste and Debris
   1. Stockpile all acceptable grubbings for reuse in native revegetation areas
   2. Remove and dispose of all waste materials and debris from clearing, grubbing, stripping and demolition off site

3.4 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. Excavation and backfill operations shall be performed in such a manner to prevent cave-ins of excavations or the undermining, damage or disturbing of existing utilities and structures or of new work.

B. Backfill shall be placed and compacted so as to prevent future settlement or damage to existing utilities and structures and new work

C. Any excavations improperly backfilled or where settlement occurs shall be reopened to the depth required then refilled with approved materials and compacted, and the surface restored to the required grade and condition, at no additional costs to the Owner

D. Any damage due to excavation, backfilling, or settlement of the backfill, or injury to persons or damage to property occurring as a result of such damage shall be the responsibility of the Contractor. All costs to repair such damage, in a manner satisfactory to the Engineer, shall be borne by the Contractor at no additional expense to the Owner

3.5 EXCAVATION

A. General
   1. All materials encountered during excavation, regardless of type, character, condition or composition, shall be unclassified excavation
   2. Sequence of all excavation operations shall be such as to ensure the most efficient reuse of excavated materials where suitable.
   3. Suitable materials shall be used or stockpiled for later use in backfill and subgrade preparation. All unsuitable material shall be removed from the site and legally disposed of at Contractor's expense

B. Blasting
   1. Blasting or other use of explosives is not permitted

C. Dewatering
   1. General
      a. All dewatering activities in accordance with all federal, state, and local regulations regarding site drainage, dewatering, and erosion and sediment control including permitting requirements
      b. Design and provide dewatering system using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom and/or sides. Design system to prevent differential hydrostatic head, which would result in floating out soil particles in a manner, termed as a “quick” or “boiling” condition. System shall not be dependent solely upon sumps and/or pumping water from within the excavation where differential head would result in a quick condition, which would continue to worsen the integrity of the excavation’s stability
      c. Provide and maintain adequate dewatering equipment including power supply, if necessary, to remove and dispose of surface and groundwater entering excavations, trenches, and other parts of the Work
      d. Provide dewatering system of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow all Work to be installed in a dry condition
      e. Control groundwater in a manner that preserves strength of foundation soils, does not cause instability or raveling of excavation slopes, and does not result in damage to existing structures. Where necessary to these purposes, lower water level in advance of excavation, utilizing wells, wellpoints, jet educators, or similar positive methods
      f. Keep each excavation dry during subgrade preparation and continually thereafter until the structure to be built or the pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result

g. Dewater excavations which extend to or below groundwater by lowering and keeping the groundwater level beneath such excavation at least 12 inches below the bottom of the excavation
h. Design, furnish, install, test, operate, monitor and maintain dewatering system of sufficient scope, size and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades
i. Divert surface water or otherwise prevent it from entering excavated areas or trenches to the extent practical without damaging adjacent property
j. Maintain all drainage pipes, keep clean and free of sediment during construction and final cleanup
k. Open pumping with sumps and ditches shall be allowed, provided it does not result in boils, loss of fines, softening of the ground, or instability of slopes
l. No additional payment will be made for any supplemental measures to control seepage, groundwater, or artesian head
m. Dewatering to surface waterways requires Colorado Department of Public Health and Environment dewatering permit. Contractor must obtain dewatering permit and comply with discharge requirements therein, if necessary

2. Design
   a. Contractor shall be responsible for the accuracy of the Drawings, design data, and operational records required
   b. Contractor shall be solely responsible for the design, installation, operation, maintenance, and any failure of any component of the system
3. Damages
   a. Contractor shall be responsible for and shall repair without cost to the Owner any damage to work in place, or other contractor's equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, natural resources, habitat, existing wells, and the excavation including, damage to the bottom due to heave and including but not limited to, removal and pumping out of the excavated area that may result from Contractor's negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system
   b. Remove sub grade materials rendered unsuitable by excessive wetting and replace with approved backfill material at no additional cost to the Owner
4. Maintaining Excavation in Dewatered Condition
   a. Dewatering shall be a continuous operation. Interruptions due to power outages, or any other reason will not be permitted
   b. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction and/or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance
   c. Provide standby equipment on site, installed, wired, and available for immediate operation if required to maintain dewatering on a continuous basis in the event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such

work as may be required to restore damaged structures and foundation soils at no additional cost to Owner

d. System maintenance shall include supervision by personnel skilled in the operation, maintenance, and replacement of system components, and any other work required to maintain excavation in dewatered condition

5. System Removal
   a. Remove dewatering equipment from the site, including related temporary electrical service
   b. Wells shall be removed or cut off a minimum of 3 feet below final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction

D. Borrow and Spoils
   1. Obtain suitable material required to complete fill and embankments from excavation of on-site areas and provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations
   2. Location, size, shape, depth, drainage, and surfacing of borrow or spoil pits shall be acceptable to Engineer and Owner. Provide Engineer with detailed plans prior to construction
   3. Make all areas regular in shape with graded and surfaced side and bottom slopes when completed
   4. Cut side slopes not steeper than 1:1 and uniform for the entire length of any one side
   5. Final grade for disturbed areas of borrow shall have uniform slope (maximum slope = 4:1, minimum slope = 50:1)
   6. Use material free of debris and deleterious material
   7. Contractor shall be responsible for compliance with Colorado Discharge Permit System and local erosion control permitting requirements for any and all on-site and off-site, disturbed spoil and borrow areas. Upon completion of spoil and/or borrow operations, clean up spoil and/or borrow areas in a neat and reasonable manner to the satisfaction of off-site property owner, if applicable, Owner, and Engineer

E. Stockpiles
   1. Segregate materials suitable for the following:
      a. Topsoil
      b. Embankments and fills
      c. Backfill
      d. Spoils and waste only
   2. No excavation shall be deposited or stockpiles at any time so as to endanger stability of banks or structures, health of trees and shrubs to be protected, or portions of the Work, either by direct pressure or indirectly by overloading banks contiguous to the operation
   3. Stockpile soil materials away from edge of excavations
   4. Do not obstruct or prevent access to roads, driveways, ditches, natural drainage channels, and utility control devices
   5. If in result of adjacent structures, easement limitations, or other restrictions sufficient storage is not available within Project limits, Contractor shall arrange for off-site

areas for stockpiling and for moving material to and from the storage area at no additional cost to the Owner

F. Excess Materials
   1. Use excess excavated materials in fills and embankments as indicated on the plans to the extent needed
   2. At the Owner’s discretion and with the Engineer’s approval, suitable excess excavated materials may be disposed onsite at locations directed by Owner or specified on the plans
   3. Distribute excess earth from excavations located within Owner's property to locations over unimproved Owner property identified by Owner for such purpose. Otherwise stockpile in neat piles at locations directed by the Owner.
      a. Carefully finish material thus wasted with a drag, blade machine, or other suitable tool to a smooth, uniform surface without obstructing drainage at any point
      b. Do not waste excess excavated material in the above manner where the new fill crosses drainages, driveways, or other improvements
      c. Distribute and level to thickness indicated on Drawings

G. Waste Materials
   1. Waste materials are considered unacceptable materials for compaction or placement fill and shall not include environmental pollutants, hazardous substances or waste, hazardous products and by-products
   2. Grade waste material areas and such areas shall be free draining and kept orderly in appearance
   3. Remove debris, junk, broken concrete, broken asphalt, rock, stones, stumps, logs, roots, and other unsuitable material from the site and legally dispose of materials off site at locations arranged for by the Contractor
   4. If during the course of excavation or other performance of Work, materials on the project are encountered which may be hazardous, stop work immediately and notify the Owner and Engineer within one hour of discovery

H. Excavation for Structures
   1. Remove all existing fill material below facility mat foundation to existing undisturbed natural soils or bedrock. Geotechnical engineer shall inspect excavation to ensure all previous fill material has been adequately removed
   2. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10 foot
   3. Extend excavations to a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction and inspections
   4. Trim to neat lines where details call for concrete to be deposited against earth
   5. Excavate by hand in areas where space and access will not permit use of machines
   6. Notify Engineer immediately when excavation has reached the depth indicated. Do not proceed further until approved
   7. Restore bottom of excavation to proper elevation with materials approved by Engineer in areas over excavated
   8. Remove existing unsuitable/uncompacted fill, old foundations, rubble/debris, soft or otherwise unsuitable material, and replace with suitable material in excavation

9. The subexcavation shall be configured as specified in the Geotechnical Report, Section 01020
10. Recompact overexcavation and provide 1-foot imported structural fill under backwash basins.
11. Recompact overexcavation and provide 2-feet imported structural fill under drying beds .
12. Provide dewatering and temporary drainage as required to keep excavations dry
13. Reshape subgrade and wet as required
14. Proof roll at a maximum of 24 hours prior to paving to locate any soft spots. Contractor to stabilize any soft areas with aggregate base course and compact to 95 percent of maximum density at optimum moisture content, per ASTM D1557-78, to a minimum depth of 6 inches. Reshape subgrade and wet as required.

I. Trench Excavation
1. Establish alignment and grade or elevation from offset stakes
2. Excavate trenches so pipes can be laid straight at uniform grade without dips or bumps, between the terminal elevations indicated on the Drawings
3. Comply with pipe specification sections regarding vertical and horizontal alignment and maximum joint deflection
4. Methods
   a. Excavate trenches by open cut methods except where boring or tunneling is indicated in the Contract documents, required by jurisdictional agencies or permitted by Engineer
   b. Do not use mechanical equipment in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities or structures above or below ground. In all such locations, hand excavating methods shall be used
   c. Mechanical excavation
      i. Do not use where its operation would damage buildings, culverts, or other existing property, structures, or utilities above or below ground; hand excavate only in such areas
      ii. Use mechanical equipment of a type, design, and construction and operated to provide the following:
         a) Rough trench bottom elevation can be controlled
         b) Uniform trench widths and vertical sidewalls are obtained from 1 foot above the top of the installed pipe to the bottom of the trench
         c) Trench alignment is such that pipe is accurately laid to specified alignment and is centered in the trench with adequate clearance between pipe and trench sidewalls
      iii. Do not undercut trench sidewalls
      iv. Recompact trench bottom disturbed by bucket teeth prior to placement of embedment material
5. Trench Depth
   a. Where grades or elevations are not fixed on the Drawings, excavate trenches to provide a minimum depth of backfill cover over the top of pipe as follows.
   b. Coordinate depth of cover with utility owners. Increase depth as required by utility owner and at crossings. Minimum depths are:

i. 1.5 feet for drainage piping
ii. 2.5 feet for gas piping
iii. 3.0 feet in paved or graded streets where surface grades are fixed
iv. 3.0 feet for sanitary sewer
v. 4.5 feet for water piping
vi. 2.5 feet for electric conduit
vii. 2.0 feet for irrigation piping
viii. Increase depth as required at vertical curves and for clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades

6. Trench Width
   a. Excavate to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, and placement of embedment
   b. If needed to reduce earth loads to prevent sliding, cut banks back on slopes which extend not lower than 1 foot above the top of the pipe
   c. Stipulated minimum clearances are minimum clear distances, not minimum average distances
   d. Maximum trench width from 6 inch above the top to trench bottom of the installed pipe: Pipe O.D. plus 24 inches
   e. Limiting trench widths and permissible clearances from 6 inches above top of pipe to trench bottom for installed pressure and non-pressure piping

Pipe Size (inch)	Minimum Trench Width	Maximum Trench Width
3	1’ 6”	2’ 6”
4	1’ 6”	2’ 6”
6	1’ 6”	2’ 6”
8	1’ 8”	2” 8”
10	2’ 0”	3’ 0”
12	2’ 0”	3’ 0”
16	2’ 8”	3’ 8”
18	3’ 0”	4’ 0”
24	3’ 6”	4’ 6”
36	4’ 6”	5’ 0”

   f. No excessive trench widths will be allowed to avoid the use of sheeting or shoring and bracing
   g. If the width of the lower portion of the trench exceeds the maximum permitted, provide pipe of adequate strength, special pipe embedment, or arch concrete encasement as required by loading conditions and as determined by Engineer
7. Trench Side Walls
   a. Shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the federal, state, and local ordinances and regulations
   b. Sheet and brace where necessary and as specified herein
   c. Excavate without undercutting

8. Trench Bottom
    a. Shall be thoroughly protected and maintained when suitable natural materials are encountered
    b. Shall be thoroughly compacted and in approved condition prior to placing gravel bedding, if required
    c. Where in earth, trench bottoms for 6 inches and smaller pipe may be excavated below pipe subgrade and granular embedment provided or the trench may be graded to provide uniform and continuous support between bell holes or end joints of the installed pipe at the Contractor's option
    d. Whenever so directed by Engineer, excavate to such depth below grade as Engineer directs and bring the trench bottom to grade with such material approved by Engineer
    e. Do not allow any part of bells or couplings to contact the trench bottom, walls, or granular embedment when pipe is joined
    f. PVC pipe shall not be laid directly on trench bottom
9. Trench Stabilization
    a. Thoroughly compact and consolidate subgrades for concrete structures, precast structures, and utility trench bottoms so they remain firm, dense and intact during required construction activities
    b. Remove all mud and muck during excavation
    c. Reinforce subgrades with crushed rock or gravel if mucky during construction activities
    d. Finished elevation of stabilized subgrades are to be at or below subgrade elevations indicated on Drawings
    e. Allow no more than 0.5 inch depth of mud or muck to remain on trench bottoms when pipe bedding material is placed
    f. Subgrade shall be scarified to a depth of 6 to 8 inches before compaction
10. Measure pipe cover depth vertically from top of pipe to finished ground or surface elevation
11. Do not open more trench in advance of pipe laying than is necessary to expedite the Work; not more than 200 feet
12. Except as otherwise required, excavate trenches below the underside of pipes as indicated on the plans to provide for installation of granular embedment pipe foundation material
13. Provide concrete, or other foundations made necessary by unstable soil as directed by Engineer
14. Excavate bell holes to provide adequate clearance for tools and methods of pipe installation
15. Cuts in existing surface construction
    a. No larger than necessary to provide adequate working space
    b. Cut a clean groove not less than 1½ inch deep along each side of trench or around perimeter of excavation area
    c. Remove pavement and base pavement to provide shoulder not less than 6 feet wide between cut edge and top edge of trench
    d. Do not undercut trenches, resulting in bottom trench width greater than top widths
    e. Make pavement cuts to and between straight or accurately marked curved lines parallel to trench centerline or limits of excavation

f. Remove pavement for connections to existing lines or structures only to the extent required for the installation, or as determined by Engineer
g. Where the trench crosses the drives, walks, curbs, or other surface construction, remove and replace the surface construction between saw cuts as specified for pavement

J. Pavement Overexcavation
1. Excavate subgrade for drives and parking per the lines, grades, and dimensions indicated on Drawings within a tolerance of plus or minus 0.10 foot.
2. Excavate subgrade for drives and other flatwork per the lines, grades, and dimensions indicated on plans within a tolerance of plus or minus 0.05 foot.

3.6 SHEETING, SHORING AND BRACING

A. All sheeting, shoring and bracing in accordance with OSHA and IBC requirements

B. Provide proper and substantial sheeting, shoring, and bracing, in accordance with OSHA Standards as required, to prevent caving or sliding, to protect workmen and the Work, and to protect existing structures and facilities

C. Design, furnish, build maintain and subsequently remove, to extent required, a system of temporary supports for cut and cover, open cut, temporary bypass road, or trench excavations, including bracing, dewatering, and all associated items to support the sides and ends of excavations where excavation slopes might endanger in-place or proposed improvements, extend beyond construction right-of-ways or as otherwise specified or indicated
1. Design sheeting, shoring, and bracing to withstand all loads that might be caused by earth movement or pressure
2. Shall be rigid, maintaining shape and position under all circumstances

D. Design excavation support system and components for the following to allow safe and expeditious construction of permanent structures without movement/settlement of the ground and to prevent damage to or movement of adjacent buildings, structures, other improvements and underground facilities:
1. To support lateral earth pressures
2. Loads from utilities, traffic, construction, buildings, and surcharge loads

E. Shall be provided on Site prior to start of excavation in each section and make such adjustments as are required to meet unexpected conditions

F. Space and arrange sheeting and bracing as required to exclude adjacent material and according to the stability of excavation slopes

G. Contractor shall make his own assessment of existing conditions including adjacent property, the possible effects of his proposed temporary works and construction methods, and shall select and design such support systems, methods, and details as will assure safety to the public, adjacent property, and the completed Work

H. Employ caution in the areas of underground facilities, which shall be exposed by hand or other excavation methods acceptable to Owner

I. Perform sheeting, shoring, and bracing for trench excavation, for underground facilities, and for other purposes in accordance with the safety and protection requirements of the General Conditions

J. Contractor shall be solely responsible for proper design, installation, operation, maintenance, and any failure of any component of the system

K. Do not pull trench sheeting before backfilling

L. Do not brace sheeting left in place against the pipe. Such sheeting shall be supported in a manner that precludes concentrated loads or horizontal thrusts on pipe

M. Prevent undermining and damage to all structures, buildings, underground facilities, pavements and slabs

N. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment is completed

O. Submit sheet pile cut off wall design calculations, stamped by a Colorado licensed Professional Engineer

P. Contractor shall be solely responsible for proper design, installation, operation, maintenance, and any failure of any system component
   1. Engineer review of Contractor's design and data does not relieve the Contractor from full responsibility for errors or from the entire responsibility for complete and adequate design and performance of the sheeting, shoring, and bracing system

Q. Damages
   1. Contractor shall document any and all existing damage to adjacent facilities and submit written documentation to Owner and Engineer prior to performing any excavation. Documentation shall include written description of existing damages, measurements, diagrams, maps, and associated photographs
   2. Repair all damage resulting from excavation and remove and place any existing structure or underground facility damaged during shoring and sheeting and all undermined pavements with Owner-approved equal, concrete or asphalt, at no cost to the Owner

3.7 SUBGRADE PREPARATION

A. General
   1. Excavate or fill as required to construct subgrades to elevations and grades indicated
   2. Remove soft or unsuitable material and replace with suitable material
   3. Exposed area to receive fill, backfill, or embankment shall be proofrolled to detect localized zones of excessively wet, unstable, organic, or low bearing capacity materials to extent as follows:

a. Proofroll as a single-pass operation with conventional compaction equipment during subgrade preparation and prior to placement of fill, and as a spot check process without need for complete coverage per unit area of tire.
b. Proofroll within limits of proposed construction of footings, slabs, mats or pavement and to extent of 8 feet beyond proposed exterior walls and stage limits or as otherwise noted.
c. Soft spots shall be overexcavated, backfilled, and compacted with suitable material
d. Proof roll at a maximum of 24 hours prior to paving to locate any soft spots. Contractor to stabilize any soft areas with aggregate base course and compact to specified values. Reshape subgrade and wet as required.

B. Fills and embankments subgrade
1. Disc and scarify to roughen
2. Wet or dry top 6 inches, as required, to bond with fill or embankment

C. Roadways, drives, walks, curbs, and parking area subgrade
1. Extend subgrade full width of pavement, plus 1 foot in each direction
2. Scarify and compact top 12 inches of subgrade with moisture and density control
3. Compact as specified herein
4. Proofroll subgrade for approval prior to placement of final surfacing materials

D. Concrete slabs-on-grade subgrade
1. Scarify and compact top 12 inches of subgrade with moisture and density control
2. Compact as specified herein

E. Overexcavate and scarify existing soil as required under pavement areas, slabs, curbs and walks to meet the moisture and compaction specifications herein to depth shown on Drawings

F. Refer to geotechnical report for additional requirements for subgrade preparation requirements

3.8 FILL AND BACKFILL

A. General requirements
1. Compact with mechanical tampers approved by geotechnical engineer
2. Compaction by inundation by water is not permitted
3. Backfill retaining wall structures only after all walls and support slabs of confining structures are complete and the concrete has reached its 28-day strength
4. Use small hand operated compactor within three feet of walls
5. Do not backfill until leak test on structures is complete and accepted by Engineer

B. Preparation
1. All areas to be filled or backfilled shall be free of vegetation, topsoil, wet materials, unsatisfactory soil materials, obstructions, deleterious materials, construction debris,

refuse, compressible or decayable materials and standing water from ground surface prior to placing fills

2. Perform all wetting, drying, shaping, and compacting required to prepare a suitable subgrade
3. Do not place fill when materials or materials below it are frozen
4. No fill materials containing ice or frozen lumps shall be used
5. At the completion of excavation and before placing any fills, exposed area to receive fill, backfill, embankment, slabs-on-grade, foundations or pavements shall be proofrolled to detect wet, soft, unstable, or low bearing capacity materials
    a. Soft spots will be overexcavated, backfilled and compacted with suitable material

C. Structural Backfill
1. Backfilling under and around structures shall be not performed until the following have been completed:
    a. Acceptance of construction below finish grade
    b. Inspection, testing and approval
2. Remove all debris from excavation prior to placement of material
3. Do not place backfill or fill material on surfaces that are muddy, frozen or contain frost or ice
4. No mechanized equipment is to be used within 3 feet of structure
5. Place backfill and fill materials adjacent to structures evenly and to required elevations. Take care to prevent wedging action of backfill against structures
6. Place backfill in level layers not to exceed 8 inches in loose depth for material compacted by heavy compaction equipment nor more than 6 inches in loose depth for material compacted by hand-operated tampers
7. Backfill simultaneously on all sides of structures
8. Retaining wall structures shall be backfilled after walls and support slabs of confining structures are complete and concrete has reached 28 day strength
9. If leak test is required on structure, do not backfill until approved by Engineer
10. Where a trench passes through a fill or embankment, place and compact fill or embankment to 12 inch above the top of the pipe before trenching
11. Compact as specified herein

D. Structural Fill
1. Below mat foundation
    a. Place structural fill on prepared and approved subgrade in any overexcavated areas in order to bring elevations to bottom of structure
    b. Subgrade preparation shall be as specified herein
    c. Lifts shall not exceed 6 inches in loose depth thickness
    d. Compact as specified herein
2. Below pavements and slabs on grade
    a. Place structural fill on prepared and approved subgrade in any overexcavated areas in order to bring elevations to bottom of pavement or slab
    b. Subgrade preparation shall be as specified herein
    c. Lifts shall not exceed 6 inches in loose depth thickness
    d. Compact as specified herein
    e. Compaction requirement shall be met without inundation or flooding

3. Place in horizontal layers at maximum uncompacted depth per compaction specifications herein and adequately to support items constructed or placed thereon
4. Compact with mechanical, platform type tampers
5. No mechanized equipment is to be used within 3 feet of structure
6. Where a trench passes through a fill or embankment, place and compact fill or embankment to 12 inch above the top of the pipe before trenching

E. Trench backfill
1. Compacted backfill
   a. Provide full depth of trench above embedment at all locations
   b. Beneath pavements, surfacing, driveways, curbs, gutters, walks or other surface construction or structures
   c. In street or highway shoulders
   d. Beneath fills and embankments
2. Where the trench for one pipe passes beneath the trench of another pipe, compact the backfill for the lower trench to the bottom of the upper trench
3. Site excavated materials
   a. Place suitable job excavated materials in 8 inch maximum non-compacted thickness, uniform layers
   b. Increased layer thickness may be permitted for non-cohesive material if Contractor demonstrates to Engineer's satisfaction that specified compacted density will be achieved
   c. Use methods and equipment appropriate to the material to be compacted to prevent transmission of damaging shocks to pipe
   d. Compaction as specified herein
4. Graded gravel
   a. Deposit in uniform layers of 12 inch maximum uncompacted thickness
   b. Compact with suitable vibrating roller or platform vibrator to not less than 70 percent relative density per ASTM D4253
5. Uncompacted backfill
   a. Compaction of backfill above pipe embedment in locations other than those specified, is required only to prevent future settlement
   b. May be placed by any method acceptable to Engineer which will not impose excessive concentrated or unbalanced loads, shock, or impact on, and will not result in displacement of installed pipe
   c. Until compacted depth over conduit exceeds 3 feet, do not drop fill material over 5 feet. Distance may be increased 2 feet for each additional 1 foot of cover
6. Finish the top portion of backfill with a minimum of 4 inches of topsoil, or as specified on plans, whichever is greater
7. Protection of trench backfill
   a. Where trenches are constructed in ditches or other water courses, protect backfill from erosion
   b. Install ditch checks where the ditch grade exceeds 1 percent
      i. Minimum depth: 2 feet below the original ditch or water course bottom for the full bottom width
      ii. Minimum width: 18 inches into the side slopes
      iii. Minimum thickness: 12 inches

3.9 FILL AND EMBANKMENT

A. Using suitable approved materials, shape, trim, and finish cut slopes to conform with contours and elevations indicated on Drawings

B. Suitable materials shall consist of excavations or borrow areas
   1. Borrow
      a. Borrow areas shall be arranged by Contractor at no additional cost to Owner and shall be subject to approval by Engineer
      b. Includes all topsoils and fill materials from approved off-Site locations

C. Place in layers from 4 to 8 inches where high degree of compaction is required. Otherwise, place in 8 to 12 inch layers. Shall be placed on subgrades approved by Engineer

D. Shall not be placed on frozen surface. Do not place snow, ice or frozen materials in fill

E. Level and roll subgrade so surface materials will be compact and bond with the first layer of fill or embankment
   1. Plow and scarify subgrade to a depth of six inches until uniform and free of large clods

F. Place in horizontal layers at maximum uncompacted depth per compaction specifications herein

G. Spread and level material deposited in piles and windrows before compacting

H. Thoroughly compact each layer by rolling or other means acceptable to Engineer to meet the moisture and compaction specifications herein

I. If degree of compaction is unsatisfactory, make necessary adjustments until specifications are met. Remove material placed over layers not satisfactorily compacted and recompact unsatisfactory areas

J. Where a trench passes through a fill or embankment, place and compact fill or embankment to 12 inch above the top of the pipe before excavating the trench

K. Add water and harrow, disc, blade, or otherwise work each layer to obtain the uniform moisture content and adequate compaction

L. Extend subgrade preparation and/or structural fill a minimum of 2 feet beyond back of proposed structure foundation limit

M. Refer to geotechnical report for additional requirements for fill and embankment preparation requirements

3.10 PIPE EMBEDMENT

A. Embed pipes above and below the bottom of pipe as indicated on the Drawings and as specified herein

B. Granular embedment
   1. Spread and surface grade granular embedment to provide continuous and uniform support beneath pipe at all points between pipe joints.
      a. Level bottom layer at proper grade to receive and uniformly support pipe barrel throughout length
      b. Barrel of pipe shall have a bearing for its full length
   2. Form depressions under each joint to permit the proper jointing. No part of joint shall be in contact with trench when pipe is placed in position
   3. After grading, aligning, and placing pipe in final position, and shoring home, deposit and compact sufficient embedment under and around each side of the pipe to hold the pipe in proper position and alignment during subsequent operations
   4. Place and compact embedment material uniformly and simultaneously on both sides of pipe to prevent displacement
   5. Complete embedment promptly after jointing operations and approval to proceed by Engineer
   6. Granular embedment compact by slicing with shovel or vibrating
      a. Maximum uncompacted thickness of layers: 6 inch
   7. Compacted embedment shall be compacted to 90 percent maximum density per ASTM D1557
      a. Maximum uncompacted depth thickness of horizontal layers: 8 inch

C. Arch and concrete encasement
   1. Include in locations indicated on Drawings or where over-width trench conditions need correction as approved by Engineer
   2. Install and form as indicated on Drawings or as specified
   3. Concrete shall have a 28-day minimum 3,000 psi compressive strength

D. Do not backfill until tests and inspections have been made and backfilling is authorized by Engineer. Use care in backfilling to avoid damage or displacement of pipe systems

3.11 COMPACTION

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations. Place backfill and fill uniformly along the full length of each structure as described herein.

C. Refer to geotechnical report for additional requirements for site development material, subexcavation, compaction, and related earthwork operations

D. Percentage of Maximum Dry Density Requirements: Moisture treat and compact soil to not less than the following percentages of maximum dry density and to within moisture content range according to ASTM D 698 as follows:
   1. For overexcavation areas under paving and structures: Compact each layer of backfill or fill material (as accepted by geotechnical engineer) at 95 percent maximum dry density and moisture treat to within minus 2 to plus 2 percent of optimum moisture content
   2. For fill under site features and concrete pavements not within the public right-of-way: Compact to depth of 12" minimum at 95 percent of maximum density within minus 2 to plus 2 percent of optimum moisture content. Extend compaction and moisture treatment to a minimum of one foot beyond the outermost extent of site concrete and asphalt. Compact in right-of-way to municipal standards and specifications.
   3. Utility trench backfill: Compact each layer of backfill at 95 percent maximum dry density to within minus 2 to plus 2 percent of optimum moisture content
   4. For fill under open or unpaved areas, scarify and compact the top 6 inches below subgrade and each layer of backfill or fill material to 90 percent maximum dry density to within minus 2 to plus 2 percent of optimum moisture content
   5. Do not deposit or compact tamped or otherwise mechanically compacted backfill if frozen or if in water
   6. Take particular care to compact backfill which will be beneath slabs, pipes, drives, roads, parking areas, curb, gutters, or other surface construction

3.12 DRAINAGE MAINTENANCE

A. Do not backfill trenches across roadways, drives, walks or other trafficways adjacent to drainage ditches or water courses prior to backfilling the trench on the upstream side of the trafficway to prevent impounding water after pipe is laid

B. Backfill so that water does not accumulate in unfilled or partially filled trenches

C. Remove materials deposited in roadway ditches or other water courses crossed by the trench line immediately after backfilling is completed and restore ditches and water courses to original section, grade, and contours

D. Do not obstruct surface drainage any longer than necessary

E. Provide and maintain temporary bridges and other structures across unfilled trenches as required to maintain traffic

3.13 SITE GRADING

A. Excavate, fill, compact fill, and grade to bring project area outside buildings of final grades or subgrades

B. When rock is encountered in paving areas outside buildings, overexcavate to 6 inches below final grade and backfill to grade with approved earth compacted-in-place

C. Grading

1. After completion of all other outside work and after backfilling is completed and settled, bring to grade at the indicated elevations, slopes and contours, all areas being graded on site
2. Finish grades shall be no more than 0.1 foot above or below those indicated
3. Tolerance for areas within 2 feet of building and areas to be paved shall not exceed 0.15 foot above or below established subgrade
4. Graders and other power equipment may be used for final grading and slope dressing if the result is uniform and equivalent to hand work
5. Grade all surfaces for effective drainage, provide a 2 percent minimum slope except as otherwise required
6. Finish all ditches, swales, and gutters to drain readily
7. Provide a smooth transition between adjacent existing grades and new grades
8. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances
9. Slope grades to direct water away from buildings and prevent ponds from forming where not designed.
10. Finish subgrades at unpaved areas to required elevations within a tolerance of plus or minus one (1) inch

D. Topsoil
1. Place topsoil at locations and to limits indicated on plans and includes all areas not specified to receive paving or other surface treatment including borrow and waste areas
2. Material: Shall be fertile, friable, and loamy soil of uniform quality, free from stiff clay, hard clods, and stones greater than 3 inches in any dimension and shall be relatively free from grass, roots, and weeds. Borrow shall be used when required

3.14 BLASTING

A. Blasting or other use of explosives is not permitted without Owner and Engineer approval. Blasting should be performed in accordance with applicable federal, state, and local requirements and permits, and other applicable regulator permits

B. General Blasting Requirements
1. Blast damage behind the trim line shall be minimized. Blast damage is defined to include widening and loosening of existing joints or foliation, displacement of rocks and/or creation of new fractures. Utilize the natural geologic bedding planes and joint structure as best practiced and in a predicted and controlled manner to form the final cuts.
2. Controlled perimeter blasting methods shall be used to limit blast damage and overbreak behind the excavation line.
3. Perimeter drill hole diameters shall not exceed 3 inches without Engineer approval. Perimeter drill holes shall be drilled such that the vertical tolerance is less than 5 percent of the hole depth up to a maximum horizontal deviation of 6 inches as measured between the hole collar (top) and the hole bottom unless approved by the Engineer unless allowed by the Engineer.

4. Spacing of perimeter drill holes shall not exceed 24-inches unless satisfactory results are demonstrated by test blasts in critical areas unless allowed by the Engineer. In any case, the maximum hole spacing shall not exceed 30-inches unless allowed by the Engineer.
5. Production hole diameters shall not exceed 2 ½-inches unless allowed by the Engineer.
6. Production holes shall be denoted in a controlled delay sequence. Production blasting shall consist of the main fragmentation blasting resulting from more widely spaced production holes drilled throughout the main excavation area. Production holes shall be detonated in a controlled delay sequence. Production blasting shall be designed to prevent escape of material beyond the construction limits shown on the plans.
7. Stemming of drill holes will be required to confine any explosive gases, however, explosive gases are not expected at this worksite. High quality angular stemming such as crushed fine gravel shall be used. Aggregate produced from drill cutting will not be accepted.
8. The design of drilling and blasting patterns, explosive types, and quantities shall be determined by the Contractor. Control blasting so that ground motion and frequency limitations discussed in "Blasting Requirements" below are met.
9. The Contractor shall be responsible for any damage done to persons, private property, owner property, the work, existing structures, utilities, other facilities.

C. Blasting Plans
1. General Blasting Plan: Within 7 days after the Notice of Award, prior to commencing drilling and blasting operations, submit the following information to the Engineer for review and approval:
2. Names and experience of blasting supervisors: Blasting supervisors shall have a minimum of five years experience in supervising the loading and firing of charges for rock excavation and shall have all necessary licenses and permits required by the State and other agencies having jurisdiction.
3. Methods for and locations of explosives storage.
4. Methods to be employed for traffic control and other public safety precautions in the use, storage and transportation of explosives.
5. General methods and approach to blasting which account for the full range of geologic settings and physical conditions present on the project. The approach shall describe how the specific blasting plans will account for various cut geometries, rock types, access problems and required face contours.
6. Method and equipment for the required pre-blast survey and environmental monitoring, and anticipated peak particle velocity level monitoring, structure and appurtenant structures monitoring, and wall monitoring.
7. Equipment intended to be used in or support of blasting operations.
8. Method of containment to prevent rock material from escaping the construction limits, and contingency measures for unanticipated fly rock.
9. Specific Blasting Plan: After the general blasting information is reviewed and approved, and not less than 3 days prior to the drilling of each cut or portion thereof, or at any time the Contractor proposes to change the drilling and blasting methods, submit a "Blasting Plan" to the Engineer for review. The blasting plan shall be reviewed by the Engineer and Blasting Consultant before any drilling and blasting

work commences. The blasting plan shall contain full details of drilling and blasting patterns and controls the Contractor proposes to use for both the controlled and production blasting. All blasting plan submittals and modifications shall be approved in writing by the Blasting Consultant in accordance with "Blasting Requirements" below. The blasting plan shall contain the following minimum information:

a. Station limits of proposed shot.
b. Scale drawings showing plan and section views of all variations of the proposed drill pattern, including clearing limits, free face, burden blasthole spacing, drill hole location, subdrill depths, lift height, blasthole diameters, and blasthole angles.
c. Loading diagram showing powder factor, type and amount of explosives, primers, initiator, and locations and depths of stemming for all substantial variations within the pattern.
d. Initiation method and sequence of blastholes, including delay times and delay system.
e. Manufacturer's data sheets for all explosives, primers, and initiators to be employed.
f. Fly rock control measures.
g. Estimated quantities, measured in cubic yards, of rock in-place, and linear feet of both production and controlled blast drill hole.
h. Location and attitude of significant fracturing, rock type changes and special circumstances to be accounted for in the plan.
i. Identification of environmental monitoring method, equipment, and location.

10. Blasting Report: Shall be submitted to the Engineer after each blasting operation and prior to any further blasting operations. The report shall include the following information:
    a. Blasting Consultant: A Blasting Consultant shall be retained by the Contractor to approve the construction blasting design and blasting plans.
    b. A copy of the drilling log information as described above.
    c. Measurements of all production and control holes.
    d. Name of blasting foreman and date and time of blast.
    e. Comments on success of the blast in terms of the specific blasting objectives.
11. Blasting Requirements:
    a. Blasting Consultant: A Blasting Consultant shall be retained by the Contractor to approve the construction blasting design and blasting plans.
        i. The Blasting Consultant shall be and expert in drilling and blasting of rock slopes and shall have at least 5 years of experience in blast design of near-vertical rock cuts and rock slopes. The Blasting Consultant shall not be an employee of the explosives manufacturer or explosives distributor.
        ii. The Blasting Consultant shall be present during all test blasts, and shall sign approval of all proposed blasting plans.
        iii. The qualifications of the Blasting Consultant shall be submitted to the Engineer for review, and the selection of the Blasting Consultant shall be subject to the approval of the Engineer.
        iv. The Blasting Consultant shall also be able to demonstrate a familiarity with geologic principles and practices as applied to blasting and rock excavation.
        v. Prior to establishing a date for the preconstruction conference, submit a resume to the Engineer for the proposed Blasting Consultant which shall

include education background related to blasting and detailed resume of experience in the blasting field. A list of at least 3 urban rock blasting projects that demonstrate successfully completed work on which the Blasting Consultant has worked shall be part of the information provided. The list shall also contain the names and telephone numbers of project Owners with sufficient knowledge of the projects to verify the submitted information.

b. Vibration Specialist: Retain a Vibration Specialist to determine safe vibration limits and locations of seismographs to monitor vibrations.
   i. The Vibration Specialist shall be an expert in vibration monitoring of blasts and shall have at least 5 years of experience in vibration monitoring of blasts.
   ii. The Vibration Specialist will be approved by the Engineer prior to beginning any drilling and blasting work.
   iii. When it is a possibility that vibration damage to and adjacent structure may occur, monitor each blast with an approved seismograph located between the blast area and the structure of concern. Seismograph locations shall be approved by the Blasting Consultant and the Engineer prior to each blast.
   iv. Seismographs shall be capable of recording particle velocities for 3 mutually perpendicular components of vibration in the range required for this project and as recommended by the Vibration Specialist.
   v. Perform seismographic monitoring of all blasts to ensure the maximum peak particle velocity with respect structures within 500 feet of the blast area.
   vi. The Vibration Specialist shall review all seismograph data after each blast to determine whether particle velocities have exceeded peak particle velocity criteria. Where peak particle velocities have been exceeded, an inspection of the structure to determine possible damage may be required, and this will be performed at the Contractor's expense.
   vii. The Vibration Specialist shall submit written documentation to the Engineer summarizing the seismograph data after each blast and prior to performing and additional blasts.
   viii. The following data from each blast shall be submitted to the Engineer prior to performing any additional blasts.
      A) Model and manufacturer of each seismograph.
      B) Plan indicating locations of each seismograph.
      C) Type of ground each seismograph was placed on.
      D) Maximum peak particle velocity of each velocity component.
      E) Dated copy of all seismograph data, signed by the Vibration Specialist.

c. Post-blast inspections shall be performed upon receipt of a complaint of property damage from the person in charge of the property or if the possibility of damage to structures due to exceeding the maximum peak particle velocity has occurred. These inspections, if required, shall be submitted by the CONTRATOR within 7 calendar days of receipt of the complaint or within 7 calendar days of discovery of a blast exceeding the maximum peak particle velocity.

d. Maintain Airblast Control – Airblast monitoring systems shall be installed by the Contractor to measure airblast overpressure.
   i. Submit the locations of each airblast monitoring system to the Engineer prior to each blast.

ii. Equipment specifically designed to measure airblasts shall be used.
iii. Submit records of the peak overpressure measurements to the Engineer after each blast as part of the blasting reports submitted to the Engineer after each blasting operation.

e. Pre-Blast Condition Survey: Perform an initial pre-blast condition survey of nearby existing residential structures, retaining walls and other facilities that may be potentially impacted by the blasting operation at least 14 days before blasting. The survey shall extend to all residences surrounding the area of blasting, in addition to residences and structures located within 500 feet of blasting. The survey shall be conducted by the Contractor, [MUNICIPALITY], the geotechnical engineer and each property owner. The condition of structures shall be documented using photos, descriptions and other means. The Contractor shall be required to conduct observations of the properties visited in the pre-condition survey on each day blasting is performed. Crack monitors installed by the geotechnical engineering during the precondition survey will read by the Contractor after each day of blasting.
   i. A Pre-Blast Condition Survey report for the initial survey and shall be submitted to the Engineer and Blasting Consultant at least 7 days prior to the beginning of any drilling and blasting work.
   ii. Pre-Blast condition surveys shall be conducted at all facilities, walls and structures within 500 feet of the Blast Area of the project.
   iii. Contractor shall be responsible for any and all damage associated with his blasting activities.

3.15 SETTLEMENT

A. Warranty for settlement of all fills, embankments, and backfills is stipulated in the General Conditions from final completion of Contract under which Work is performed

B. Repair or replace within 30 days after notice by Engineer or Owner

3.16 FIELD QUALITY CONTROL

A. Provide under provisions of General Conditions and Division 1 Specifications

B. Coordinate testing with Owner. Owner will provide all field testing to determine compliance of in-place and backfill materials and compaction in accordance with the specifications, and to verify design bearing capacities.

C. Fills and Embankment
   1. Two moisture-density relationship tests, ASTM D698, on each type of fill material
   2. One in-place compaction test for each 5,000 square feet every 1.5 feet of vertical lift of material placed
   3. Additional in-place compaction tests will be at the discretion of the Owner

D. Pipe Embedment and Backfill

1. Two moisture-density relationship tests, ASTM D698, or two relative density tests, ASTM D4253, as appropriate for each type of embedment on backfill material proposed, except granular embedment material
2. One in-place compaction test every 200 lineal feet of trench in the compacted embedment zone and at every 1.5 feet of vertical lift of backfill materials, ASTM D6938. One in-place compaction test near top of trench for trench depth of 2 feet or less, ASTM D6938
3. Additional in-place compaction tests will be at the discretion of the Owner

E. Pavement and Structural Subgrades
1. At a minimum, two moisture-density relationship tests, ASTM D698, or two relative density tests, ASTM D4253, as appropriate and adequate for each type backfill material proposed
2. Perform tests for each footing, concrete site feature, and drainage structure subgrade. Perform tests at every 50 linear feet of subgrade of foundation walls, retaining walls, and curbing, pans, drainage features, walks, etc. (or portions thereof). Perform tests every 2,000 square feet required of building slab area, exterior slabs and pavement/flatwork areas (with no less than 3 tests). Test at subgrade and at every vertical lift of backfill materials placed.

F. Inspection and approval
1. A qualified geotechnical engineer shall inspect the natural soil at bottom of excavations for structures.
2. Do not prepare subgrade or place concrete until such inspection has taken place or waived by geotechnical engineer and resulting recommendations of geotechnical engineer have been carried out
3. Prior to placement of structural fill, overexcavated foundations subgrades shall be observed and tested by a qualified geotechnical engineer to ensure suitable bearing materials exist
4. Geotechnical engineer shall provide a letter to Engineer to confirm the presence of suitable subgrade materials and properly placed fill materials by Contractor in accordance with Contract Documents.

G. Retests of failed compaction shall be performed by geotechnical engineer for Owner, but paid for by Contractor

END OF SECTION

SECTION 02510

WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Buried pipe, fittings, and associated accessories for water distribution and transmission lines

B. Hydrants, valves and appurtenances

1.2 RELATED SECTIONS

A. Section 02300 – Earthwork

B. Section 02676 – Disinfection of Water Systems

C. Section 03400 – Precast Concrete Structures

1.3 REFERENCES

A. American National Standards Institute (ANSI)/ American Water Works Association (AWWA)
   1. A21.5/C105 – Polyethylene Encasement for Ductile-Iron Pipe Systems
   2. A21.10/C110 – Ductile-Iron and Gray-Iron Fittings
   3. A21.11/C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
   4. A21.53/C153 – Ductile-Iron Compact Fittings

B. American Society for Testing and Materials (ASTM)
   1. A48 – Gray Iron Castings
   2. A126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings
   3. A276 – Stainless Steel Bars and Shapes
   4. A536 – Ductile Iron Castings
   5. B763 – Copper Alloy Sand Castings for Valve Applications
   6. D429 –Test Methods for Rubber Property-Adhesion to Rigid Substrates
   7. D1351 – Thermoplastic Polyethylene Insulation for Electrical Wire and Cable
   8. D3139 - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
   9. D3950 – Standard Specification for Strapping, Nonmetallic (and Joining Methods)
   10. F477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. American Water Works Association (AWWA)
   1. C104 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
   2. C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings

3. C504 – Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm)
4. C509 – Resilient Seated Gate Valves for Water Supply Service
5. C550 – Protective Interior Coatings for Valves and Hydrants
6. C600 – Installation of Ductile-Iron Mains and Their Appurtenances
7. C605 – Underground Installation of PVC and PVCO Pressure Pipe and Fittings
8. C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution
9. C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm)
10. M17 – Installation, Field Testing, and Maintenance of Fire Hydrants
11. M23 – PVC Pipe Design and Installation
12. M41 – Ductile-Iron Pipe and Fittings

D. Colorado Department of Transportation (CDOT)

E. National Fire Protection Agency (NFPA)

F. NSF Certification
   1. Standard 61 (NSF 61) – Drinking Water System Components – Health Effects

G. Surface Preparation Standards (SSPC)
   1. SP2 – Hand Tool Cleaning
   2. SP3 – Power Tool Cleaning

H. Uni-Bell PVC Pipe Association
   1. Uni-Pub-8: Tapping Guide for PVC Pressure Pipe

1.4 SUBMITTALS

A. Submit under provisions of Division 1 Specifications

B. Product Data: Provide manufacturer's catalog information with dimensions, material and assembled weight. Indicate pressure ratings for pipe, fittings, valves
   1. Pipe materials
   2. Special, fitting, and coupling details
   3. Joint restraint system
   4. Valves
   5. Laying and installation schedule
   6. Specifications and data sheets
   7. Affidavits of compliance for protective shop coatings and linings

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. Provide prior to shipment

D. Test Reports: Submit reports of field pressure tests and disinfection under provisions of Section 01340

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 Specifications

B. Accurately record actual locations of piping mains, valves, connections, top of pipe elevations, and any unmapped utilities

C. Identify and describe unexpected variations to subsoil conditions or uncharted utilities

1.6 QUALITY ASSURANCE

A. Manufacturers shall be experienced in the design and manufacturing of materials specified herein for a minimum period of 5 years

B. All PVC pipe, regardless of diameter, shall be supplied by a single manufacturer

C. Perform Work in accordance with the Colorado Department of Public Health and Environment (CDPHE) and Pueblo County

D. Contractor shall conduct visual inspection before installation

E. Provide manufacturer's name and pressure rating marked on piping and valves

F. Provide piping complete with all fittings, jointing materials, supports, joint restraint system, and necessary appurtenances for watertight, fully operational water lines

1.7 REGULATORY REQUIREMENTS

A. Conform to all municipal codes and ordinances, laws and regulations of San Miguel County, Town of Telluride, CDPHE, the water notes and details on the drawings and as specified herein, and CDPHE Stormwater Management and/or Construction Dewatering Permit

B. In case of apparent conflict, CDPHE requirements govern over these specifications

C. In absence of State and local regulations, International Plumbing Code applies

D. NFPA Compliance: Install fire water systems in accordance with NFPA 24 “Standard for the Installation of Private Fire Service Mains and Their Appurtenances”

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1 Specifications

B. During loading, transporting and unloading, exercise care to prevent damage to material
   1. Use nylon slings only
   2. Do not drop pipe or fittings
   3. Do not roll or skid against pipe already on ground

4. Repair any damage done to coating or lining
5. Handle per manufacturer's recommendations
6. Store rubber gaskets in cool dark location
7. Store all material on wood pallets or timbers

C. Adequately tag or otherwise mark all piping, fittings, and valves as to size per AWWA C509, C900, and C905

D. Shop coated materials shall be handled, transported, stored and shipped in a manner that will prevent damage to the coating and lining. Coating or lining damaged in handling or other operations shall be repaired to the approval of and at no additional cost to the Owner

E. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the Engineer shall be repaired in accordance with these Specifications and at no additional cost to the Owner

F. Pipe
   1. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation
   2. PVC pipe has reduced flexibility and impact resistance as temperatures approach and drop below freezing. Extra care should be used in handling PVC pipe during cold weather
   3. Do not store PVC pipe uncovered in direct UV light
   4. Pipe stored along the trench side shall be suitably supported off the ground to avoid damage to the coating

G. Valves and Hydrants
   1. Prepare valves for shipping as follows:
      a. Ensure that valves are dry and internally protected against rust and corrosion
      b. Protect vales against damage to threaded ends, flange faces, and weld ends
      c. Seal valve ends to prevent entry of foreign materials into valve body
      d. Set valves in best position for handling
      e. Set valves closed to prevent damage
   2. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C509
   3. Storage: Use the following precautions for valves, including fire hydrants, during storage:
      a. Do not remove end protectors unless necessary for inspection; then reinstall for storage
      b. Protect valves from weather by storing indoors or support valves off ground or pavement in watertight enclosures when outdoor storage is necessary

1.9 JOB CONDITIONS

A. All work which requires the interruption of active water service lines must be completed as quickly as possible in order to minimize inconvenience to customers and risk to the Owner and coordinated as specified in Division 1

PART 2 PRODUCTS

2.1 PVC – 4" TO 12" DIAMETER

A. Manufacturers
   1. Diamond Plastics Corporation
   2. JM Eagle
   3. North American Pipe Corporation
   4. Vinyltech Corporation
   5. Or accepted substitution

B. The following piping shall be small diameter PVC pipe as indicated on Drawings and as specified herein:
   1. Water distribution mains: 6", 8" and 12" diameter
   2. Fire hydrant laterals and blow off drain lines: 6" diameter
   3. Diameters: Cast iron pipe equivalent outside diameters

C. Pipe: AWWA C900, DR 18 except as otherwise specified or indicated on the Drawings

D. Marking: Identification markings on pipe shall conform to AWWA C900

E. Fittings: Ductile iron compact fittings: ANSI A 21.53/AWWA C153
   1. Working pressure rating: 350 psi rating
   2. Joint: Mechanical joints with restraints
   3. Coating:
      a. Exterior: AWWA C111, Asphalt coated
      b. Interior: AWWA C104 and C111, lined with double thickness cement seal coated
      c. Or interior and exterior: AWWA C116, fusion bonded epoxy coating

F. Joints: ASTM D3139, integral bell or mechanical joint
   1. Push-on joints: pipe to pipe joints, except as otherwise specified or indicated on Drawings. Push on joints are not permitted on fittings or valves
      a. Integral bell type with elastomeric gaskets, ASTM F477 factory installed
      b. Suitable for buried service
      c. Gaskets:
         i) Material: Virgin SBR rubber suitable for potable water conforming to AWWA C111
         ii) Lubricant shall be suitable for potable water contact
   2. Restraint device for PVC push on joint
      a. Restraint material: ASTM A536 , ductile iron

b. A split ring shall be used behind the pipe bell. A serrated ring shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring
c. Nuts and bolts torqued to requirements of manufacturer
d. Pressure rating consistent with pipe pressure rating
e. Restraint coatings shall be consistent with manufacturer's standard
f. Manufacturers:
    i) EBAA Iron Inc. "Series 1600"
    ii) Romac Industries "Series 611"
    iii) Or accepted substitution

3. Mechanical joint restraint
    a. Provide mechanical joint restraint for all ductile iron fittings connecting to PVC pipe
    b. Restraint devices for shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA A21.10/C110
    c. Pressure rating consistent with pipe pressure rating
    d. Restraint coatings shall be consistent with manufacturer's standard
    e. Manufacturer:
        i) EBAA Iron "MEGALUG 2000 PV"
        ii) Romac Industries "Roma-Grip"
        iii) Or accepted substitution

G. Couplings
1. Provide for connection between PVC and Asbestos Cement water distribution pipe
2. Material: Ductile Iron, ASTM A536 Grade 65-45-12
3. End Rings: Ductile Iron, ASTM A536
4. Gaskets: Virgin SBR rubber suitable for potable conforming to AWWA C111
5. Bolts and Heavy Hex Nuts: UNC 5/8" rolled threads with black finish.
6. Manufacturer:
    a. JCM
    b. EJ Prescott
    c. Or accepted substitution

2.2 PVC – 14” TO 48” DIAMETER

A. Manufacturers
1. Diamond Plastic Industries
2. JM Eagle
3. North American Pipe Corporation
4. Vinyltech Corporation
5. Or accepted substitution

B. The following piping shall be large diameter PVC pipe as indicated on Drawings and as specified herein:
1. Water transmission mains: 18", 24" and 36" diameter
2. Diameters: Cast iron pipe equivalent outside diameters

C. Pipe: AWWA C905, DR 21 except as otherwise specified or indicated on the Drawings

D. Marking: Identification markings on pipe shall conform to AWWA C905

E. Fittings: Ductile iron fittings, ANSI A 21.53/AWWA C153 or ANSI A21.10/AWWA C110
   1. Working pressure rating: 250 psi rating
   2. Joint: mechanical joints with restraints
   3. Coating:
      a. Exterior: AWWA C111
      b. Asphalt coated interior: AWWA C104 and C111, lined with double thickness cement and seal coated
      c. Or interior and exterior: AWWA C116, fusion bonded epoxy coating

F. Joints: ASTM D3139, integral bell or mechanical joint
   1. Push-on joints: pipe to pipe joints, except as otherwise specified or indicated on Drawings. Push on joints are not permitted on fittings or valves
      a. Integral bell type with elastomeric gaskets, ASTM F477 factory installed
      b. Suitable for buried service
      c. Gaskets:
         i) Material: Virgin SBR rubber suitable for potable conforming to AWWA C111
         ii) Lubricant shall be suitable for potable water contact
   2. Restraint device for PVC push on joint
      a. Restraint material: ASTM A536, ductile iron
      b. A backup ring shall be used behind the PVC bell. A restraint ring, incorporating a plurality of individually-actuating gripping surfaces, shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring
      c. Pressure rating consistent with pipe pressure rating
      d. Restraint coatings shall be consistent with manufacturer's standard
      e. Manufacturers:
         i) EBAA Iron Inc. "Series 2800"
         ii) Romac Industries "Series 470"
         iii) Or accepted substitution
   3. Mechanical joint restraint
      a. Provide mechanical joint restraint for all ductile iron fittings connecting to PVC pipe
      b. Restraint devices for shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA A21.10/ C110
      c. Pressure rating consistent with pipe pressure rating
      d. Restraint coatings shall be consistent with manufacturer's standard
      e. Manufacturer:
         i) EBAA Iron "MEGALUG 2000 PV"
         ii) Romac Industries "Roma-Grip"
         iii) Or accepted substitution

2.3 PVC SADDLE TAP

A. Provide saddle tap for connection to air release/vacuum breaker combination valves as shown on the Drawings

B. Use tapping saddle manufactured specifically for C900 and C905 PVC pipe with stainless steel wide band straps, nuts and washers

C. Manufacturer:
   1. Mueller
   2. Or accepted substitution

2.4 PIPE ACCESSORIES

A. Identification Marker Tape: Provide metallic core tape, blue with black letters “CAUTION - WATER LINE BELOW” continuously printed plastic tape with metallic core, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide identification markers of one of the following:
   1. Allen Systems, Inc.
   2. Emed Co., Inc.
   3. Seton Name Plate Corp.
   4. Or accepted substitution

B. Tracer Wire
   1. Provide tracer wire for all PVC pipe
   2. All tracer wire shall be 12 AWG solid copper wire coated with 45 mil Type HMW - PE blue insulation compliant with ASTM D1351 specifically designed for direct burial in corrosive soil or water
   3. UL listed

C. Tracer Wire Test Stations
   1. 4-inch with locking lid
   2. Manufacturers:
      a. CP Test Services
      b. Glenn Series "Glenn-4"
      c. Or accepted substitution

D. Corrosion Control
   1. Rust inhibitive primer:
      a. Tnemec "Series 77H Chem-Prime"
      b. Or accepted substitution
   2. Rust preventative compound:
      a. Houghton "Rust Veto 344"
      b. Rust-Oleum "R-9"
      c. Or accepted substitution

E. Polyethylene encasement

1. Provide encasement for all ductile iron fittings, restrained mechanical joints and valves
2. High-density, cross-laminated polyethylene film (minimum 4 mil) or linear low-density polyethylene film (min 8mil)
3. Polyethylene flat tube: meet appropriate minimum width for size of pipe installed per AWWA C105, Method A, secured with polyethylene compatible adhesive tape
4. Flat sheet polyethylene: Provide wrapping odd shaped appurtenance following C105, secured with polyethylene compatible adhesive tape
5. Joint tape: Self-sticking, PVC or polyethylene, 2-inch wide, 10 mils thick
   a. Manufacturer:
      i) Chase "Chasekote 750"
      ii) Kendall "Polyken 900"
      iii) 3M "Scotchrap 50"
      iv) Or accepted substitution
6. Strapping: Nonmetallic, water resistant, ASTM D3950

F. Field applied tape encasement: AWWA C214
   1. Primer: Polyken #927
   2. Tape: Polyken #930 or #934
   3. Apply primer and Polyken wrap for harness rods

2.5 GATE VALVES – 3" TO 12" AND ACCESSORIES

A. Manufacturers:
   1. Mueller
   2. American AVK
   3. American Flow Control
   4. Clow
   5. Kennedy
   6. Or accepted substitution

B. AWWA C509, Iron body, bronze trim, two O-ring stem seals, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, extension stem, and extension valve box, pressure rating of 250 psi. For installation in horizontal or near horizontal pipe lines
   1. Non-adjustable elastomeric stem seals
      a. Adjustable packing glands are not permitted
   2. Direct operation of stem from above via 2-inch square nut
      a. No gear box provided
   3. Rotation: Counterclockwise to open with the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut

C. Valve stem material: ASTM B763, UNS alloy C99500 minimum yield strength of 40,000 psi
   1. Valve stem extensions: Provide valve stem extensions as necessary for proper valve operation with a 7 ft key with tee handle
   2. Provide one (1) key to Owner prior to project closeout

D. Extension stems
   1. Provide for buried valves with operating nuts more than 4.5 feet below grade
   2. Non-rising stems
      a. Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
      b. Connected to the valve by a flexible socket coupling
      c. All other connections pinned
      d. Extend stem to within 6-inch of grade
      e. Provide spacers to center stem in valve box
      f. Provide wrench nut

E. Coating
   1. AWWA C550 and NSF 61 certified
   2. Minimum 8 mils dry film thickness
   3. Fusion bonded epoxy applied to all ferrous metal surfaces after cleaning surfaces of grease, dirt and moisture, and performing near-white blast cleaning following SSPC-SP10
   4. Do not coat fasteners or machined surfaces subject to contact and relative movement against other surfaces during operation of valve or other surfaces where such coating would compromise proper installation or functionality of valve

F. Valve boxes, depth as required for valve
   1. Three piece cast iron (complying with ASTM A48, Class 20A) adjustable screw type, 5.25-inch diameter, minimum thickness of 3/16 inch
   2. Box, cover, and base coated by dipping in asphalt varnish.
   3. Cover marked with word, “WATER.”
   4. Provide extension piece to permit 6-inch adjustment above finish grade
   5. Manufacturers:
      a. Tyler Pipe Company "Series 6860 with #160 oval base"
      b. East Jordan Iron Works "8560 Series"
      c. Tyler Union "6860 Series"
      d. Or accepted substitution

2.6 BUTTERFLY VALVES – 18" TO 36" (DIRECT BURY) AND ACCESSORIES

A. Manufacturers:
   1. DeZurick
   2. Pratt
   3. Milliken
   4. Or accepted substitution.

B. AWWA C504 Class 150B for direct bury service
   1. Valve body shall be constructed of cast iron ASTM A126 Class B and conform to AWWA C504 in terms of laying lengths and minimum body shell thickness
   2. Mechanical joint ends following AWWA C111
   3. Valve disc shall be cast iron or ductile iron furnished with Type 316 stainless steel seating edge to mate with rubber seat on body

a. Valve disc shall seat in position at 90 degrees to pipe axis and shall rotate 90 degrees between full-open and tight-closed position. Install valves with valve shafts horizontal and convex side of disc facing anticipated direction of flow
b. Disc shall not creep or flutter under service conditions

4. Seat: Buna-N-Rubber
   a. 18-inch: Bonded seats that meet ASTM D429 Method B
   b. 24-inch and larger: Seats retained in the valve body by mechanical means without metal retainers or other devices located in the flow stream
   c. Retaining hardware for seats: type 304 or 316 stainless steel. Nuts and screws used with clamps and discs for rubber seats shall be held securley with locktight, or other approved method, to prevent loosening by vibration or cavitational effects
5. Valve Shaft: type 304 SS, ASTM A276
   a. Shaft bearings: stainless steel in accordance with AWWA C504. Design valve shaft to withstand 3 times amount of torque necessary to open valve
   b. Packing: Standard self adjusting and wear compensating, split-V type, and replaceable without removing actuator assembly
6. Actuators:
   a. Provide manual actuators for single project, from same manufacturer
   b. Shaft connecting actuator to valve body must be fully enclosed. Bonnet and extension to be fully enclosed and water tight
   c. Provide bonnet extensions, as required, between valve body and actuator. Space between actuator housing and valve body shall be completely enclosed so that no moving parts are exposed to soil or elements
   d. Provide actuators for valves with size based on line velocity of 12 feet per second and unidirectional service.
      i) Equip with gear manual actuator
      ii) Fully enclosed, traveling-nut type. Traveling nut shall engage alignment grooves in the housing
      iii) Traveling nut actuator shall be self-locking and designed to transmit twice the required actuator torque without damages to faces of gear teeth or contact faces of nut
   e. Oil-tight and watertight actuator housing for valves, specifically designed for buried service and factory packed with suitable grease
   f. Equipped with 2-inch actuator nut
   g. Rotation: Counterclockwise to open with the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut
   h. Valve operating key: Provide one (1) for project, 7 ft length with tee handle
7. Coating
   a. Follow AWWA C550 and NSF 61 certified
   b. Coat interior wetted ferrous surfaces of valve, with epoxy suitable for potable water conditions: in accordance with AWWA C550 and coating manufacturer's recommendations
   c. Provide three coats of two component, high-build epoxy with minimum dry film thickness of 12 mils
   d. Epoxy coating: Indurall 3300, or accepted substitution

C. Extension stems
   1. Provide as specified for buried valves with operating nuts more than 4.5 feet below grade
   2. Non-rising stems
      a. Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
      b. Connected to the valve by a flexible socket coupling
      c. All other connections pinned
      d. Extend stem to within 6-inch of grade
      e. Provide spacers to center stem in valve box
      f. Provide wrench nut

D. Valve boxes, depth as required for valve
   1. Three piece cast iron (complying with ASTM A48, Class 20A) adjustable screw type, 5.25-inch diameter, minimum thickness of 3/16 inch
   2. Box, cover, and base coated by dipping in asphalt varnish.
   3. Cover marked with word, “WATER.”
   4. Provide extension piece to permit 6-inch adjustment above finish grade
   5. Manufacturers:
      a. Tyler Pipe Company "Series 6860 with #160 oval base"
      b. East Jordan Iron Works "8560 Series"
      c. Tyler Union "6860 Series"
      d. Or accepted substitution

2.7 AIR RELEASE AND VACUUM BREAKER COMBINATION VALVES

A. Provide combination air release and vacuum breaker valves as indicated in schedule below
   1. Provide integral type that functions as both an air release and a vacuum breaker valve
   2. Size as indicated on Schedule
   3. Provide a shutoff valve
      a. 2" and smaller valve size: ball valve
      b. Larger than 2" valve size: gate valve
   4. Manufacturers:
      a. Vent-o-mat "RBX"
      b. GA "Figure CAV"
      c. Val-Matic "200C Series"
      d. APCO "140C Series"
      e. Or accepted substitution

B. Air Release/Vacuum Breaker Combination Valve Schedule

Station	Size	Min. Operating Pressure (psi)	Max. Operating Pressure (psi)	Connection
19+50.00	3"	7.25	232	Flanged
28+80.00	2"	7.25	232	Screw
50+50.00	2"	7.25	232	Screw

69+98.77	3"	7.25	232	Flanged
88+80.00	3"	7.25	232	Flanged
101+63.62	1"	7.25	232	Screw
100+97.81	3"	7.25	232	Flanged
119+76.82	3"	7.25	232	Flanged

2.8 BLOW-OFF DRAIN

A. Provide blow-off drains where indicated on the Drawings as shown on Details

2.9 FIRE HYDRANTS:

A. Fire hydrants to be provided by Owner for installation where indicated on the Drawings

B. Hydrant Gravel: Hydrant gravel shall be well graded crushed stone or gravel, conforming to AASHTO #67 gradation as listed below:

1. Sieve Size	2. Percent Passing
3. 1”	4. 100
5. 3/4”	6. 90-100
7. 3/8”	8. 20-55
9. No. 4	10. 0-10
11. No. 8	12. 0-5

2.10 BEDDING

A. Bedding: As specified in Section 02300

2.11 ACCESSORIES – MISCELLANEOUS

A. Concrete for Thrust Blocks: constructed of “Class B” Concrete as defined by CDOT Construction Specifications with maximum water to cement ratio of 0.63 by weight and 28-day compressive strength of 3,000 psi

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions under provisions of Division 1 Specifications

B. Verify locations and inverts or tops of pipe for connections to existing system as well as crossings with other utilities as indicated on the drawings. Report any discrepancies to Engineer

C. Carefully examine pipe and fittings for cracks, damage to linings, and other defects prior to installation

D. Remove all defective piping from site and replace

E. Examine areas for weak or structural defects or deviations beyond allowable tolerances for piping clearances that adversely affect excavation and quality of Work

F. Start installation only when conditions are satisfactory

3.2 PREPARATION

A. Ream pipe and tube ends and remove burrs

B. Remove scale and dirt, on inside and outside, before assembly

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 02300

B. Place bedding material in accordance with Section 02300

3.4 INSTALLATION - PIPE

A. Install PVC Pipe in accordance with AWWA M23

B. Install Ductile Iron Fittings in accordance with AWWA M41

C. Route pipe as indicated on the Drawings

D. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when connected

E. Install as specified or in accordance with the manufacturer's recommendations

F. Cutting Pipe
   1. Cut pipe to measurement taken at the site, not from the drawings
   2. Cut pipe neatly without damage to pipe
   3. Cut smooth, straight, and at right angles to pipe axis
   4. Dress and bevel end of cut pipe to remove roughness and sharp corners
   5. Cut pipe with saw or abrasive wheel
   6. Follow state and federal regulations pertaining to cutting asbestos concrete pipe as necessary

G. Install pipe to indicated elevations. Maintain minimum 4.5 feet depth of ground cover and maintain minimum grade for drainage. Establish elevations of buried piping to ensure minimum cover is achieved. Report any variations from plan to Owner and Engineer
   1. Allow for all air to be released at high points
   2. Slope water pipe and position drain at low points

H. Install pipe to allow for expansion and contraction without stressing pipe or joints

I. Protect from lateral displacement by placing embedment evenly on both sides of pipe

J. Do not lay pipe in water. Maintain groundwater level a minimum of 12 inches below pipe to be installed. Do not lay pipe under unsuitable weather or trench conditions

K. Make changes in horizontal, vertical, and curved alignment shown on drawings by using joint deflections in the amount permissible by manufacturer and shown on drawings

L. Do not bend pipe

M. Deflect pipe at joints

N. Do not deflect PVC pipe at connection to ductile iron fittings

O. Form and place concrete for thrust blocks at each elbow or change of direction of pipe main as indicated on Drawings

P. Utility crossings
   1. Whenever possible, lay water mains over sanitary and storm sewers to provide vertical separation of at least 18-inch between invert of water main and crown of sewer
   2. If standard crossing detail is not available and above separation cannot be met, provide one continuous length of watertight sewer pipe 20' long centered on water main with joints between different pipes encased in 6-inch minimum of concrete and extending 6-inch either side of joint or encase sewer pipe in 6-inch of concrete completely around pipe, for not less than 10' either side of water main
   3. Water Mains Passing Under Sanitary Sewers: If vertical separation is less than 18-inch, provide structural support for sewer. Provide concrete encasement where water lines pass under sanitary sewer line. Reference detail shown on Drawings

Q. Maintain a minimum 10 feet of horizontal separation and 18 inches of vertical separation between water main and storm or sanitary sewer lines in accordance with the CDPHE
   1. Provide concrete encasement if these clearances cannot be achieved and when water line is below sanitary sewer line

R. Tracer wire and marker tape
   1. Install tracer wire continuous over top of pipe
   2. Install tracer wire test stations at fire hydrants and 500 LF of water line
   3. Terminate tracer wire following drawing details
   4. Tape tracer wire to top of pipe using PVC tape every 4 feet along the pipe, and on each side of fitting
      a. Tape: minimum 2 inches wide and wrapping full circumference of pipe
   5. Install identification /warning marker tape in fill area of trench above all water lines

S. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system

T. Install access fittings to permit disinfection of water system, subject to approval by Engineer

U. Backfill trench in accordance with Section 02300

3.5 JOINTS

A. Make pipe joints carefully and neatly

B. Connect piping in accordance with manufacturer's recommendations

C. Push-on joints
   1. Lay pipe with bell ends facing the direction of laying except when Engineer authorizes reverse laying
   2. Assembly of PVC plain end into bell: follow PVC pipe manufacturer's recommendation
   3. For PVC pipe, Contractor to ensure that pipe is not inserted into the bell ends beyond the push line
      a. Utilize EBAA Mega-Stop bell protection, or approved substitution, if necessary, to ensure previously laid pipe joints are not impacted by ongoing installation
   4. Lubricate joint surfaces immediately before completing the joint
   5. Bevel spigot ends of field cut piping
   6. Groove spigot ends of field cut restrained joint piping if required by joint system
   7. Install restrained joints following manufacturer's recommendations

D. Mechanical joints
   1. Before assembling joint, clean both bell and plain end of rust and foreign matter
   2. Assemble joint following AWWA C111, C600, C605 and as specified
   3. Lubricate gasket and install in accordance with manufacturer's instructions
   4. If an effective seal is not obtained, disassemble joint, clean thoroughly, and reassemble
   5. Do not over tighten bolts to compensate for poor installation
   6. Carefully align holes in mechanical joints with restraint device to permit installation of the harness bolts
   7. Install mechanical joint pieces so the mechanical joint holes straddle the top centerline for horizontal piping, or the side centerline for vertical piping

3.6 PROTECTIVE COATING

A. Provide polyethylene tube encasement on all buried ductile iron fittings and valves
   1. Encase ductile iron fittings and valves in polyethylene per AWWA C105, Method A, secured with polyethylene compatible adhesive tape. Overlap polyethylene onto PVC pipe a minimum of 6 inches
   2. Before backfilling, inspect polyethylene for rips, punctures and other damage and repair following AWWA C105

B. Coat exposed ferrous metal surfaces of joints, couplings, and uncoated steel with primer and tape coating system after installation. Do not coat stainless steel or high strength low alloy steel nuts and bolts

1. Surface Preparation: Clean surfaces of rust, scale, soil, mud, oil, grease, and other contaminants by hand or power tool following SSPC-SP2 or SP3 and other appropriate means as recommended by coating manufacturer Remove excess moisture and provide surface dryness as recommended by coating manufacturer
2. Application: Apply primer in uniform manner to clean and dry surfaces following coating manufacturer's recommendations
    a. Fill complex and irregular surfaces with appropriate mastic or filler tape to eliminate bridging; then apply tape/wrap to primed and filled surfaces following coating manufacturer's recommendations.
    b. When coating restraining rods or strapping, apply tape wrap longitudinally
    c. Where metal being coated enters concrete, overlap coating onto concrete by minimum of 2 inches after placement of concrete
3. Inspection: After field coating of specified items, conduct visual inspection to verify complete coverage has been accomplished.
    a. Repair damaged or incompletely coated surfaces following coating manufacturer's recommendations

C. Metal Harness Rods
    1. Provide field applied primer and Polyken tape wrap

3.7 CONCRETE ENCASEMENT

A. Provide where indicated on the Drawings

B. Suitably support and block pipe and anchor against flotation

3.8 INSTALLATION – VALVES AND HYDRANTS

A. Carefully inspect valve before installation. Clean interior. Operate valve to determine parts in proper working order, with valves seating and drain valve operating properly. Set plumb and center stem in valve box and securely brace into place. Comply with AWWA C600 and referenced standards

B. Center and plumb valve box over valve. Set box cover flush with finished grade.
    1. Backfill and compact under and around valve boxes to ensure no vertical loads are transmitted to valve operators or bonnets

C. Comply with AWWA M17 for fire hydrant installation. Install with gate valve and provisions for drainage

D. Install valves, hydrants, and accessories in accordance with the manufacturer's recommendations and in accordance with referenced standards and specifications.

E. Hydrants and valves to be set plumb on solid bearing surface

F. Locate hydrant flange a minimum of 3” and maximum 6” above adjacent finished grade or flush with the adjacent top of curb. Contractor to verify final grade or adjust flange height upon the completion of final grading

G. Drainage shall be provided at the base of the hydrant by placing rock from the bottom of the trench to at least 12 inches above the barrel flange of the hydrant and to a distance of 12 inches around the elbow. The minimum distance from the bottom of the trench to the bottom of the hydrant elbow shall be 6 inches. The minimum amount of rock placed shall be 1/3 cubic yard

3.9 TAPPING

A. Tapping shall be performed using standard tapping saddles designed for use on PVC piping in accordance with AWWA C605. Tapping shall be performed only with use of tap saddles or sleeves. NO DIRECT TAPPING WILL BE PERMITTED. Tapping shall be performed in accordance with the applicable sections for saddle tapping as per “Uni-Pub-8: Tapping Guide for PVC Pressure Pipe by Uni-Bell PVC Pipe Association"

B. All connections requiring a larger diameter than that recommended by the pipe supplier, should be made with a pipe connection as specified and indicated on the drawings.

C. Equipment used for tapping shall be made specifically for tapping PVC pipe:
   1. Tapping bits shall be slotted “shell” style cutters, specifically made for PVC pipe. ‘Hole saws’ made for cutting wood, steel, ductile iron, or other materials are strictly prohibited

3.10 THRUST BLOCKS

A. Installation:
   1. Thrust blocks shall be constructed at bends and fittings that require support due to unbalanced line thrust. Care shall be taken to ensure that outlets, cover bolts, nuts, clamps, and other fittings are accessible. A bond breaker shall be placed between the pipe and the thrust block to aid in future removal. If a large thrust block is to be placed, it shall be separated into sections by a suitable material. Bearing surface areas are minimum areas to bear against the undisturbed trench wall. If the soil bearing capacity is insufficient to provide adequate support based on minimum bearing areas established by Drawing Details, then the minimum bearing area shall be increased to a size that shall ensure support restraint. In every instance, the thrust block shall bear against undisturbed earth
   2. Before placing concrete, equipment used in the mixing and transport shall be cleaned. Debris, water, or ice shall be removed from the area to be occupied by concrete. Concrete shall not be placed on frozen subgrade. Concrete shall be placed only in the presence of the Owner or Engineer unless inspection is waived prior to the placement

B. Formwork for Thrust blocks:
   1. Forming for concrete thrust blocks and anchors shall be done by bulkheading around the shape of the thrust block or anchor with wood, burlap sacks, or reinforced paper sacks that are filled with sand or earth. Sacks shall be constructed of a size easily handled when full and left in place in the trench. Wood forms shall be removed before backfilling.

2. Horizontal struts or braces required for trench shoring shall not remain in concrete thrust blocks. Prior to placing concrete, the forms and ditch bank will be inspected and approved by Owner or Engineer
3. When concrete is deposited against the ground without the use of forms, the ground shall be thoroughly moistened or other provisions made to prevent the ground from drawing water in from the concrete

C. Thrust block Curing Time:
   1. Newly placed concrete shall be allowed to set undisturbed for a minimum of 24 hours

D. Compaction of Fill Over Thrust blocks
   1. Backfill may be placed over thrust blocks once the surface has set sufficiently and they are able to resist the weight of the backfill. However, tamping or compacting shall not be allowed above the thrust block for a minimum of 24 hours after placement

3.11 ABANDONMENT

A. Cap ends of main as shown. Place required concrete blocking as shown on drawing details

B. Where mains are to be abandoned and removed to a fitting or valve, cut and plug main at fitting or valve
   1. When shown on drawings, remove fire hydrants and valves, including lead joint tees when encountered; salvage and deliver removed fire hydrants and valves to the Owner.
   2. Pipe, fittings, and other appurtenances that are removed, but are not required to be salvaged become property of Contractor
      a. Remove and dispose of offsite

3.12 ERECTION TOLERANCES

A. Establish invert elevations as shown on the drawings

B. Construct pipe within manufacturer’s tolerances of horizontal and vertical deflection

3.13 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions set forth by the referenced standards

B. Test each line at the Contractor's expense in the presence and to the satisfaction of Owner or Engineer

C. Disinfection
   1. Disinfect in accordance with Section 02676

D. Hydrostatic Pressure Tests

1. Provide all necessary pumping equipment, piping connections, pressure gauges with maximum of 5 psi increments, and other required equipment, facilities, and materials
2. All water used for pressure testing must be potable and delivered in acceptable containers
3. Immediately locate and replace all pipe fittings, valves, pipe joints, and other materials found to be defective with new and acceptable material
4. If tests indicate work does not meet specified requirements, remove work, replace, and retest at no cost to Owner
5. Procedure
   a. Disconnect all fixture devices and other accessories which may be damaged by the specified test pressure
   b. Plug or cap ends as required
   c. Bleed system to eliminate all air from system
   d. No pressure testing shall be permitted until all concrete thrust blocks have adequate curing time to reach design strength, 7 day minimum
   e. Notify Owner and Engineer 48 hours prior to testing
   f. Test for 2 hours with no more than 5 psi pressure loss
   g. Leakage is the quantity of water added to a test section to maintain test pressure ±5 psi:

$$L = \frac{S \times D \times (P)^{0.5}}{133{,}200}$$

   Where:
   L = allowable leakage in gallons per hour
   S = length of pipe tested, in feet
   D = nominal diameter of pipe, in inches
   P = average test pressure during test, psig
6. Hydrostatic Test Conditions: At lowest point in the line or section under test pressure or operating pressure, whichever is greater, as scheduled below

Pipe	Test Pressure	Operating Pressure	Test Medium	System
36-inch PVC	150 psi	110 psi	Water	Transmission
24-inch PVC	150 psi	160 psi	Water	Transmission
18-inch PVC	150 psi	170 psi	Water	Transmission
12-inch PVC	150 psi	160 psi	Water	Distribution
8-inch PVC	150 psi	160 psi	Water	Distribution
6-inch PVC	150 psi	160 psi	Water	Hydrant

7. While the test pressure is maintained, an examination shall be made of the pipeline and any leaks located and repaired. Pipe or fittings found to be faulty shall be removed and replaced. Leakage is not allowed through the bonnet of the line valve. A valve leaking through the bonnet may be repaired in place or removed and replaced. Cutting and replacement of pavement as well as excavation and backfilling may be necessary when locating and repairing leaks discovered during pressure testing.

8. After visible leaks are stopped, repeat procedure beginning at 3.13.D.5 of this section

E. PVC Water Pipe Continuity Testing
   1. Test tracer wire for continuity, in the presence of Owner and Engineer, after backfill is complete and before Substantial Completion
   2. Notify Owner and Engineer five working days in advance to schedule testing
   3. Continuity test to consist of locating the PVC water pipe with an electronic-type pipe locator
   4. If test is negative for continuity, repair or replace as necessary to achieve continuity

F. Bac-T Testing
   1. After completion of water line disinfection as specified in Section 02676, Contractor shall take Bac-T samples to ensure pipe has been properly disinfected and submit results to Engineer
   2. If water line fails Bac-T sampling, any repeat disinfection and Bac-T testing will be at the Contractor’s expense
   3. The Contractor shall receive District's approval before placing a water line in service

END OF SECTION

SECTION 02530

SANITARY SEWERAGE SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Polyvinyl chloride (PVC) non-pressure pipe for sanitary sewer with all jointing materials, fittings, and other appurtenances required for a complete installation

B. All precast manholes complete with steps, ring and cover as required

1.2 RELATED SECTIONS

A. Section 02300 – Earthwork

1.3 REFERENCES

A. ASTM D1784 - Rigid Polyvinyl Chloride Compounds

B. ASTM D3034 - PVC Gravity Sewer Pipe, Type PSM

C. ASTM D2321 - Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe

D. ASTM D3212 - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

E. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F. ASTM C150 - Portland Cement

G. ASTM C478 – Precast Concrete Structures

H. ASTM C497 - Testing Concrete Pipe, Manhole Sections, or Tile

I. ASTM A48 - Gray Iron Castings

J. ASTM A185 - Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

K. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

L. ASTM C33 - Concrete Aggregates

M. ASTM C478 - Precast Reinforced Concrete Manhole Sections

1.4 SUBMITTALS

A. Submit under provisions of Division One Specifications

B. Shop Drawings: Provide piping layout and assembly drawings with fitting dimensions. Provide sufficient information to verify compliance with specifications

C. Product Data: Provide data on pipe and gasket materials, pipe fittings, and accessories. Provide manufacturer's catalog information with recommended installation requirements

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements and applicable standards

E. Test Reports: Submit reports of field exfiltration/infiltration, mandrel and lamp tests under provisions of Division One Specifications

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with the Colorado Department of Public Health and Environment (CDPHE) Stormwater and/or Groundwater Discharge Permit, notes on the drawings and as specified herein.

1.6 REGULATORY REQUIREMENTS

A. Conform to all municipal codes and ordinances, laws and regulations of the State of Colorado, CDPHE, EPA, and OSHA

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division One Specifications

B. Accurately record actual locations of pipe, pipe fittings, and invert elevations

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities

1.8 DELIVERY, STORAGE AND HANDLING

A. Delivery
   1. Deliver, store, protect and handle under provisions of Division One Specifications
   2. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct rays of the sun
   3. Transport and handle precast concrete units with equipment to protect from dirt and damage

B. Storage
   1. Store pipe, fittings and gaskets in clean locations protected from environmental conditions such as: (direct sunlight, heat, mud.. etc)

2. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months
3. Store pipe on a flat surface which provides even support for the barrel with bell ends overhanging
4. Do not place precast concrete units in position which will cause damage

C. Handling
1. Handle so as to insure installation in sound, undamaged condition. Do not damage the pipe by impact, bending, compression or abrasion during handling or storage
2. Use equipment, tool, and methods for unloading, reloading, hauling, and laying that do not damage pipe
   a. Use hooks/hands with broad, well-padded contact surfaces for insertion into pipe ends or nylon protected slings to handle pipe
3. Handle precast concrete structures by means of lifting inserts. Do not move from manufacturer's yard until curing is complete.

PART 2 PRODUCTS

2.1 PIPE MANUFACTURERS

A. Certainteed Corporation

B. Johns-Manville

C. Or accepted substitution

2.2 GROUT MANUFACTURERS

A. Non-Shrink, Non-Metallic Grout
1. Master Builders: Masterflow 928
2. Burke: Non-Ferrous Non-Shrink
3. M.R. Meadows: Sealtight 588
4. Sonneborn: Sonogrout G.P.
5. Tamms: Tammsgrout 621
6. Sika: SikaGrout 212
7. Or accepted substitution

B. Epoxy Grout
1. Burke: BurkEpoxy Anchoring Grout
2. L&M Inc.: Epogrout
3. Sika: Sikadur 42, Grout Pack
4. Or accepted substitution

2.3 PIPE MATERIALS

A. Pipe and Fittings

1. 4 thru 12-inch, ASTM D3034, T-1 wall, SDR 35, non-pressure pipe. Use SDR 35 unless otherwise noted on plans
   a. Cell classification: ASTM D1784
2. Pipe length: 12-20 feet standard manufactured length for construction

B. Joints: ASTM D3132 and F477 - Rubber gasket with one compression gasket ring, integral bell and spigot type
   1. Designed to hold pipe in alignment, provide flexibility, separate the ends of pipe lengths, resist applied earth pressures, and provide fluid tightness
   2. Rubber rings: ASTM F477

2.4 MATERIALS

A. Plugs and Caps: Use pipe plugs or caps provided by the pipe manufacturer and approved by the Engineer for pipe stubouts.

B. Cleanouts: Provide as indicated, pipe extension to grade with ferrule and countersink cleanout plug. Provide round cast-iron access frame over cleanout, with heavy duty secured scoriated cover with lifting device cast with the word “SANITARY”.

C. Reinforcement
   1. Reinforcing Steel: ASTM A615 Grade 60
   2. Welded Wire Fabric: ASTM A185

D. Concrete: Refer to Division Three Specifications if applicable
   1. Minimum compressive strength: 4000 psi at 28 days
   2. Cement: ASTM C150, Portland Cement, Type II
   3. Aggregates: ASTM C33, free of deleterious substances

E. Gaskets: ASTM C923
   1. Mastic: FS SS-S-210A, "RAM-NEK" or approved substitution
   2. Rubber: Neoprene, 40$\pm$ 5 hardness when measured by ASTM D2240, Type A durometer

F. Frames and Castings: ASTM A48 with asphalt varnish coating hot dip applied at foundry, 6 mils thick Class 30b

G. Manhole Rings and Covers
   1. Cast iron, heavy duty traffic type, ASTM A48, Class 35B. Grind bearing surfaces to ensure flat, true surfaces
   2. Covers to seat at all points on ring
   3. Covers to be cast with "SANITARY" in 2" tall flush letters
   4. Provide type as indicated on the drawings

H. Manhole Height Adjustment: Use precast concrete grade rings

I. Rock Subbase: 1-1/2 inch minus, well-graded gravel over compacted subgrade

J. Water: Clean and free of deleterious substances

2.5 MANHOLES

A. Precast Concrete Units:
   1. Manufacturers: Carder Concrete Products, Amcor Precast, or accepted equal
   2. Specification: ASTM C478 and C789
   3. Minimum wall thickness: greater of 6 inch 1/12 of internal diameter
   4. Reinforced
   5. Grade rings as required
   6. Cast steps into units.

B. Precast Units or Cast-in-place as shown. Use concrete that will attain a 28-day compressive strength of not less than 4,000 psi with a cement content of not less than 6 sacks per cu. yd. Openings to be precast per plan or sawcut in field.

C. Manhole Steps: Steel bar, 1/2 inch Grade 60, drop-front type, with polypropylene coating applied by manufacturer, Type MA Industries, Inc. "PS2-PF" or equal.

2.6 FABRICATION

A. Vault/Manhole Sections
   1. Precast concrete dimensions as shown on plans
   2. Minimum manhole inside diameter: 48 inch
   3. Precast lid and Cones: Same or greater reinforcement and wall thickness as vault or manhole section with capability for H20 loading
   4. Vault Joints: Shiplap or tongue and groove with double mastic gaskets, each joint to set equally and tightly
   5. Manhole Joints: Keylock type with double mastic gaskets, each joint to set equally and tightly
   6. Access opening: Minimum 24 clear or as indicated
   7. Pipe connection: As indicated on Drawings
   8. Pipe knockout: As indicated on Drawings
   9. Precast concrete, monolithic base or cast-in-place base
   10. Manhole steps: 12 inch on center, vertical alignment above largest bench or open area

B. Grating and Metal Frame: As specified on drawings

2.7 CONCRETE MATERIALS

A. Follow requirements specified in Division Three sections.

2.8 SOIL MATERIALS

A. Furnish pipe bedding and cover as specified in Section 02300, Earthwork.

2.9 IDENTIFICATION

A. Underground Type Plastic Line Marker: Manufacturer's standard permanent, continuous-printed plastic tape with metallic core, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide green tape with black printing reading "CAUTION SANITARY SEWAGE LINE BURIED BELOW." Provide identification markers of one of the following:
   1. Allen Systems, Inc.
   2. Emed Co., Inc.
   3. Seton Name Plate Corp.

2.10 SOURCE QUALITY CONTROL

A. Identification Marks: Clearly and permanently marked at not greater than 5 foot intervals with pipe diameter, PVC cell classification, manufacturer, plant, shift, ASTM, date designations and service designation

B. Testing per ASTM D3034
   1. Test products not manufactured in the U.S. at an acceptable laboratory in the U.S.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine pipe and fittings and do not use individual sections containing cracks, dents, abrasions, and other defects

3.2 INSTALLATION

A. Install pipe in accordance with ASTM D2321 as modified herein or on the drawings

B. Perform all laying and jointing in the presence of an Owner inspector and other consultants as specified by quality control specifications.

C. Cutting
   1. Cut and bevel ends in accordance with manufacturer's standard recommendations
   2. Machine cut ends smooth and square to proper dimensions
   3. Do not cut with a cold chisel, iron pipe cutter, flame or any other method that may fracture the pipe or leave ragged, uneven edges
   4. Remove burrs and wipe off all dust and dirt from jointing surfaces

D. Pipe Laying
   1. Inspect pipe and accessories for cracks and other defects before lowering into trench
   2. Repair or replace any defective, damaged or unsound pipe
   3. Remove all dirt and foreign material from the inside of pipe before laying
   4. Check bedding for firmness and uniformity of surface immediately before laying each section of pipe

5. Carefully lower pipe, fittings, valves, and accessories into the trench with derricks, ropes, and other suitable equipment to prevent damage
6. Do not dump or drop pipe or accessories into trench
7. Lay to lines and grades indicated on drawings or as specified
    a. Lay piping beginning at a low point of system, true to line and grade with unbroken continuity of invert.
    b. Closely joint to form a smooth flow line
    c. Place bell end or groove ends of piping facing upstream
    d. Maximum length of pipe that can be used without exceeding the allowable deflection at a coupling shall be determined
    e. Maximum deflection at flexible couplings as recommended by the manufacturer
    f. Maximum deflection at a joint: As recommended by the manufacturer, but not more than 3-1/2 inches
8. Utilize implements, tools, and facilities as recommended by the manufacturer
9. Keep pipe clean during and after laying
10. Close all open ends with watertight expandable type sewer plugs or test plugs
11. Remove and relay any pipe which has floated
12. Do not lay pipe when
    a. There is water in the trench
    b. Trench conditions are unsuitable
    c. Weather conditions are unsuitable
13. Use acceptable adaptors at manhole and structure connections to provide a watertight seal and flexibility; provide a short length of pipe outside each connection
14. Protect from lateral displacement by placing and compacting bedding material under provisions of Section 02300

E. Jointing
1. Assemble in accordance with the manufacturer's instructions
2. Wipe clean pipe ends, gasket and gasket groove before inserting gasket
3. Apply lubricant furnished by the pipe manufacturer to the gasket and the outside of the spigot end
4. Utilize an assembly tool as recommended by the manufacturer to center the sleeve over the spigot end
5. Insert the spigot end to the reference mark
6. Check gasket location after assembly with a suitable gage
    a. Gasket locations to be the distance from the sleeve and recommended by the coupling manufacturer for their full circumference
    b. If not within the required limits, disassemble and reassemble the joint
7. Completely encase all transition joints between VCP and PVC sanitary lines with minimum 6-inch thick concrete extending one foot either side of joints

F. Fittings
1. Install utilizing standard methods
2. Lower into trench with rope or other means to prevent damage
3. Attach rope around the exterior
4. Do not attach rope through the interior
5. Carefully connect to pipe or other facility

6. Check joint to insure a sound and proper joint

G. Sanitary Sewer Service Lines
1. Place true to line and grade in accordance with the drawings, from mainline stub out to building service, in shortest direct route
2. Locate 10 feet from all water lines.
3. Terminate 5 feet from building line or as shown on the drawings

H. Backfill
1. Pipe Cover:
   a. Use specified bedding material for pipe cover material. Use cover material that is clean, free from organic materials, chucks of soil, frozen material or other unsuitable materials.
   b. Place and compact cover material starting at top of pipe bedding extending upwards. Place in lifts which achieve density of 95%, ASTM D698 at a point 6-inch above top of pipe.
2. Conform to requirements of Section 02300

I. Compaction
1. Compact backfill following requirements of Section 02300

J. Water Line and Sanitary Sewer Crossings
1. Whenever possible lay water mains over sanitary sewers to provide vertical separation of at least 18-inches between invert of water main and crown of sewer.
2. If above separation cannot be met, provide one continuous length of watertight sewer pipe 20 feet long centered on water main with joints between different pipes encased in 6-inch minimum of concrete and extending 6-inches either side of joint or encase sewer pipe in 6-inches of concrete completely around pipe, for not less than 10 feet either side of water main.
3. Water Mains Passing Under Sewers: If vertical separation less than 18-inches provide structural support for sewer

3.3 PRECAST STRUCTURE PREPARATION

A. Verify items provided by other section of Work are properly sized and located

B. Verify that built-in items are in proper location, ready for roughing into Work

C. Verify excavation for manholes is correct

D. Excavation and Backfill: Refer to Section 02300 for requirements

E. Rock Subbase: Remove water, excavate, and place 1 1/2 inch rock 6 inch minimum depth, vibrate for compaction

3.4 PLACING MANHOLE

A. Place base pad, trowel top surface level to accept manhole section with uniform bearing all around

B. Place sufficient non-shrink grout on base to ensure watertight fit between first manhole section and base or place first manhole section directly in wet concrete

C. Place manhole sections plumb and level, trim to correct elevations

D. Clean ends of sections and place double mastic gasket

E. Fill inside and outside of joint completely with non-shrink grout and trowel smooth

F. Cure non-shrink grout using approved methods outlined in Division Three specifications.

G. Set cover rings and covers level without tipping, to correct elevations or set cover rings and covers with slight tip to match cross slope of finished surface where directed by Engineer

H. Completed manholes shall be rigid and watertight

I. Coordinate with other sections of work to provide correct size, shape, and location

3.5 PREFORMED GASKETS

A. Remove and replace manhole sections which have chipped or cracked joints

B. Thoroughly clean section joints

C. Install gasket in conformance with manufacturer's recommendations

D. Only use primer furnished by gasket manufacturer

3.6 MANHOLE INVERT

A. Place concrete in bottom of manhole and form smooth transition. Trowel smooth and brush for non-skid finish. Slope bench 1 inch per foot for drainage to invert.

B. Invert shape to conform to radius of pipe it connects

C. Remove all rough sections or sharp edges which tend to obstruct flow or cause material to snag. Remove all grout droplets from invert

D. Construct in conformance with standard drawings

3.7 MANHOLE RINGS AND COVERS

A. Place rings in bed of non-shrink grout on top of manholes

B. Ensure no infiltration will enter manhole at this location

C. Carry non-shrink grout over flange of ring

D. Set top of ring 6 inches below roadway surfaces as shown on drawings

E. Use precast grade rings for height adjustment

3.8 CONNECTION TO EXISTING MANHOLES

A. Maintain flow at all times

B. Prior approval of proposed method for maintaining flow must be obtained from Engineer

C. Cover area around new pipe with non-shrink grout and or waterstop gasket to ensure a watertight structure

D. Make connection during low flow periods

3.9 FIELD QUALITY CONTROL

A. Exfiltration/Infiltration Test
   1. Perform an exfiltration test on each reach of sanitary service and sewer pipe between manholes or discharge
      a. Test the first reach prior to backfilling and before installing any of the remaining pipe
      b. Provide all necessary piping between the reach to be tested and the water supply, together with all required materials and equipment
      c. Methods used, scheduling, and duration of tests shall be acceptable to Engineer
      d. Air testing may be allowed: Submit complete information to Engineer for review describing the proposed test method including the method of testing manholes before beginning testing
   2. Procedure
      a. Block off all manhole openings except those connecting with the reach under test
      b. Fill the line
         i) Average depth: 10 feet above invert except as required by manhole depth
         ii) Maximum depth at lower end: 25 feet above crown
         iii) Minimum depth at upper end: 5 feet above crown
      c. Add and measure water as required to maintain a constant level
         i) Maximum exfiltration/infiltration: 0.039 gallons per inch of nominal diameter per hour per 100 feet of pipe.
         ii) Manholes considered section of 48-inch pipe
         iii) Maintain test for at least 2 hours or as long as necessary, in the inspector's opinion, to locate all leaks
   3. Repair and retest any reach which exceeds the allowable exfiltration/infiltration

B. Infiltration

1. At any time prior to expiration of the correction period, infiltration exceeds 0.039 gallons per inch of nominal diameter per 100 feet per hour, locate the leaks and make repairs

C. Pipe Deflection Test
1. No sooner than 30 days after placement and compaction of backfill, but prior to placement of permanent surface materials, clean and mandrel each line to detect obstructions (deflections, joint offsets, lateral pipe intrusions, etc.)
2. Use a rigid mandrel with diameter of at least 95 percent of the pipes specified average inside diameter and a length of the mandrel circular portion at least equal to the nominal pipe diameter
3. Maximum allowable deflection is 5 percent of the base internal diameter. Mandrel outside diameters in inches are as follows:

Pipe Size	Base I.D.	Mandrel O.D.
6	5.792	5.50
8	7.764	7.38
10	9.711	9.23
12	11.558	10.98

4. Pull the mandrel through the pipe by hand
5. Relay or replace all pipe exceeding the 5 percent deflection at no additional cost to the Owner
6. Retest repaired sections
7. Maximum allowable deflection at end of one year correction period, 7-1/2 percent of the base internal diameter tested in the same manner. Uncover and repair sections exceeding the allowable deflection

D. TV Inspection will be provided as requested by Owner and approved by the Engineer at the expense of the Contractor.

E. All sewer lines shall be inspected visually to verify accuracy of alignment and freedom from debris and obstructions. The full diameter of the pipe should be visible when viewed between consecutive manholes. The method of test can be photography, closed circuit television or visually lamping with mirrors and lights.

F. Lamp Test
1. Each section between manholes will be lamped by contractor in the presence of engineer
2. A true circle will be required in the lamp tests to indicate a properly constructed sewer line
3. Repair any sections not passing the lamp test at contractor’s expense.

3.10 FIELD QUALITY CONTROL – MANHOLES

A. Test all manholes:

1. Vacuum test:
   a. Plug all inlets and outlets in such a manner as to prevent displacement of plugs
   b. Install and operate vacuum tester head assembly in accordance with equipment specifications and manufacturer instructions
   c. Attach the vacuum pump assembly to the proper connection on the test head assembly. Ensure that vacuum inlet/outlet valve is closed
   d. Inflate sealing element to twice the pressure test to be used. Do not over inflate
   e. Start vacuum pump assembly engine and allow preset RPM to stabilize
   f. Open vacuum inlet/outlet valve and evacuate manhole to 5-inches Hg (mercury)
   g. Close vacuum inlet/outlet valve, disconnect vacuum pump and monitor vacuum. Record time for vacuum to drop from initial 5 inches Hg to 4 inches Hg.
   h. Acceptance for 5 foot diameter manhole is when the time to drop from 5 inches Hg to 4 inches Hg meets or exceeds requirements as defined below:

Maximum Allowable Vacuum Drop		
Manhole Depth Rim to Invert	Manhole Diameter in feet	Time for Vacuum to Drop 1 inch Hg
10 feet or less	5	150 seconds
10 feet to 15 feet	5	180 seconds
15 feet to 25 feet	5	210 seconds

   i. Adjust time to drop from 5 inches Hg to 4 inches Hg for other manhole diameters as follows:
      i) 4 foot diameter manhole: Subtract 30 seconds from time shown above
      ii) 6 foot diameter manhole: Add 30 seconds to time shown above
   j. Repair all manholes that fail leakage test and retest until manhole passes test at no additional cost
   k. If joint mastic or gasket is displaced during vacuum test, disassemble manhole and replace seal
   l. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn, Retesting shall proceed until a satisfactory test is obtained.
2. All testing shall be witnessed by Engineer. Contractor shall provide a minimum of 48 hours notice to Engineer prior to testing.

3.11 CLEANUP AND RESTORATION

A. Restore pavements, curbs and gutters, utilities, and other improvements to condition equal to or better than before work began and to satisfaction of Engineer.

B. Deposit waste material in designated waste areas and disposal site graded and shaped.

END OF SECTION

SECTION 02616

SITE PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping and necessary appurtenances for concrete structures for exterior locations:
   1. Headworks building piping
   2. Other miscellaneous exterior piping

1.2 RELATED SECTIONS

A. Section 02300 – Earthwork

B. Section 02676 – Disinfection of Water Systems

C. Section 03000 – Concrete

D. Section 03600 – Grout

E. Section 15060 – Pipe and Pipe Fittings

F. Section 15100 – Valves, Cocks, and Hydrants

1.3 REFERENCES

A. American National Standards Institute – ANSI:
   1. B16.1 – Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800

B. American Society of Testing and Materials
   1. A307 – Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
   2. A536 – Ductile Iron Castings
   3. D1248 –Polyethylene Plastics Extrusion Materials for Wire and Cable

C. American Water Works Association – AWWA:
   1. C104 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
   2. C105 – Polyethylene Encasement for Ductile-Iron Pipe Systems
   3. C110 – Ductile-Iron and Gray-Iron Fittings, 3-Inch through 48-Inch, for Water and Other Liquids
   4. C111 – Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pressure Pipe and Fittings
   5. C115 – Flanged Ductile-Iron Pipe with Ductile-Iron or Grey-Iron Threaded Flanges
   6. C150 – Thickness Design of Ductile-Iron Pipe
   7. C151 – Ductile-Iron Pipe, Centrifugally Cast
   8. C153 – Ductile-Iron Compact Fittings for Water Service
   9. C600 – Installation of Ductile-Iron Water Mains and Their Appurtenances

10. C651 – Disinfecting Water Mains

D. Colorado Department of Transportation (CDOT)
   1. Road and Bridge Construction

E. National Science Foundation – NSF:
   1. NSF 61 – Drinking Water System Components – Health Effects

1.4 SUBMITTALS

A. Submit under provisions of Division 1 specifications

B. Shop Drawings:
   1. Provide drawings with pipe and structure details, design standards, reinforcement, dimensions, layout fabrication and assembly drawings and shall include, but not limited to, the following:
      a. Layout of pipe drawings
      b. Pipe and joint details
      c. Specials, fittings, and coupling details
      d. Specification data sheets
      e. Certificates of compliance with applicable standard and specification and testing certificates
   2. Provide additional detailed information including elevations, fittings, specialty materials or fabrications for special or custom features, structures, junctions and/or pipes
   3. Specifications, data sheets and affidavits of compliance for coatings and linings
   4. Provide pipe-laying and installation schedule

C. Product Data: Provide sufficient data on features, pipe, joints, gasket material, lubricant and accessories to verify compliance with specifications

D. Manufacturers Certificate and affidavits: Furnish
   1. Furnish the following prior to fabrication
      a. Details: Pipe, joint, special, fitting and coupling
      b. Shop coating
      c. Shop coatings and linings: specifications, data sheets, and compliance affidavits
   2. Furnish the following prior to shipment
      a. Compliance affidavit for applicable standards
      b. Test certificates

E. Test Reports: Submit all shop and field test reports in accordance with Division 1 Specifications Product Data

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 Specifications

B. Accurately record actual locations of piping mains, valves, connections, centerline of pressure pipe elevations, and top of gravity pipe elevations

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities

1.6 REGULATORY REQUIREMENTS

A. Conform to all state and local municipal codes and ordinances, laws and regulations

B. In case of apparent conflict, state and local requirements govern over these specifications

C. In absence of state and local regulations, International Plumbing Code applies

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1 specifications

B. Delivery
   1. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct sunlight

C. Storage
   1. Store pipe, fittings and gaskets in clean locations protected from environmental conditions such as: direct sunlight, mud, etc.
   2. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months
   3. Store pipe on a flat surface which provides even support for the barrel with bell ends overhanging
      a. Do not stack pipe higher than 5 feet

D. Storage: Use the following precautions for valves, during storage:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage
      a. Protect valves from weather by storing indoors or support valves off ground or pavement in watertight enclosures when outdoor storage is necessary

E. Handling
   1. Handle so as to insure installation in sound undamaged condition
   2. Use equipment, tools and methods for unloading, reloading, hauling and laying that do not damage pipe or cause an impact. Damaged pipe will be cause for rejection
   3. Use hooks or straps with broad, well padded contact surfaces for lifting sections of pipe

F. Preparation for Transport: Prepare valves, for shipping as follows: Ensure that valves are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends, flange faces, and weld ends. Set valves in best position for handling. Set valves closed to prevent rattling

G. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C500

H. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation

I. Seal valve ends to prevent entry of foreign materials into valve body

J. During loading, transporting and unloading, exercise care to prevent damage to material
   1. Use nylon slings only
   2. Do not drop pipe or fittings
   3. Do not roll or skid against pipe already on ground
   4. Repair any damage done to coating or lining
   5. Handle per manufacturer's recommendations
   6. Store rubber gaskets in cool dark location
   7. Store all material on wood pallets or timbers

K. Adequately tag or otherwise mark all piping and fittings as to size

1.8 ENVIRONMENTAL REQUIREMENTS

A. Weather limitations: Do not install piping over frozen surfaces or in standing water

PART 2 PRODUCTS

2.1 GENERAL

A. General: Provide pipes and fittings of the following materials, joint types, sizes, and weight/class indicated on Drawings or specified.

B. Fittings: Furnish bends, ells, tees, wyes, couplings and other fittings of the same type and class of material having equal or superior physical and chemical properties as acceptable to the Engineer

C. All buried pipe shall be installed with tracer wire and metallic core identification tape

2.2 DUCTILE IRON PIPE

A. Ductile-iron pipe shall conform to AWWA C115, C150 and C151 except as otherwise specified

B. Contractor shall submit complete process piping drawings and shall include all location and dimensions of piping, fittings, valves, and coupling

C. Acceptable Manufacturers
   1. U.S. Pipe
   2. Tyler Pipe
   3. Griffin Pipe Products Company
   4. Or accepted substitution

D. Pipe

1. ANSI A21.51/AWWA C151: As listed below except as otherwise specified or indicated on Drawings
2. Where fitted with push-on joints and mechanical joints: Class 350
3. Where fitted with restrained joints: Class 350

E. Fittings
1. Full body fittings shall be ductile iron and conform to ANSI A21.10/AWWA C110, ASTM A536
2. Compact fittings shall be ductile iron and conform to ANSI A21.53/AWWA C153
3. Fittings shall have a pressure rating no less than that of adjoining pipe
4. Fittings for pipe with mechanical or push-on joints shall have mechanical joints
5. Comply with requirements for restrained fittings as indicated on Drawings

F. Joints
1. Mechanical and push-on joints
   a. Shall have a pressure rating no less than that of adjoining pipe
   b. Mechanical joints
      i) Less than 30-inches in diameter: Shall be in accordance with ANSI A21.11/AWWA C111
   c. Push-on joints
      i) 30-inches in diameter and greater: Shall be in accordance with ANSI A21.11/AWWA C111
      ii) Lubricant: Heavy vegetable soap solution suitable for potable water contact
   d. Mechanical joints with tie rods
      i) Tie rods: ASTM A307, galvanized entire length
      ii) Steel pipe spacers: ASTM A120, standard weight galvanized
      iii) Washers: ANSI A27.2 plain steel, galvanized
      iv) Plastic plugs: As recommended by pipe manufacturer
   e. Restrained push-on joints
      i) 30-inch and below:
      ii) Griffin Snap-Lok
      iii) U.S. Pipe TR-Flex
      iv) Or accepted substitution
   f. Restrained mechanical joints
      i) 30-inch and below:
      ii) Griffin Bolt-Lok
      iii) American MJ Coupled Joint
      iv) Or accepted substitution
      v) Restrained mechanical joints at fittings
      vi) EBAA Iron Inc., Meg-a-Lug Series 1100
      vii) Uni-Flange Corporation, 1400 Series
   g. Bolts and nuts: Corrosion-resistant bolts and nits for use with ductile iron joints shall be high strength, low alloy steel as specified in ANSI/AWWA C111/ANSI A21.11
      i) Cor-Ten
      ii) Usalloy
      iii) Durabolt

h. Gaskets shall be neoprene or other synthetic rubber. Natural rubber is not acceptable.

2. Threaded connections:
   a. ANSI B1.20.3 NPT: Provide boss or tapping saddle at all tapped connections

G. Couplings
1. Mechanical couplings:
   a. Dresser Style 38
   b. Rockwell 411
   c. Or accepted substitution
2. Insulated Mechanical Couplings:
   a. Dresser Style 39
   b. Or accepted substitution
3. Transition Couplings:
   a. Rockwell 415
   b. Dresser Style 39
   c. Or accepted substitution
4. Glands color coded: Black

H. Corrosion control
1. Ductile-iron Pipe and Fittings Shop Lining and Coating
   a. Shall be in accordance with AWWA C104:
   b. Cement-lined, ANSI A21.4
   c. Bituminous coating: Manufacturer's standard
2. Polyethylene encasement for all ductile iron pipe, all fittings and valves, AWWA C105: seamless tube, ASTM D1248, Type I, Class C, Grade E-1, 8 mils thick
   a. Joint tape: Self-sticking, PVC or polyethylene, 2-inch wide, 10 mils thick
      i) Chase Chasekote 750
      ii) Kendall Polyken 900
      iii) 3M Scotchrap 50
      iv) Northtown Company
      v) Or accepted substitution
   b. Strapping: Nonmetallic, water resistant, FS PPP-S-760, Type II
      i) Entire fitting or valve shall be covered by a complete wrap of 48-inch wide polyethylene sheet material cover over each set of lugs

2.3 STEEL PIPE – 30-INCH DIAMETER

A. Pipe: AWWA C200
1. Fabricated or mill type
   a. ASTM A53 Type E or S Grade B
   b. Or ASTM A134 made from:
      i) Steel plate: ASTM A283, Grade C, with maximum carbon content of 0.30 percent and maximum manganese content of 1.2 percent, or ASTM A570, Grade 30
   c. Or ASTM A139, Grade B, 21000
   d. Or ASTM A135, Grade B

2. Wall thickness: 1/4 inch minimum continuous spiral seam welded on inside and outside of pipe
3. Specified pipe size: actual outside dimension
4. Stab joint pipe specified diameter, nominal diameter
5. Reinforce or increase shell thickness of pipe, fittings and specials to maintain combined stress due to internal pressure and bending below 20,000 psi
6. Shop testing per AWWA C200 Section 4.3
7. For pipe with mechanical couplings, the space between pipe ends shall be at least 1/2 inch, but not greater than the manufacturer's recommendations

B. Fittings and Specials: fabricated or wrought seamless
   1. AWWA C200, Section 4, or ASTM A234, Grade WPA, unless otherwise required
      a. Steel plate: Same as for pipe specified above
   2. Wrought seamless: short or long radius, Contractor's option

C. End of Sections
   1. Field butt welding: outside be beveled to 37-1/2 degrees ± 1/32 inch
   2. Welded bell and spigot: AWWA C200
   3. For fitting with slip on flanges: AWWA C200
      a. Slip-on flanges may be used in lieu of weld neck flanges shown on Drawings, except on short radius fittings
   4. For mechanical couplings, plain end types per AWWA C200 shall be used
      a. Welds shall be ground flush on ends without pipe stops to permit slipping the coupling in at least one direction to clear pipe joint
      b. The outside diameter and out-of-round tolerances shall be within the limits of the coupling manufacturer
   5. For victaulic couplings, shall be grooved or collared type, per size and thickness of pipe, fitting, or special and maximum working pressure consistent with manufacturer's recommendations
      a. Grooving dimensions shall conform to rigid/standard grooving dimensions

D. Flanged Joints
   1. Shall be flanged where indicated on Drawings and in accordance with ANSI B16.1
      a. Flanges: Slip-on or welding neck, except where otherwise indicated
         i) Material: ASTM A181, Grade 1 or ASTM A283, Grade B or C
         ii) Dimensions and drilling: AWWA C207, Class D, Table 1 or 2
         iii) Coordinate flange dimensiosn and drillings among piping, valves,a and equipment
         iv) Bore weld neck flange to ID of pipe
         v) Faces shall be finished to a plane surface within a maximum tolerance of 0.010 inch
         vi) Diameter shall have a maximum tolerance of 0.005 inch/foot for flange faces from the normal with respect to axis of pipe
         vii) Flanges shall be tested for true plane after welding, reface if necessary
         viii) Flange dimensions and drillings shall be coordinated between piping, valves and equipment
      b. Flange bolting
         i) Material: ASTM A307

ii) Type: Bolt and nut, bolt-stud and 2 nuts permitted for 1 inch and larger
iii) Bolts and bolt-studs
iv) Length: Ends project ¼ inch to ½ inch beyond nuts
v) Ends: Chamfered or rounded
vi) Threading: ANSI B1.1, coarse thread series, Class 2A fit. Bolt studs may be threaded full length. Studs for tapped holes threaded to match holes
vii) Bolt heads
viii) Shape: Hexagonal or square
ix) Dimensions: ANSI B18.2 heavy pattern for hexagonal, regular pattern for square
x) Nuts
xi) Dimensions: ANSI B18.2 heavy, semi-finished pattern
xii) Threading: ANSI B1.1 coarse thread series, Class 1B fit

E. Shop Welded Joints
1. Provided joints shall be water tight and sound and free from embedded scale and slag
2. Tensile strength across the weld shall not be less than that of the thinner of connected sections
3. Yield point of the welded joint shall be tested by independent laboratory at contractor's expense
4. Butt welds shall be used for all welded joints in line pipe assemblies and in fabrication of fittings and other specials
5. For slip-on flange attachments, fillet welds shall be used per AWWA C207
6. Back-up welding strips or rings shall not be allowed for shop welds

F. Coupled Joints
1. Mechanical couplings
   a. Provide couplings with a middle ring length not less than 7-inches
   b. Where couplings are used for closures or where union connections are required omit pipestop from inner surface of middle rings
   c. Couplings shall be cleaned and shop primed with manufacturer's standard rust inhibitive primer
   d. Transition coupling
      i) Dresser “62”
      ii) Rockwell “413”
      iii) Or accepted substitution
   e. Others
      i) Dresser “Style 38”
      ii) Rockwell “411 Flexible Coupling”
      iii) Or accepted substitution
2. Flange coupling adapters
   a. Provided per coupling manufacturer's recommendations
   b. Determine adapter location and drill anchor stud holes after pipe placement
   c. Provided restraints for all flanged coupling adapters
   d. Stud holes diameter shall not be more than 1/8 inch larger than diameter of stud projection
   e. 4-inches thru 12-inches

i) Rockwell “912”
ii) Dresser “127” with anchor lugs
iii) Or accepted substitution

3. Grooved Couplings
   a. Mil-C-10387
   b. Gustin-Bacon "Gruvagrip Series 100"
   c. Or accepted substitution

2.4 STEEL PIPE – LESS THAN 4-INCH DIAMETER

A. Pipe
1. Galvanized
2. For standard weight: ASTM A53 standard weight (Schedule 40)
3. Nipples shall be CS5, extra strong (Schedule 80)
   a. Close nipples shall not be permitted without special authorization in each case
4. Fittings
   a. Malleable iron per ANSI B16.3
   b. Galvanized, Type II galvanized
5. Welding shall conform to ANSI B16.9
6. Compression fittings:
   a. Dresser "165 Plus-temp Couplings" with restraining rings
   b. Telsco "Series 700 Clamp Style Fittings" with stainless steel clamp rings
   c. Or accepted substitution
7. Unions shall be malleable steel or forged steel
   a. Malleable iron shall conform to FS WW-U-531, Class 2
      i) Type B galvanized
   b. Forged steel shall be tongue and groove flange type with non metallic gaskets
8. Flanges shall be ANSI B16.1, 125 pound, or ANSI B16.5 150 pound
   a. Flange bolts and nuts shall conform to ASTM A307. Length shall be such that after installation, bolts project 1/8 inch to 3/8 inch beyond outer face of nut
   b. Flange gaskets shall be red rubber ring type, 1/8 inch thick, or ozone resistant Teflon 1/8 thick and shall conform to ASTM D1330, Grade I
9. Mechanical couplings
   a. Dresser "Style 38"
   b. Smith-Blair "Type 411"
   c. Or accepted substitution
10. Grooved Couplings
    a. Mil-C-10387
    b. Gustin-Bacon "Gruvagrip Series 100"
    c. Victaulic "Style 77"
    d. Or accepted substitution
11. Expansion Joints
    a. 2-1/2 inches and smaller: Flexonics "Model H Expansion Compensation" or accepted substitution
    b. 3-inches and larger: Flanged with stainless steel bellows, Flexonics "Free Flexing Expansion Joint" or accepted substitution

2.5 COPPER TUBING – 3 INCHES OR LESS

A. Copper Tube: ASTM B88; Type K, soft-annealed temper with flared connections.
   1. Fittings: Wrought-copper solder-joint fittings, ANSI B16.22; soldered joints, pressure type.

2.6 POLYVINYL CHLORIDE (PVC) – 14 INCHES THROUGH 30 INCHES

A. Gasketed PVC pressure pipe, DR 25, AWWA C905

B. Maximum pipe length: 20'

C. Joints rubber gasket with one compression gasket ring
   1. ASTM D3139 and F477
   2. Designed to hold pipe in alignment, provide flexibility, separate the ends of pipe lengths, resist applied earth pressures, and provide fluid tightness
      a. Rubber gasket rings: ASTM F477

2.7 BUTTERFLY VALVES – 16-INCHES THROUGH 30-INCHES (DIRECT BURY)

A. Manufacturers:
   1. Mueller
   2. Pratt
   3. Milliken
   4. Or accepted substitution.

B. AWWA C504 for Class 75B service, direct bury
   1. Valve body shall be constructed of cast iron ASTM-A126 Class B and conform to AWWA C504 in terms of laying lengths and minimum body shell thickness.
   2. Valve disc shall be furnished with Type 316 stainless steel seating edge to mate with rubber seat on body.
   3. Seat – Buna-N-Rubber
      a. Size smaller than 20" – bonded seats that meet ASTM D-429 Method B
      b. Size 24" and larger – seats retained in the valve body by mechanical means without metal retainers or other devices located in the flow stream
   4. Shaft – type 304 SS, ASTM A276
      a. Standard self adjusting split V packing
      b. Seals – design shall allow replacement without removing the valve shaft
   5. Bearings – sleeve type, corrosion resistant and self lubricating
   6. Actuators – fully grease packed and have stops in the open/close posision
      a. Shall have a mechanic stop which will withstand an input torque 450 ft lbs against the stop
      b. Traveling nut shall engage alignment grooves in the housing
      c. Built in packing leak bypass
   7. Painting
      a. interior and exterior (except for seating) surfaces coated with Ameron Amerlock 370, AWWA C550 to C504

b. interior and exterior covered with polyamide cured epoxy coating applied over a sand blasted, "new white metal surface" per SSPC-SP10, minimum of 6 mils in compliance with AWWA C550

C. Rotation: Counter clockwise to open with the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut. Nut size = 2”

D. Valve operating key: Provide one (1) for project, 7' length with tee handle

2.8 GATE VALVES – 3-INCHES THROUGH 12-INCHES

A. Manufacturers:
1. Mueller
2. Clow
3. American Flow Control
4. Waterous
5. U.S. Pipe Metro Seal
6. Or accepted substitution.

B. AWWA C509, Iron body, bronze trim, two O-ring stem seals, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, extension stem, and extension valve box, pressure rating of 200 psi

C. Rotation: Counter clockwise to open with the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut. Nut size = 2”

D. Valve operating key: Provide one (1) for project, 7' length with tee handle

2.9 DUCKBILL ELASTOMERIC CHECK VALVES – 18 INCHES

A. Manufacturers:
1. Tideflex – "Series 35"
2. Or accepted substitution

B. Check valves shall be all rubber and the flow of operated check type with a flanged end connection. Port area shall contour down to a duckbill which shall allow passage of flow in one direction and prevent reverse flow
1. Flange and flexible duckbill sleeve shall be one piece rubber construction with nylon reinforcement
2. Bill portion shall be thinner and more flexible than valve body and formed into a curve of 180°
3. Bill slit must be 1.57 times nominal pipe diameter, minimum

C. Flange drilling – conform to ANSI B16.1 Class 125/ANSI B16.5, Class 150
1. Furnish with galvanized or stainless steel back-up rings for installaion
2. AWWA C509, Iron body, bronze trim, two O-ring stem seals, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, extension stem, and extension valve box, pressure rating of 200 psi

2.10 SLIDE GATE – 12-INCH

A. Manufacturers:
   1. Waterman – "C-10 Canal Gate"
   2. Or accepted substitution.

B. Gate shall be grey iron with an all bolted steel frame with 1/4" minimum thickness.

C. Standard stem – leaded steel to resist corrosion, epoxy coated , operated at the structural frame top by a neavy cast-bronze lift nut and a cast iron wheel

D. Wedge blocks – cast iron with two (2) machine bolts
   1. Seats – cast iron, machined or ground

E. Handwheel – solid rim "easy grip"

F. Frame – Type: flatback for wall mounting

G. Install per manufacturer's instructions

2.11 FLOATING SUCTION STRAINER

A. Provide four (4), 6-inch floating suction strainers. Two (2) floating suction stariners shall be installed in each of the backwash basins

B. Hose Size: 6-inch

C. Maximum Capacity: 792 gpm

D. Strainer Hole Size: 3/16-inch diameter

E. Manufacturer:
   1. Megator "Dolphin Strainer"

F. Install per manufacturer instructions

2.12 YARD HYDRANT

A. Provide 1-1/4 inch water supply line to frost proof yard hydrant for backwash basins with galvanized casing and brass mechanism as shown in Drawing details
   1. Provide with brass vacuum breaker/automatic drain

B. Manufacturer:
   1. Merrill "Any Flow Series" Hi-Cap 1-inch
   2. Or accepted substitution

2.13 MATERIALS

A. Plugs and Caps: Use pipe plugs or caps provided by the pipe manufacturer and approved by the Engineer for pipe stubouts

B. Cleanouts and Pressure Cleanouts: Provide as indicated on Drawings, pipe extension to grade with ferrule and countersink cleanout plug. Provide round cast-iron access frame over cleanout, with heavy duty secured scoriated cover with lifting device cast with the following words associated with the following pipe:
   1. "DECANT" – Backwash basin pipe

C. Reinforcement
   1. Reinforcing Steel: ASTM A615 Grade 60
   2. Welded Wire Fabric: ASTM A185

D. Concrete: Refer to Division 3 specifications
   1. Minimum compressive strength: 4000 psi at 28 days
   2. Cement: ASTM C150, Portland Cement, Type II
   3. Aggregates: ASTM C33, free of deleterious substances

E. Rock Subbase: 1-1/2 inch minus, well-graded gravel over compacted subgrade

F. Water: Clean and free of deleterious substances

G. Grout:
   1. Non-Shrink, Non-Metallic Grout: Factory premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 4000 psi in one day and 8000 psi in 7 days
   2. Epoxy Grout: Three Component Epoxy Resin System
      i) Two liquid epoxy components
      ii) One inert aggregate filtered component
      iii) Each component furnished in separate package for mixing at job site

2.14 SOIL MATERIALS

A. Furnish pipe bedding and cover as specified in Section 02300

2.15 ACCESSORIES

A. Concrete for Thrust Blocks: constructed of "Class B" Concrete as defined by CDOT standards, with maximum water to cement ratio of 0.63 by weight and 28-day compressive strength of 2500 psi minimum

B. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, and valves. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages
   1. Clamps, straps and washers: Steel, ASTM A506
   2. Rods: Steel, ASTM A575
   3. Rod Couplings: Malleable-iron, ASTM A197
   4. Bolts: Steel, ASTM A307
   5. Cast-Iron Washers: Gray-iron, ASTM A126

C. Valve Accessories

1. Extension stems
    a. Provide where indicated on drawings, specified, or required for proper operation and for buried valves.
    b. Non-rising stems
        i) Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
        ii) Connected to the valve by a flexible socket coupling
        iii) All other connections pinned, keyed, or socket
    c. Stem guides
        i) Cast iron, bronze brushed, adjustable in two (2) directions
        ii) If extension stem length exceeds 10' or the weight exceeds 50 lbs., design top guide to carry the stem weight and provide a collar on the stem to bear against the thrust guide
        iii) Max spacing
            Non-rising stems: 100 times stem O.D.
            Rising stems: 60 times stem O.D.
            Ten foot maximum
    d. Buried valves
        i) Extend stem to within 1.0 foot of grade.
        ii) Provide spaces to center stem in valve box
        iii) Provide wrench nut
2. Valve boxes
    a. Provide for all buried valves
    b. Boxes shall consist of a cast iron cover, lid, and base castings. No slip type boxes shall be allowed
    c. Type: Cast iron or ductile iron, extension sleeve (screw) type
    d. Minimum thickness: 3/16" at any point
    e. Coating: Bituminous varnish
    f. Cast appropriate name designation of service in cover.
    g. Shaft shall be ductile iron and minimum diameter of 5¼"
    h. An appropriate word designating the valve service type on the cover
    i. Manufacturer:
        i) Neenah Foundry Company
        ii) Tyler Company
        iii) Mueller Company
        iv) Or approved equal

D. Identification
    1. Provide metallic core tape, blue with letters “CAUTION - WATER LINE BELOW” continuously printed

2.16 CORROSION CONTROL

A. Shop paint all ferrous metal surfaces of valves and accessories, both interior and exterior for corrosion protection. Manufacturer's standard paint will be acceptable if it is functionally equivalent and compatible with specified field coatings

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions under provisions of Division 1 specifications

B. Verify locations and inverts or tops of pipe are as indicated

C. Carefully examine pipe and fittings for cracks, damage to linings, and other defects prior to installation

D. Remove all defective pipe from site and replace

E. Examine areas for weak or structural defects or deviations beyond allowable tolerances for piping clearances that adversely affect excavation and quality of Work.

F. Start installation only when conditions are satisfactory

3.2 PREPARATION

A. Thoroughly clean pipe and fittings of foreign matter before installation. Remove scale and dirt, on inside and outside, before assembly

B. Ream pipe and tube ends and remove burrs

C. Prepare pipe connections to equipment with flanges or unions. Clean joint contact surfaces with wire brush is necessary, wipe clean, and keep clean until jointing is complete.

D. Cut ends of metallic pipe, recoat with manufacturer's coatings

E. Shape trench and place bedding as specified in Section 02300 and as shown on the drawings. Do not disturb trench bottom during excavation. Hand trim excavation for accurate placement of pipe to elevations indicated
   1. Dig bell or coupling holes
   2. Do not support pipe on blocks or mounds of earth
   3. Provide uniform and continuous bearing and support for full length of pipe between bell holes
   4. Minor disturbance over a maximum length of 18 inches near the middle of each length of pipe will be permissible by the withdrawal of pipe slings or other lifting tackle
   5. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth, compact to 95 percent
   6. Backfill in accordance with Section 02300

F. Alignment and Grade
   1. Except as indicated on the Drawings, lay all pipe straight and at a uniform grade
   2. Use batter boards to determine and check pipe subgrades

3. Other methods of maintaining alignment and grade may be acceptable if approved by the Engineer

3.3 PIPE INSTALLATION

A. Inspect pipe and accessories for defects before lowering into trench

B. Replace any defective, damaged or unsound pipe

C. Cutting Pipe
   1. Cut pipe to measurement taken at the site, not from the drawings
   2. Cut pipe neatly without damage to pipe or cement lining
   3. Cut smooth, straight, and at right angles to pipe axis
   4. Dress and bevel end of cut pipe to remove roughness and sharp corners
   5. Cut pipe with saw, abrasive wheel or pipe cutter designed specifically for the pipe material

D. Group piping with other site piping work whenever practical

E. Install pipe to indicated elevations. Adjust to maintain minimum 4.5 feet depth of bury and maintain minimum grade for drainage and also allow for all air to be released at high points

F. Install ductile iron fittings to AWWA C600

G. Route pipe as indicated on plan and profile drawings

H. Install pipe to allow for expansion and contraction without stressing pipe or joints

I. Slope pipe and position drain at low points

J. Protect from lateral displacement by placing embedment evenly on both sides of pipe as specified in Section 02300

K. Do not lay pipe in water. Maintain groundwater level a minimum of 12 inches below pipe to be installed. Do not lay pipe under unsuitable weather or trench conditions

L. Lay pipe with bell ends facing the direction of laying except when Engineer authorizes reverse laying

M. Form and place concrete for thrust blocks at each elbow or change of direction of pipe main

N. Install trace wire continuous over top of pipe. Tracer wire shall be Type THHN, AWG size #12, UL listed with a single copper conductor, PVC insulation, and nylon jacket. Test stations at post hydrants shall be CP Test Services, Glenn Series Glenn-4 with locking lid, 3 ½” c 4”, or approved equal. Install water main marker strip in trench above all water mains

O. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system

P. Carefully lower pipe, fittings, and accessories into the trench with slings, ropes, and other suitable equipment to prevent damage. Do not dump or drop pipe or accessories into trench

Q. Joint to form true and smooth line

R. Remove any pipe not making a good fit

S. Begin pipe laying at the lowest point unless reverse laying is accepted by Engineer

T. Utilize implements, tools and facilities as recommended by the manufacturer if required to remove debris

U. During construction, close all open ends with watertight expandable type plugs
   1. At the end of each day's operations
   2. Whenever pipe ends are left unattended
   3. Deposit adequate backfill on pipe to prevent flotation
   4. Do not use wood, burlap or other similar temporary plugs

V. Remove and re-lay any pipe which has floated

3.4 JOINTS

A. Make pipe joints carefully and neatly

B. Connect piping in accordance with manufacturer's recommendations

C. Push-on joints
   1. Lubricate joint surfaces immediately before completing the joint
   2. Bevel spigot ends of field cut piping
   3. Groove spigot ends of field cut restrained joint piping if required by joint system

D. Mechanical Joints
   1. Thoroughly lubricate gaskets and install in accordance with manufacturer’s instructions
   2. If an effective seal is not obtained, disassemble joint, clean thoroughly, and reassemble
   3. Do not over tighten bolts to compensate for poor installation
   4. Carefully align holes in mechanical joints with restraint device to permit installation of the harness bolts
   5. Install flange and mechanical joint pieces so the mechanical jointholes, as well as the flange holes, straddle the top centerline for horizontal piping, or the side centerline for vertical piping

3.5 CONCRETE ENCASEMENT

A. Provide where indicated on the Drawings

B. Suitably support and block pipe and anchor against flotation

3.6 INSTALLATION - BURIED VALVES

A. Install valves and accessories in accordance with the manufacturer's recommendations and in accordance with referenced standards and specifications

B. Set valves on solid bearing

C. Center and plumb valve box over valve. Set box cover flush with finished grade. Evenly fill around box and thoroughly compact on all sides

D. Extend stem to within 6 inches of final grade. Provide spacers to center stem in valve box

E. Carefully inspect valve before installation. Clean interior. Operate valve to determine parts in proper working order, with valves seating and drain valve operating properly. Set plumb and center stem in valve box and securely brace into place. Comply with AWWA C600 and referenced standards

3.7 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with AWWA C651 and Section 02676

3.8 PROTECTIVE COATING

A. Provide polyethylene tube encasement on all buried DIP pipe, fittings, valves and fire hydrant extensions
   1. Comply with AWWA C105 and referenced standards

B. Metal Surfaces
   1. Coat all steel clamp rods, bolts, and other metal accessories used in tapping saddles, anchorages, cut ends of pipe, follower rings and bolts or joint harnesses subject to submergence or contract with the earth and not concrete encased, but including pipe fittings and bolts in polyethylene tube protection
   2. Apply 2 coats of coal tar paint to clean, dry metal surfaces, allow first coat to dry before applying second coat

3.9 GROUT

A. PREPARATION
   1. Non-Shrink, Non-Metallic Grout, General Use
      a. Clean concrete surface to receive grout
      b. Saturate concrete with water for 24 hrs prior to grouting and remove excess water just prior to placing grout

c. Cold weather conditions
   i) Warm concrete, substrate and base plate to 40 deg F, or above; store grout in warm area
   ii) Follow manufacturer's recommendations for cold weather application
d. Hot weather conditions
   i) Use cold mixing water and cool base plate if possible; store grout in cool area
   ii) Follow manufacturer's recommendations for hot weather application
e. Apply to clean, sound surface
f. Apply latex bonding agent to hardened concrete, mix-in-grout, or as directed by Engineer

2. Epoxy Grout: Apply only to clean, dry, sound surface
   a. Patching cavities in concrete including, but not limited to, tie holes, and structural and equipment support

B. APPLICATION
1. Non-Shrink, Non-Metallic Grout
   a. Mix in a mechanical mixer
   b. Use no more water than necessary to produce flowable grout
   c. Provide air vents where necessary to eliminate air pockets
   d. Place in accordance with manufacturer's instructions
   e. Where exposed to view finish grout edges smooth
   f. Protect against rapid moisture loss by immediately covering with wet rags and polyethylene sheets or curing compound
   g. Wet cure grout for 7 days, minimum
   h. Maintain the temperature at a minimum of 40 deg F until grout reaches 3000 psi
   i. After placement of grout, eliminate excessive external vibration
2. Epoxy Grout
   a. Mix and place in accordance with manufacturer's instructions
   b. Completely fill all cavities and spaces around dowels and anchors without voids
   c. Obtain manufacturer's technical assistance as required to insure proper placement

3.10 ERECTION TOLERANCES

A. Establish invert elevations and slopes as shown on Drawings

B. Respect pipe manufacturer’s tolerances of horizontal and vertical deflection

3.11 FIELD QUALITY CONTROL

A. General
1. Utilize pressures, media and pressure test durations as specified on Piping Schedules
2. Isolate equipment which may be damaged by the specified pressure test conditions
3. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates. Select each gauge so that the specified test pressure falls within the upper half of the gauge's range. Notify Engineer 24 hours prior to each test
4. Completely assemble and test new piping systems prior to connection to existing pipe systems

5. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance
6. Provide all necessary equipment and perform all work required in connection with the tests and inspections
7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination

B. Testing methods and criteria
1. Ductile iron pipe systems: Test ductile iron pipe in accordance with the latest version of AWWA C600. Per AWWA C600, the allowable leakage in gallons per hour from buried ductile iron pipe systems shall be less than the length of pipeline tested in feet, times the nominal diameter of the pipe in inches, times the square root of the average test pressure during the leakage test in pounds per square inch (gauge), divided by 133,200. The duration of each leakage test shall be two hours. The equation for computing the allowable leakage is:

   i) $L = (SDP^{0.5})/133{,}200$

   Where:
   L = allowable leakage, in gallons per hour
   S = length of the pipe tested, in feet
   D = nominal diameter of the pipe, in inches
   P = average test pressure during the leakage test, in psi

2. PVC pressure pipe systems: Test PVC pipe in accordance with the latest version of AWWA M23.
3. Hydrostatic pressure testing
   a. For buried piping: Perform testing after backfill and proper compaction of trenches. Where lines are installed under roadways and parking areas, perform tests after completion of final grade preparation and prior to application of surface courses. Notify Engineer at least 48 hours prior to testing. Provide temporary restraints for expansion joints for additional pressure load under test. Isolate equipment in piping system with rated pressure lower than pipe test pressure by valves or blind flanges
4. Notify Engineer of the date and time for each pipe test 1 week prior to actual testing

C. Dielectric Testing Methods and Criteria
1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained
2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition
3. Check the integrity of each cadwelding connection using a light hammer blow at a 45 degree angle

D. Mandrel Test
1. No sooner than 30 days after placement and compaction of backfill, but prior to placement of permanent surface materials, clean and mandrel each line to detect obstructions (deflections, joint offsets, lateral pipe intrusions, etc.)

2. Use a rigid mandrel with diameter of at least 95% of the pipes specified average inside diameter and a length of the mandrel circular portion at least equal to the nominal pipe diameter
   a. Where pipe fittings and valves do not allow mandrel test use other methods to confirm joint offsets and pipe being clean and free of obstructions
3. Pull the mandrel through the pipe by hand
4. All pipe exceeding the 5° deflection shall be relaid or replaced by the Contractor at no additional cost to the Owner

3.12 CLEANING AND DRAINING

A. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when connected

B. Wire brush, if necessary, wipe clean and keep joint contact surfaces clean until connection is complete

3.13 PIPING SCHEDULE

A. Install pipes as scheduled in the pipe schedule provided below

Description	**Size (inches)**	**Material**	**Working Pressure (psi)**	**Maximum Test Pressure (psi)**
Backwash Influent	30	DIP	10	25
Backwash Header	30	Steel	10	-
Basin Decant	10	DIP	5	20
Basin Overflow	16	DIP	5	20
Basin Dewatering Drain	4	DIP	5	20
Clearwell Overflow	18	PVC	5	20
Perimeter Underdrain	4	HDPE	-	-
Yard Hydrant	1-1/2	Galv Steel	50	75
Diffused Air	3/4	Copper	50	75

3.14 VALVE SCHEDULE, VALVES LARGER THAN 4-INCHES

A. Install valves as scheduled in the valve schedule provided below

B. The following abbrevations are used in the valve schedule:
   1. MJ: Mechanical Joint
   2. FL: Flanged Joint
   3. GV: Gate Valve
   4. SG: Slide Gate Valve
   5. PV: Plug Valve
   6. BFV: Butterfly Valve

VALVE SCHEDULE					
Item No.	**Type**	**Size (inches)**	**Area Location**	**Type of Installation**	**Valve End Connection**
1	BFV	30	Inlet to Basin 1	Direct Bury	MJ & MJ
2	BFV	30	Inlet to Basin 2	Direct Bury	MJ & MJ
3	BFV	16	Basin 1 Overflow	Direct Bury	MJ & MJ
4	BFV	16	Basin 2 Overflow	Direct Bury	MJ & MJ
5	PV	4	Basin 1 Dewatering Drain	Direct Bury	MJ & MJ
6	PV	4	Basin 2 Dewatering Drain	Direct Bury	MJ & MJ
7	GV	10	Basin 1 Dewater (Dolphin)	Direct Bury	MJ & MJ
8	GV	10	Basin 1 Dewater (Dolphin)	Direct Bury	MJ & MJ
9	GV	10	Basin 1 Secondary Dewater	Direct Bury	MJ & MJ
10	GV	10	Basin 1 Secondary Dewater	Direct Bury	MJ & MJ
11	CV	18	Clearwell Overflow 1	Exterior	FL
12	CV	18	Cleawell Overflow 2	Exterior	FL
13	SG-V	12	Basin 1 Interior Wall Transfer	Exterior	Wall frame
14	SG-V	12	Basin 2 Interior Wall Transfer	Exterior	Wall frame

END OF SECTION

SECTION 02676

DISINFECTION OF WATER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Disinfection of potable water piping, potable water storage facilities, treatment unit equipment and piping, pumping equipment and piping; testing and reporting results

1.2 RELATED SECTIONS

A. Section 00315 – Pre-Selected Equipment

B. Section 02616 – Site Piping

C. Section 11302 – Prepackaged Treatment Unit System Installation

D. Section 15060 – Pipe and Pipe Fittings

E. Section 15100 – Valves, Cocks and Hydrants

1.3 REFERENCES

A. American Water Works Association (AWWA)
   1. B300 – Standard for Hypochlorites
   2. B301 – Standard for Liquid Chlorine
   3. B302 – Standard for Ammonium Sulfate
   4. B303 – Standard for Sodium Chlorite
   5. C651 – Disinfecting Water Mains
   6. C652 – Disinfection of Water Storage Facilities
   7. C653 – Disinfection of Water Treatment Plants

B. National Sanitation Foundation (NSF)
   1. Standard 60 – Drinking Water Treatment Chemicals - Health Effects

1.4 SUBMITTALS

A. Test Reports: Indicate results comparative to specified requirements

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700

B. Disinfection report; record:
   1. Type and form of disinfectant used
   2. Date and time of disinfectant injection start and time of completion

3. Test locations
4. Initial and 24 hour disinfectant residuals (quantity in treated water) in parts per million (ppm) or milligram per liter (mg/L) for each outlet tested
5. Date and time of flushing start and completion
6. Disinfectant residual after flushing in ppm for each outlet tested

C. Bacteriological report; record:
1. Date issued, project name, and testing laboratory name, address, and telephone number
2. Time and date of water sample collection
3. Name of person collecting samples
4. Test locations
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested
6. Coliform bacteria test results for each outlet tested
7. Bacteriologist's signature and authority

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651, C652, C653, and the Colorado Department of Public Health and Environment (CDPHE)

1.7 REGULATORY REQUIREMENTS

A. Conform to AWWA C651, C652, C653, as appropriate, and the Colorado Department of Public Health and Environment regulations for performing the work of this Section

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Calcium and sodium hypochlorite shall conform to AWWA B300 and B301

B. Store hypochlorite in a cool, dark place away from flammable materials

PART 3 EXECUTION

3.1 CLEANING

A. Verify that piping and filtration system has been cleaned and inspected

B. Verify that piping has been successfully pressure tested and flushed

C. Perform scheduling and disinfection activity with start-up, testing, adjusting, demonstration procedures, including coordination with related systems

3.2 DISINFECTION

A. Provide and attach required equipment to perform the work of this Section

B. Tablet, continuous, or slug disinfection may be followed in accordance with AWWA C651

C. The preferred method is continuous disinfection, summarized as follows:
   1. Inject treatment disinfectant, free chlorine in liquid form into piping system to obtain 50 to 80 ppm residual
   2. Bleed water from outlets to ensure distribution and test for disinfectant residual
   3. Maintain disinfectant in system for 24 hours
   4. If final disinfectant residual tests less than 25 ppm, repeat treatment
   5. Flush, circulate and clean until residual equal to that of incoming potable water or 1.0 mg/L is achieved

D. Replace permanent system devices removed for disinfection

3.3 FINAL FLUSHING

A. Maintain a flushing velocity of 2.5 feet per second in piping

B. Collect chlorinated water for proper disposal and/or dechlorinate to less than 0.1 ppm free chlorine prior to discharge in accordance with State, County, and local regulations

3.4 FIELD QUALITY CONTROL

A. After final flush, and before main or equipment is placed in service, collect water samples from representative points along the main or from the equipment and field test for chlorine residual

B. Chlorine residual shall be within 50 percent of the chlorine residual prevailing in the source

C. If initial disinfection fails to provide satisfactory samples, repeat disinfection until satisfactory samples have been obtained

3.5 TESTING AND ACCEPTANCE

A. The Owner will perform and pay for Bacteriological sampling and testing (Bac-T) after equipment, tanks, or pipes have been disinfected and flushed. Contractor will assist Owner with obtaining samples

B. If any portion of the piping or equipment or tanks fails Bacteriological testing, the Contractor is responsible for repeating disinfection procedures until passing Bacteriological test is obtained

END OF SECTION

SECTION 02950

SEEDING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Soil preparation

B. Fertilization

C. Seeding methods

D. Areas to be reseeded

E. Seed Mix

F. Maintenance

G. Seed protection and slope stabilization

1.2 RELATED SECTIONS

A. Section 02300 – Earthwork

1.3 REFERENCES

A. American Association of Nurserymen – Standardized Plant Names

B. Colorado Department of Transportation (CDOT) – Construction Specifications

C. Federal Specification (FS)
   1. O-F-241 – Fertilizers, Mixed, Commercial

1.4 SUBMITTALS

A. Submit under Division 1 Specifications

B. Product Data: Live Seed analyses for grass mixtures not more than 9 months old including percent of live seed, germination, all crop seeds in excess of 1 percent, inerts and weeds

1.5 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging

B. Provide a certificate of the PLS test of the grass seed intended for the project, certifying that the seed furnished is from a lot that has been tested by a recognized laboratory

C. All brands furnished shall be free from such noxious seeds as Russian or Canadian Thistle, Coarse Fescue, European Birdweed, Johnson Grass and Leaf Spurge

1.6 QUALIFICATIONS

A. Applicator: Company specializing in performing work of this section with landscaping license from State of Colorado
   1. Experienced with type, elevation, topography and scale of work specified
   2. Adequate equipment and personnel to perform work

1.7 REGULATORY REQUIREMENTS

A. Comply with codes and ordinances of local regulatory agencies for fertilizer and herbicide composition and regulations of State of Colorado and San Miguel County

B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division One specifications

B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable

C. Deliver all commercial fertilizer (18-46-0) mixed in bags of the manufacturer, showing weight, chemical analysis and manufacturer name. Store in such a manner such that its effectiveness will not be impaired

1.9 ENVIRONMENTAL REQUIREMENTS

A. Do not prepare or seed frozen soils

B. Perform seeding and planting only after preceding work establishing final ground surface is completed

C. Conduct minimum of two (2) soil tests to confirm fertilizer type and application rates

1.10 MAINTENANCE SERVICE

A. Maintain seeded areas immediately after placement until grass is well established and exhibits vigorous growing condition

1.11 WARRANTY

A. All plant material and work accomplished under this section shall be guaranteed to provide a uniform stand of grass acceptable to the Owner at the end of a one (1) year time period from the completion of the Seeding and Erosion Control work

PART 2 PRODUCTS

2.1 SEED SUPPLIERS

A. Manufacturers:
   1. Arkansas Valley Seed Co.
   2. Or accepted substitution

B. Provide the latest crop available in accordance with Colorado Department of Agriculture Seed Laws, Chapter 35, Article 27

C. Compensate for percentage of purity and germination by furnishing sufficient additional seed to equal the specified pure live seed product. The formula for determining the quantity of pure live seed (PLS) shall be:

   Pounds of Seed (Bulk) x Purity x Germination = Pounds of Pure Live Seed (PLS)

2.2 GRASS SEED MIX

A. Apply Midgrass Prairie seed mixture at a PLS rate acre per acre as follows to all areas distributed during construction

Species	**Variety**	**Pounds/ Acre**
Grasses:		
Western Wheatgrass	Arriba	10.0
Big Bluestern	Pawnee	4.5
Side-oats Grama	El Reno	1.5
Blue Grama	Lovington	0.35
Switchgrass	Pathfinder	1.5
Kentucky Bluegrass	Common	0.15
Indiangrass	Cheyenne	1.5
Little Bluestern	Cimaron	2.0
Green Needlegrass	Native	1.0
Forbs:		
Butterfly Weed	–	0.4
Yarrow	–	0.4
Blanketflower	–	0.4
Blue flag	–	0.4
Gay Feather	–	0.4
Blue Flax	–	0.4
Purple Prairie Clover	–	0.4
Prairie Comeflower	–	0.4
Scarlet Globemallow	–	0.4

2.3 SOIL MATERIALS

A. Select onsite topsoil: Earth material of loose friable clay loam reasonably free of admixtures of subsoil, refuse stumps, roots, rocks, brush, weeds or other material which can be detrimental to the proper development of site revegetation

2.4 ACCESSORIES

A. Soil Additives (Fertilizer)
   1. Dry fertilizers: Primary element composition by weight of 6-10-5
      a. Nitrogen (N) six (6%) percent of which fifty (50%) percent inorganic, phosphoric acid (P_2O_5) ten (10%) percent, and potash (K_2O) five (5%) percent
   2. Commercial fertilizer: Primary element composition by weight of 18-46-0
      a. Nitrogen, eighteen (18%) percent, of which fifty (50%) percent is organic, and phosphoric acid (P_20_5), forty-six (46%) percent
      b. These elements may be organic, inorganic, or a combination and shall be available according to the methods adopted by the Association of Official Chemists
   3. Dry, pelletized or granular, uniform in composition and a free flowing product. Do not use material which has caked, segregated, exceeded the expiration date of application, or be otherwise damaged
   4. Thoroughly mixed by the manufacturer. Clearly identify the contents of each container. Do not use materials and containers previously opened, exceeding the expiration date for application or otherwise damaged

B. Erosion Control Fabric: Reference Section 02300
   1. Silt fences used for erosion control barriers: Refer to Drawings and Section 02300

C. Water: Clean, fresh and free of substances or matter which could inhibit vigorous growth of grass

D. Mulching Material: Hydromulch with tackifier as specified in CDOT Construction Specifications Section 213

PART 3 EXECUTION

3.1 GENERAL

A. Seed all areas disturbed by construction, including all areas along the roadside ditches

B. Pattern for seeding and fertilization as required by field conditions. In no case shall revegetation occur within 30 days of the application of any chemical weed control substance

C. Engineer to review grading prior to seeding

3.2 SOIL PREPARATION

A. Uniformly place and spread topsoil removed during grubbing and stored on site. Provide minimum thickness of 4 inches to meet finished grade. Key topsoil to the underlying and

surrounding material by the use of harrows, rollers or other equipment suitable for the purpose

B. Apply water to the topsoil for compaction purposes in a fine spray by nozzles in such a manner that it will not wash or erode the newly placed soil

C. Exercise care during soil preparation on all embankments so as not to disturb established ground cover. Areas disturbed during the soil preparation will be fertilized and seeded at the discretion of the Engineer in accordance with these documents

3.3 FERTILIZATION

A. Do not proceed with fertilization in adverse weather and unsuitable ground conditions. Examples of these respective conditions may be wind, precipitation, frozen and untillable ground or conditions detrimental to the effectiveness of the application

B. Apply fertilizer in a manner to assure uniform distribution, light watering is acceptable for dispersion

C. In cases where work progress is stopped due to the above conditions, fertilization will begin again, when appropriate conditions exist. The application will begin again with a reasonable overlapping of the previously applied area

3.4 SEEDING METHODS

A. All seeding shall be installed by either the hydroseeding or drilling method

B. Do not proceed with seeding in adverse weather and unsuitable ground conditions. Examples of these respective conditions may be wind, precipitation, frozen or untillable ground or conditions detrimental to the effectiveness of the application. All seeding shall be performed between either March 1st to May 30th of the calendar year of construction unless indicated otherwise by Engineer

C. Hydroseeding
   1. Apply seeded slurry with hydraulic seeded at a rate of 160 lbs live seed per 1,00 square feet, evenly in two intersecting directions
   2. Do not hydroseed areas in excess of that which can be mulched on same day
   3. Immediately following seeding apply mulch to a thickness of 1/8 inch
   4. Apply water with a fine sprat immediately after each area has been mulched. Saturate to four(4) inches of soil

D. Drilling:
   1. Accomplish seeding by means of an approved power drawn drill, followed by drag chains. The grass drill should be equipped with a satisfactory feeding mechanism, agitation, and double disk furrow openers. Equip drills with depth bands set to maintain a planting depth of approximately 3 to 2 inch and shall be set to space rows not more than 7 inches apart
   2. If inspections indicate that strips wider than the specified space between the rows planted have been left or other areas skipped, the Engineer will require immediate

resowing of seed in such areas at the Contractor's expense. The seeding mixture shown in the Materials Section applies at a pure live seed rate per acre

3. Apply water with a fine spray immediately after each area has been mulched. Saturate to four (4) inches of soil depth
4. Provide additional watering weekly until revegetation seed has germinated

3.5 AREAS TO BE RESEEDED

A. Reseed all areas that are damaged or disturbed by the Contractor's activities during the entire project scope

B. Additional areas as requested by the Owner and approved by the Engineer

3.6 MAINTENANCE

A. Fertilize the seeded areas once a uniform stand of grass has been established

B. Maintain seeded areas until there is an acceptable uniform plant growth. Reseed areas that are not producing a uniform plant growth within five (5) weeks following seeding. Acceptable uniform plant growth shall be defined as that time when the scattered bare spots, not greater than 1 square foot in area, do not exceed three percent (3%) of the seeded area

C. Maintenance period - 1 year

D. Areas that are seeded late in the fall planting season which are not producing acceptable uniform plant growth, as described above, shall be reseeded during the following spring planting season. If such a condition exists, and the Contractor has diligently, in the opinion of the Engineer, pursued the performance of his work, the Owner at his option, may extend the contract completion date and reduce contract retainage. Retainage may be reduced to less than five percent (5%) of the total contract amount, but shall be at least two (2) times the estimated cost of obtaining the required growth in the indicated areas, plus areas which are susceptible to damage by winter kill, washout or other causes

E. Contractor shall control perennial weeds, thistle, spotted and napweed, spurge and other weeds during the maintenance period

3.7 SEED PROTECTION AND SLOPE STABILIZATION

A. Cover seeded slopes with erosion control fabric where grade is 3 to 1 or greater and where indicated on the Drawings and/or Section 02300. Cover seed with mulch in all other areas

B. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 6 inch overlap minimum of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil

C. Secure outside edges and overlaps at 48 inch intervals with 4-inch to 6-inch U-shaped type pins or wooden stakes depending on ground condition

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches

F. Maintain integrity of erosion control fabric until seed germination. If seed is washed out before germination, fertilize, reseed and restore affected areas

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Construction Contract and other Division 1 specification sections apply to the work of this section.

B. Refer to the structural drawings for additional concrete requirements.

1.2 SECTION INCLUDES

A. Cast-in-place concrete

B. Reinforcing steel

C. Forms

D. Concrete accessories

1.3 REFERENCE STANDARDS AND GUIDES

A. Comply with the following except as modified by supplementary requirements of this Project Specification.

B. American Concrete Institute – ACI:
1. 117 – Standard Specifications for Tolerances for Concrete Construction and Materials
2. 211.5 – Guide for Submittal of Concrete Proportions
3. 214 – Recommended Practice for Evaluating Compression Test Results of Field Concrete
4. 301 – Specifications for Structural Concrete
5. 302.1 – Guide for Concrete Floor and Slab Construction
6. 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete
7. 305 – Hot Weather Concreting
8. 306 – Cold Weather Concreting
9. 308 – Guide to Curing Concrete
10. 309 – Guide for Consolidation of Concrete
11. 315 – Details and Detailing of Concrete Reinforcement
12. 347 – Guide to Formwork for Concrete
13. 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary
14. 350.1 – Tightness Testing of Environmental Engineering Concrete Structures and Commentary
15. 439.3 – Mechanical Connections of Reinforcing Bars
16. 546 – Concrete Repair Guide`1

17. SP-66 – Detailing Manual

C. American Standards and Testing Materials (ASTM)
1. A615 – Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
2. A706 – Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
3. C31 – Practice for Making and Curing Concrete Test Specimens in the Field
4. C33 – Concrete Aggregates
5. C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
6. C94 – Specification for Ready-Mixed Concrete
7. C138 – Test Method for Density (unit weight), yield and Air Content (Gravimetric) of Concrete.
8. C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
9. C150 – Specification for Portland Cement
10. C171 – Sheet Materials for Curing Concrete
11. C173 or C231 – Test Methods for Air Content of Freshly Mixed Concrete
12. C260 – Air Entraining Admixtures for Concrete
13. C309 – Liquid Membrane-Forming Compounds for Curing Concrete
14. C494 – Chemical Admixtures for Concrete
15. C618 – Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral admixture in Portland Cement Concrete
16. C1064 – Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
17. D994 – Preformed Expansion Joint Filler for Concrete (Bituminous Type)
18. D1190 – Concrete Joint Sealer, Hot-Poured Elastic Type
19. D1751 – Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
20. D1752 – Performed Sponge Rubber and Cork Expansion Joint Filler for Concrete Paving and Structural Construction
21. D2103 – Polyethylene Film and Sheeting

D. Concrete Reinforcing Steel Institute (CRSI)
1. DA4 – Manual of Standard Practice
2. P1 – Placing Reinforcing Bars

E. National Institute of Standards and Technology (NIST)
1. PS 1 – Structural Plywood

1.4 PERFORMANCE TOLERANCES

A. Confirm to ACI 177, ACI 301, ACI 347 and ACI 350 as modified herein. In case of conflict, ACI 117 governs. ACI 350 governs where ACI 117 does not apply.

1.5 SUBMITTALS

A. Submit under provisions of Division 1 specifications

B. Shop Drawings: Reinforcing bar lists, fabrication and placement drawings

1. Indicated bar sizes, spacing, locations, and quantities of reinforcing steel and wire fabric. Bending and cutting schedules shall be included in all shop drawings.
2. Indicate pertinent dimensions, materials, bracing, arrangement of joints and ties, and exact location of openings, framing, and special conditions affecting work
3. All shop drawings shall be original drawings produced by the supplier and shall not be reproductions of the Contract Documents

C. Product Data: Provide sufficient information on products specified to verify compliance with specifications. Provide data on
   1. Attachment accessories
   2. Admixtures and mixes
   3. Curing Compounds
   4. Sealers
   5. Bonding Agents
   6. Patching Mortar
   7. Waterstops

D. Test Reports
   1. Submit reports of tentative concrete mix design and testing two (2) weeks prior to placing any concrete, including
      a. Slump range on which the design is based
      b. Total gal of water per cu yd
      c. Brand, type, composition, and quantity of cement with manufacturer and plant location identified
      d. Brand, type, composition and quantity of fly ash
      e. Specific gravity and gradation of each aggregate
      f. Ratio of fine to total aggregates
      g. Surface-dry weight of each aggregate per cu yd
      h. Brand, type ASTM designation, active chemical ingredients and quantity of each admixture
      i. Air content and tolerance
      j. Water/cementitious material ratio and tolerance
      k. Compressive strength based at 7- and 28-day compression tests
      l. Submit reports of field quality control testing
      m. Time of initial set
   2. Submit suppliers certified fly ash test reports for each shipment delivered to concrete supplier
      a. Physical and chemical characteristics
      b. Certification of compliance with the specifications
      c. Signed by Contractor and concrete supplier
   3. Existing data on proposed design mixes are acceptable if certified and complete

E. Construction Joint Locations: Submit all proposed construction joint locations in slabs and walls to Engineer two (2) weeks prior to placing any concrete.

F. Waterstop Product Data and Installation Procedures:
   1. Product data for all waterstops to be used, including preformed intersections

2. Product data for waterstop splicing iron, showing compliance with manufacturer's recommendations
3. Installation procedures to be followed, showing compliance with manufacturer's recommendations

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301 and ACI 350. Maintain one copy of each document on site.

B. Follow recommendations of ACI 305 when concreting in hot weather, as defined by ACI 305 Section 1.2.

C. Follow recommendations of ACI 306 when concreting in cold weather, as defined by ACI 306 Section 1.1.

D. Acquire cement and aggregate from same source for all work

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle materials under provisions of Division One Specifications

B. Cement and fly ash: Store in moisture proof enclosures, do not use if caked or lumpy

C. Aggregate: Store to prevent segregation and inclusion of foreign materials, do not use the bottom 6-inch of piles in contact with the ground

D. Reinforcing steel
1. Store on supports 6” minimum off of ground, which will keep it from contact with ground and protected from oil or other materials detrimental to steel or bonding capability. Cover to prevent unacceptable surface corrosion and contamination.
2. Tag bundles of reinforcing bars and wire spirals with metal tag showing specification, grade, size, quantity and suitable identification to permit checking, sorting and placing.
3. Tag bundles of flat sheets and rolls of welded wire fabric similar to reinforcing bars.

E. Rubber and plastic materials: Store in a cool place, do not expose to direct sunlight

F. Prepare a delivery ticket for each load of ready-mixed concrete

G. Truck operator shall hand ticket to Geotechnical Engineer or Third Party Inspector at the time of delivery with ticket to show:
1. Quantity delivered
2. Actual quantity of each material in batch
3. Outdoor temp in the shade
4. Time at which cement was added
5. Numerical sequence of the delivery
6. Quantity of water that can be added in the field based on mix design

7. Free moisture in fine and coarse aggregate in percent by weight
8. Temperature of batch

PART 2 PRODUCTS

2.1 FORMS

A. Prefabricated: The Burke Company "Burke Forming System," Simplex "Industrial Steel Frame Forms", Symons "Steel-Ply", Universal "Uniform", or accepted substitution

B. Plywood: PS 1, waterproof resin-bonded, exterior type Douglas Fir; face adjacent to concrete Grade B or better

C. Lumber: Straight, uniform width and thickness; free from knots, offsets, holes, dents, and other surface defects

D. Chamfer strips: Clear, white pine, surface against concrete planed

E. Form coating: Colorless biodegradable oil or water based release agent that will not stain concrete and is VOC compliant. Acceptable products: The Burke Company "Burke Release #1," Industrial lubricants "Nox-Crete Form Coating", L & M "Debond", or accepted substitution

F. Form ties: Removable end, permanently embedded body types with waterstops not requiring auxiliary spreaders, with cones on both ends, embedded portion 1-inch minimum back from concrete face. If not provided with threaded ends, constructed for breaking off ends without damage to concrete.

2.2 REINFORCING STEEL

A. Bars: ASTM A615, Grade 60

B. Beam Stirrups and column ties: ASTM A615, grade 40

C. Bar supports: CRSI Class 1, fabricated from galvanized wire having PVC coated legs

D. Tie wire: 16 ½ gage or heavier, black annealed wire

E. Reinforcing to be welded: ASTM A706

2.3 CONCRETE

A. Cement: ASTM C150, Type I/II tested to meet type V for sulfate resistance per ASTM C150 Table 4 and ASTM C452. Cement should have a tricalcium aluminate content of not more than 8 percent.

B. Fly ash: ASTM C618, Class F

C. Fine aggregate: Clean, natural sand, ASTM C33; no manufactured or artificial sand.

D. Coarse aggregate: Crushed rock, natural gravel, or other inert granular material, ASTM C33 except clay and shale particles no more than 1%. Free of all materials deleteriously reactive with alkalies in the cement in an amount to cause excessive expansion of concrete.

E. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or steel. Provide mixing water free from deleterious amounts of chloride ion for prestressed concrete or for concrete which will contain aluminum embedments including that portion of the mixing water contributed in the form of free moisture on the aggregates

F. Admixtures
   1. Acceleration: High range water reducer
   2. Retarder: ASTM C494, Type D; Grace "Daratard 17," Master Builders "Pozzolith 200N, 220N, 322N", Sika Chemical "Plastiment", or accepted substitution
   3. Plasticizer: ASTM C494, Type A; Grace "WRDA 35, 64, or 82HC, "Sika Chemical "Plastocrete", or accepted substitution
   4. Air entraining agent: ASTM C260; Grace "Darex AEA", Master Builders "MB-VR", Sika Chemical "AEA", or accepted substitution

2.4 WATERSTOPS

A. Expansion and contraction joints:
   1. Hydropholic waterstop,
      a. 3/4” inch wide by 3/8 inch thick, Adeka “MC-2010MN”, Hydrotite CJ-10202K or accepted substitution
      b. Waterstop shall be treated to not expand when in contact with fresh concrete.

2.5 ACCESSORIES

A. Polyethylene curing film: ASTM C171, 6 mil

B. Membrane curing compound and floor sealer: ASTM C309, Sonneborn "Sonosil" curing compound or Sonneborn "Kure-N-Harden" concrete hardener and dust proofer, or accepted substitution

C. Bonding Admixture and Bonding Agent: Sika "Sikalatex" bonding admixture and agent or Tamms "Akkro-7T" bonding admixture and Tamms "Tamms Bond" bonding agent, or accepted substitution

D. Vapor Barrier: Polyethylene-coated reinforced paper, Sisalkraft “Mois-top” or accepted substitution

E. Patching Mortar: Sika “Sikatop”, L&M “Duratop”, Master Builders “EMACO R” or accepted substitution.

F. Evaporation Retardant: L&M “Econ”, Master Builders “Confilm”, Sika “Sikafilm” or accepted substitution

2.6 MIXES

A. Concrete Mix: Measure and combine cement, aggregate, water, and admixtures in accordance with ASTM C94 and ACI 211.1
   1. Cement: When used in exposed concrete shall be one brand from one source. Do not mix different cements in same element of Work
   2. Water-Cement Ratio (if fly ash used, water-cement plus fly ash ratio): 0.45 maximum for Class A concrete, 0.50 maximum for Class B concrete
   3. Air-Entrainment: Air-entrain concrete exposed to exterior or exposed to liquids
   4. Chemical Admixtures: Use is optional to aid concrete properties and allow for efficient placement. Manner of use and amount shall be in accordance with manufacturer's written recommendations and as approved by Engineer. Do not use admixtures that increase early shrinkage or negatively affect finishing.
   5. Fly Ash: Use is optional unless otherwise noted. Fly ash shall not be used in combination with blast furnace slag. Combine fly ash with cement at rate of 1.25 to 1.5 pounds fly ash for each pound reduction of cement. Amount of fly ash shall not be less than 15% or more than 25% of weight of cement plus fly ash. When fly ash used, minimum amount of cement designated may be proportionately reduced.
   6. Initial Set: 5-1/2 hrs +1 hr after water and cement are added to the aggregates as determined by ASTM C403. Adjust retarder or accelerator quantities to compensate for temperature and job condition variations.

B. Class of Concrete:
   1. Furnish in accordance with table. Cement contents listed are minimum values and shall be increased as required to attain other specified characteristics
   2. Slumps listed are maximum, except when high range water reducer is used. Maximum slump when high-range water reducer is used, 10 inches.
   3. Chloride ion content shall not exceed values listed in ACI 318, Table 4.4.1

Table 4.4.1

Class	28-Day Compressive Strength (psi)	Coarse Aggregate (size no.)	Maximum W/C Ratio	Air Content (%)	Slump (in.)
A	4000	67	0.45	6±1	3±1
B	3000	67	0.50	6±1	3±1

psi = pounds per square inch
cu yd = cubic yard
in. = inch
max = maximum

C. Concrete Usage:
   1. Class A: All locations, except where B specified
   2. Class B: Interior equipment bases, concrete fillets in tanks, and where specifically noted.
   3. Air may be omitted from interior slabs to be trowel finished.

D. Slump: 4-inch maximum before admixtures

1. As low as possible consistent with proper handling and thorough compaction

E. Volume Ratio of Fine to Total Aggregates:

Coarse Aggregate Size	Minimum Ratio	Maximum Ratio
1/2″	0.40	0.55
3/4″	0.35	0.50
1″	0.30	0.46

F. Initial Set: 5-1/2 hrs + 1 hr after water and cement are added to the aggregates as determined by ASTM C403
   1. Adjust retarder or accelerator quantities to compensate for temp and job condition variations

G. Volumetric Air Content:
   1. Maximum 6% + 1% after placement
   2. Vary air content with maximum aggregate, ASTM C94, Table 2
   3. Air may be omitted from interior slabs to be trowel finished

H. Admixtures: Content, batching method, and time of introduction in accordance with the manufacturer's recommendations for compliance with this specification
   1. Include a water reducing admixture
   2. Calcium chloride content shall not exceed 0.05% of the cement content by weight

I. Strength: Compressive strength as determined by ASTM C39

Age	Minimum Strength
7 days	3,375 psi
28 days	4,000 psi

J. Consistency: Uniform slump, suitable for the placement conditions with aggregate floating uniformly throughout the concrete mass, flowing sluggishly when vibrated or spaded

K. Adjust mix as required to meet specifications

2.7 FABRICATION

A. Reinforcing Steel: Accurately formed, fabricated in accordance with ACI 315 and 318 and CRSI DA4 except as specified or indicated on drawings, free from rust, scale and contaminants which will reduce bond

2.8 SOURCE QUALITY CONTROL

A. Test the proposed concrete mix for each size and gradation of aggregates and each consistency intended for use in the project

B. Aggregates
   1. Sample and test according to ASTM C33
   2. Determine bulk specific gravity in accordance with ASTM C127 and C128

C. Compression tests
   1. Prepare 2 sets of compression test cylinders from each proposed concrete mix, 4 cylinders per set
   2. Test 1 set of 4 cylinders at 7 days, the other at 28 days
   3. Make, cure and store in accordance with ASTM C192
   4. Test in accordance with ASTM C39

D. Slump test: ASTM C143

E. Total air content: ASTM C231

F. Fly Ash: Supplier's chemical composition and physical analysis test

G. Initial set test
   1. In accordance with ASTM C403
   2. Test at 70 degrees F and 90 degrees ambient
   3. Test at 70 degrees F on mix including specific plasticizing and entraining admixtures
   4. Test at 90 degrees F on mix including specified retarding and air entraining admixtures
   5. Fly ash: Supplier's chemical composition and physical analysis test

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions in field or under provisions of Division 1 specifications

B. Verify requirements for concrete cover over reinforcement

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete

D. PREPARATION

E. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions

F. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels with epoxy resin system

3.2 FORMS

A. Design to produce hardened concrete to the shape, lines, and dimensions indicated on the drawings

B. Conform to ACI 347 as modified herein

C. Surfaces exposed to view

1. Prefabricated plywood panel forms, job-built plywood forms, or forms lined with plywood or material approved by Engineer
2. Laid out in a regular and uniform pattern with long dimensions vertical and joints aligned
3. Produce finished surfaces free from offsets, ridges, waves, and concave or convex areas
4. Maximum deviation from a true plane: 1/8 inch within 6 feet

D. Plywood or lined forms are not required for surface normally submerged or not normally exposed to view

E. Other type of forms may be used for surfaces not restricted to plywood or lined forms as backing for form lining

F. Provide forms above all extended footings; flat segmental forms, 2 foot maximum width, may be used for curved surfaces 25 feet minimum diameter

G. Provide polyethylene film to protect concrete from water loss when placing concrete against gravel or crushed rock not containing 25 percent minimum material passing a No. 4 sieve, lap joint 4 inches

H. When placing concrete against rock, remove all loose pieces of rock and clean exposed surface with high pressure hose

I. Provide substantial forms sufficiently tight to prevent leakage of mortar

J. Brace or tie forms to maintain desired position, shape, and alignment during and after concrete placement

K. Size and space wailers, studs, internal ties and other form supports so proper working stresses are not exceeded

L. Where the top of a wall will be exposed to weathering, stop form on at least 1 side at true line and grade

M. Locations to be finished to a specified elevation, slope, or contour, bring form to true line and grade and provide a wooden guide strip at the proper location in the forms for finishing the top surface with a screed or template

N. At horizontal construction joints in walls, stop the forms on one side not more than 2 feet above the joint

O. Provide temporary opening at the bottom of columns and wall forms and wherever necessary for cleaning and inspection

P. Install form ties on exposed surfaces in uniformly spaced vertical and horizontal rows

Q. Provide chamfer strips to bevel salient edges and corners. Do not provide for top edges of walls and slabs to be tooled or for edges to be buried

R. Do not remove or disturb until concrete has attained sufficient strength to safely support all dead and live loads

S. Leave shoring beneath beams and slabs in place and reinforce as required for construction equipment and materials

T. Maintain forms in place for a minimum of 40 hours for length of curing time in accordance with ACI 306/306R when temperature is 45 deg F and below

U. Remove forms carefully to prevent surface gouging, corner or edge breakage and other damage

3.3 REINFORCING STEEL

A. Accurately position reinforcing steel on supports, spacers, hangers, or other reinforcing steel at maximum intervals of 4 feet on center

B. Secure with wire ties or suitable clips. Tie 50 percent of all reinforcement and reinforcement at intersections for wall and floor construction

C. Except at contact splices, minimum clear distances between bars, the greater of
   1. Nominal diameter of bars
   2. 1.5 times max size of coarse aggregate
   3. 3-inch in other locations

D. Where reinforcement is placed in 2 layers, place bars in upper layer directly above bars in lower layer

E. Do not install reinforcement for beams and slabs which are supported by concrete caissons until after the concrete for the caissons has been placed

F. Splices
   1. As specified or indicated on the drawings
   2. Splices at other locations will be acceptable, if approved by Engineer
   3. Do not weld or tack weld reinforcing steel except where specifically indicated on drawings
   4. Remove and replace steel upon which any unauthorized welding has been performed

3.4 EMBEDDED ITEMS

A. Cast pipe and other embedded items into concrete as placement progresses. Do not provide blockouts

B. Following restrictions shall be adhered to, unless otherwise noted
   1. No duct, conduit, pipe, or fitting placed vertically shall be larger in cross-sectional area than 4% of column into which it is placed
   2. Duct, conduit, pipe, and fittings, when placed within slabs or walls
      a. Shall not be larger than 1/3 thickness of slab or wall
      b. Shall be placed within the middle 1/3 thickness of slab or wall where possible

c. Shall not be placed closer than 3 outside diameter clear from each other when parallel
d. Shall cross each other at right angles
e. Shall be secured to prevent shifting or “floating” during concrete placement
f. Multiple conduits shall not cross each other at the same location
g. Except for conduits that must run up a column, keep conduits a minimum of 2 to 3 feet away from columns
h. Where conditions require conduit to be tied to the inside face of the reinforcing mat, the conduit shall be galvanized steel or PVC, shall not be tied directly adjacent to a parallel reinforcement bar, and shall be placed 3 outside diameter clear away from the parallel reinforcement bar.

3. Reinforcing steel shall be in place before embedded items placed and reinforcing cut or removed shall be replaced with additional reinforcing as indicated
4. Do not pass sleeves through columns without Engineer’s approval

C. Do not place ducts, conduit, and pipes in slabs on grade. Place minimum 4 inches below slab

D. Set items such as bolts, anchors, piping, and frames in concrete as shown

E. Place items constructed of dissimilar metals to avoid physical contact with reinforcing. Secure item and reinforcing to ensure they will not shift and come into contact during concrete placement. Contact between reinforcing steel and other metal, other than bare, coated, or plated carbon steel not permitted.

3.5 TRANSPORTING MIXED CONCRETE

A. Transporting of mixed concrete shall conform to ACI 305R.

B. Maximum delivery time from batch plant is 90 minutes

C. Do not exceed manufacturer's guaranteed capacity of truck agitators. Maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

D. Do not incorporate additional mixing water into the concrete during hauling or after arrival at the delivery point, unless ordered by the Engineer. If additional water is to be incorporated into the concrete, revolve the drum not less than 30 revolutions at mixing speed after the water is added and before placing concrete.

E. Notify Special Inspector of any water added to the concrete mixture

F. Furnish a water measuring device in good working condition, mounted on each transit mix truck, for measuring the water added to the mix on the site by the Engineer

G. Provide delivery ticket to Special Inspector or Owner and comply with delivery requirements of this section

3.6 PLACING CONCRETE

A. Place concrete in accordance with ACI 304, ACI 301, and ACI 318

B. Schedule and attend pre-pour meeting with Owner at least 7 days before first pour to review requirements of this specification

C. Notify Engineer and Owner not less than 48 hours in advance of the times and places at which contractor intends to place concrete

D. Predetermine limits at each pour and place all concrete within limits of pour in one continuous operation

E. Construction joint locations shall be approved by the Engineer

F. Rigidly secure forms, reinforcing steel, embedment, and anchor bolts in proper position

G. Remove all mud, water, ice, snow, frozen material, and debris from space to be occupied by concrete

H. Clean surfaces encrusted with dried concrete from previous concrete operations

I. Convey to the point of final deposit by methods which will prevent separation or loss of ingredients

J. Place concrete in final position without being moved laterally more than 5 feet

K. Place concrete in approximately horizontal layers of proper depth for proper compaction, not more than 2 feet

L. Place subsequent layer while the preceding layer is still plastic

M. Place and compact concrete in wall or column forms before placing any reinforcing steel in the system to be supported by the walls and columns

N. Top finish concrete when thoroughly settled

O. Remove all laitance, debris, and surplus water from the tops of the forms by screeding, scraping or other effective means

P. Overfill the forms for walls whose tops will be exposed to the weather and screed off the excess after the concrete has settled

Q. Provide vertical construction joints as required to comply with these requirements

R. Limit portions of columns and walls poured monolithically with floor on roof slabs to 6 feet of vertical height

S. Allow concrete in walls and columns to settle at least 2 hours before concrete is placed in structural systems to be supported by the walls and columns

3.7 BONDING TO HARDENED CONCRETE

A. Place new concrete on rough, clean, damp faces of existing concrete

B. Roughen concrete to be bonded to future concrete to 1/4 inch amplitude

C. Remove surface mortar of smooth surfaces to expose aggregate

D. Clean hardened concrete of all foreign substances, including curing compound, washed with clean water, and keep saturated for 24 hrs preceding placement of fresh concrete

E. Apply epoxy bonding agent for bonding to hardened concrete

3.8 CONSOLIDATION

A. Thoroughly consolidate concrete during and immediately after placement

B. Work concrete around all reinforcements and embedments and into the corners of the forms

C. Use mechanical vibrators which will maintain 9,000 cycles per minutes when immersed in the concrete, 1 ½ hp motor minimum

3.9 COLD WEATHER CONCRETING

A. Conform to ACI 306, except as modified herein

B. Minimum concrete temp at the time of mixing

Outdoor Temp at Placement (in shade)	Concrete Temp at Mixing
Below 30°F	70°F
Between 30°F & 45°F	60°F
Above 45°F	45°F

C. Do not place heated concrete which is warmer than 80 degrees F

D. If freezing temp are expected during curing, maintain the concrete temp at or above 50 deg F for 5 days or 70 deg F for 3 days with forms in place

E. Do not allow concrete to cool suddenly

3.10 HOT WEATHER CONCRETING

A. Conform to ACI 305, except as modified herein

B. At air temp of 90 degrees F and above keep concrete as cool as possible during placement and curing

C. Do not allow concrete temperature to exceed 80 deg F at placement

D. Prevent plastic shrinkage cracking due to rapid evaporation of moisture

E. Do not place concrete when the actual or anticipated evaporation rate equals or exceeds 0.2 lbs per sq ft per hr as determined from ACI 305, Fig 2.1.5

3.11 CONSTRUCTION JOINTS

A. As indicated on the drawings, designated by Engineer, or approved by Engineer

B. In walls
   1. At floor panels
   2. Walls: At 1/4 the distance between intersecting walls or as shown on drawings
   3. Walls: Lap reinforcing steel the minimum lap length indicated on the Drawings on one side of construction joint

C. Install construction joints in slabs perpendicular to the planes of their surfaces

3.12 WATERTIGHT JOINTS

A. Provide watertight joints with continuous waterstops at the following locations:
   1. Walls and bottom slabs of tank where below finished grade and in contact with backfill or subgrade material on the opposite side
   2. Walls in contact with liquid where the opposite face is above finished grade
   3. Other locations indicated on the drawings

B. Hydrophilic Waterstops
   1. Follow all manufacturer's recommendations and instructions for installation.
   2. Provide a smooth even surface to ensure good bond between waterstop and substrate.
   3. Locate waterstops in center of construction joints.
   4. Splice waterstops in accordance with manufacturer's recommendations.
   5. Prior to application of waterstop remove all dust, oil, or other contaminants from the concrete surface prior to adhering the waterstop.
   6. Secure waterstop sufficiently to substrate to prohibit movement of waterstop during placement of fresh concrete.

3.13 FINISHING SLABS AND FLATWORK

A. Slab Finishes:

Description	Concrete Finish
Surfaces to Receive Grout or Topping	Float
Submerged and Buried Slabs	Float
Sealer Applied Floors and Slabs	3 Trowelings
Exterior Exposed Slabs	Float and Broom Finish
Exterior Stairs and Walks	Float and Broom Finish

B. After placement, screed concrete with straightedges, power strike-offs or vibrating screeds

C. After screeding, bull float or darby surfaces to eliminate ridges and to fill in voids left by screeding

D. Float:
   1. Use magnesium or aluminum hand floats or power floats with slip on float shoes
   2. Float finish shall result in uniform smooth granular texture

E. Trowel:
   1. Use steel trowels
   2. Use power or hand troweling
   3. Final troweling shall be by hand and continue until concrete surface consolidated to uniform, smooth, dense surface free of trowel marks and irregularities

F. Broom Finish: Use fine, soft-bristled broom and broom at right angles to direction of traffic to give nonskid finish approved by Engineer

G. Floor Sealer:
   1. Apply in accordance with manufacturer's written instructions
   2. Apply first cost after final troweling, surface water glaze has dissipated, and when surface is hard enough to sustain foot traffic on same day as pour
   3. When floor has been water cured, apply first coat after curing has been completed. Apply within one day of floor being dry enough for application.
   4. Apply second coat after Work completed and ready for occupancy

H. For special coatings or finishes, see room finish schedule

I. Tolerances:
   1. Concrete slabs shall be within 3/16 inch of 10 foot straightedge in all directions except where slabs are dished for drains. Deviations from elevation indicated shall not exceed 3/4 inch.
   2. Pitch floor to floor drains minimum 1/8 inch per foot or as shown. Pitch bottom of slab or beam to match top slope to maintain thickness or depth indicated. As an alternate, bottom of slab or beam may be placed level provided that min thickness or depth is maintained.

3.14 CURING AND PROTECTION

A. Protect concrete from moisture loss at relatively constant temperature for at least 7 days after placement except that the time period for curing by saturation for concrete being protected from low temp shall be 1 day less than the duration of low temp protection

B. Cure concrete by methods which will keep concrete surfaces adequately wet during curing, in accordance with ACI 308

C. Maintain rate of temperature change less than 5 degrees F in any one (1) hour period

D. Water curing
   1. Begin water saturation as quickly as possible after initial set

2. Regulate water application to provide complete surface coverage with a minimum of runoff
3. Interrupt the application of water to walls for grout cleaning only over the area being cleaned at the time and do not permit the surface to become dry during such an interruption

E. Membrane curing
1. Membrane curing compound may be used in lieu of water curing on concrete which will not be covered later with mortar or concrete
2. Spray apply membrane curing compound at not more than:
   a. General use: 300 sf per gal recommended
3. Cover unformed surfaces within 30 minutes of final finishing
4. If forms are removed before the end of the curing period, immediately apply curing compound to the formed surface before they dry out
5. Protect curing compound against abrasion during the curing period

F. Film curing
1. Polyethylene sheeting may be used in lieu of water curing on concrete which will be covered or hidden from view
2. Begin film curing as quickly after initial set of the concrete as possible
3. Completely cover the surfaces with polyethylene sheeting
4. Overlap the sheeting edges for sealing and anchorage
5. Seal joints between sheets
6. Promptly repair tears, holes, and other damage
7. Anchor covering continuously at edges and on the surfaces as required to prevent billowing

3.15 REPAIR OF SURFACE DEFECTS

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. General:
1. Prior to starting repair work, obtain Engineer's approval of proposed repair techniques and materials
2. Method of repair shall not adversely affect the appearance of the finished structure
3. Develop repair techniques on portion of as-cast surface selected by Engineer. Surface of repair remaining exposed to view shall match color and texture of adjacent surfaces.
4. Prepare surfaces, apply and install materials, and cure as recommended by material manufacturers

C. Tie Holes: Fill plastic cone snap tie holes with Patching Mortar. Fill taper tie through-bolt form tie holes with Non-Shrink Grout.

D. Defective Areas:

1. Remove honeycombing, stone pockets, spalls, and other defective concrete down to sound concrete. If chipping required, make edges perpendicular to surface. Do not feather edges.
2. Fill defective area with Patching Mortar

E. Leaks or Wet Spots:
1. Inject, patch and repair areas where leaks or wet spots have occurred inside dry structures
2. Inject, patch and repair areas where leaks or wet spots have occurred in wet wells, basins, tanks, and other structures which are to hold water.

F. Comply with Chapter 9, ACI 301

3.16 FINISHING FORMED SURFACES

A. Remove fins and other surface projections from all formed surfaces except exterior surfaces that will be in contact with earth backfill and are not specified to be dampproofed

B. Use a power grinder, if necessary, to remove projections and provide a flush surface

C. Remove fins and fill all tie holes on surfaces exposed to view
1. Clean, dry and fill tie holes with epoxy grout
2. Finish flush to match the texture of adjacent concrete

D. Grout clean all exposed surfaces under provisions of Chapter 10, ACI 301 where indicated otherwise, including surfaces of the equipment pad for the filters,
1. Grout clean surfaces exposed to view to produce a smooth uniform surface free of marks, voids, surface glaze and cement dust
2. Use non-shrink grout mix with bonding agent. Dampen surface and apply with cork or rubber float

3.17 FLOOR SEALER

A. Seal all uncovered concrete floors which will be subject to foot traffic

B. Application procedure of 2 coats in addition to any applied as membrane curing compound
1. Apply after floor is cleaned in preparation for final inspection

C. Application procedure of 2 coats when curing compound is not used
1. First coat: At end of curing period before any traffic is permitted on floor
2. Second coat: After floor is cleaned, in preparation for final inspection

D. Apply in accordance with manufacturer's recommendations

3.18 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 under provisions of Section 01400

B. Owner's geotechnical consultant provide field and compressive strength tests to determine compliance of concrete materials in accordance with the specifications except as indicated otherwise under provisions of Section 01400

C. The Owner shall pay for a field and compressive strength tests to determine compliance of concrete material in accordance with the specifications

D. Field Control Test
   1. Tests by ACI certified technician
   2. Provide all equipment, supplies, and the services of one or more employees, as required
   3. The test frequencies specified are minimum. Additional tests may be performed as required by the job conditions

E. Slump: Provide a sample from each truck load in accordance with ASTM C143 if requested by Engineer and when making test cylinders

F. Air Content: Provide a sample from each truck load if requested by Engineer and when making test cylinders

G. Compression Tests
   1. Provide one set of 6 cylinders each day when up to 50 cu yds have been placed
   2. Make one additional set of 6 cylinders for each additional 50 cu yds or each major pour placed in one day
   3. Test two cylinders in each set at 7 days
   4. Test two cylinders in each set at 28 days
   5. The other two cylinders to be used as directed by Engineer at any time
   6. Engineer will evaluate in accordance with ACI 214 and 318
   7. Make, cure, store, and deliver cylinders in accordance with ASTM C31
   8. Test in accordance with ASTM C39
   9. Mark or tag each set of test cylinders with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump

H. Storage Facilities for Concrete Test Cylinders
   1. Including water necessary, a specially prepared box with high-low thermometer and thermostatically controlled heating devices in accordance with ASTM C31

I. Failure of Test Cylinder Results: Evaluation of concrete structures where laboratory-cured cylinders fail to meet 28-day concrete strength requirements of the contract documents will be subject to, but not limited to, the following measures.

1. Upon failure of 28-day test cylinder results, the Engineer may require the Contractor, at his expense, to obtain and test at least three 4-inch diameter cored samples from area in question
2. Concrete will be considered adequate if average of three core tests is at least 85 percent of, and if no single core is less than 75 percent of, the specified 28-day strength
3. In the event an area is found to be structurally unsound, the Engineer may order removal and replacement of concrete as required. The cost of the core tests and removal and replacement of defective concrete shall be borne by the Contractor
4. Fill all core holes as specified for repairing defective concrete
5. Additional measures may be required at the direction of the Engineer in accordance with ACI 350

END OF SECTION

SECTION 03400

PRECAST CONCRETE ROOF MEMBERS

PART 1 GENERAL

1.1 SUMMARY

A. Provide precast prestressed concrete roof members where shown on the Drawings, as specified herein, and as needed for a complete and proper installation

1.2 RELATED SECTIONS

A. Section 03300 – Cast-In-Place Concrete

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A36 – Standard Specification for Carbon Structural Steel
   2. A184 – Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
   3. A185 – Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
   4. A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
   5. A416 – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
   6. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   7. C33 – Standard Specification for Concrete Aggregates
   8. C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
   9. C150 – Standard Specification for Portland Cement

B. American Concrete Institute (ACI):
   1. 318 – Building Code Requirements for Structural Concrete and Commentary

C. Precast Concrete Institute (PCI):
   1. MNL-116 – Manual for Quality Control, for Plants and Production of Structural Precast Concrete Products

D. American Society of Civil Engineers (ASCE)
   1. 7 – Minimum Design Loads for Buildings and Other Structures

1.4 SYSTEM DESCRIPTION

A. Precast manufacturer shall be responsible for structural design of individual precast prestressed components and connections between components

B. Design, reinforce, and prestress units as required by ACI 318, PCI Design Handbook, local building code, and as specified herein

C. Design and provide members capable of supporting superimposed loads shown on Drawings including following:
   1. Roof Live Load:
      a. 75 pounds per square foot snow
      b. 20 pounds per square foot live load
   2. Roofing Dead Load: 20 pounds per square foot
   3. Wind Load: 90 miles per hour
   4. Monorail and crane loads with lifted load applied at any point along monorail length
   5. Roof and floor mounted mechanical equipment and piping
   6. Increased snow loads (drift) in accordance with ASCE 7
   7. Seismic Load: 0.14 w

D. Provide 1-1/2 hour UL fire resistance rated units unless otherwise noted

E. Roof plank shall be hollow core Machine Cast (Dry Cast) units

F. Conform to the shapes indicated

1.5 SUBMITTALS

A. Submit in accordance with Section 01340

B. Shop Drawings:
   1. Content:
      a. Dimensions
      b. Design loads
      c. Design camber
      d. Fabrication details
      e. Details of inserts, anchors, connections, accessories, joints, and openings
      f. Chamfer and radius of corners
      g. Reinforcement and tendons
      h. Welds
      i. Finishes
      j. Lifting positions and devices
   2. Erection drawings including piece numbers and table referencing piece numbers to standard unit designations
   3. Shop Drawings shall bear seal of Professional Engineer registered in State of Colorado

C. Product Data:
   1. Catalog or table information for standard precast units
   2. Sandwich panel insulation

D. Miscellaneous Submittals:
   1. Evidence of certification or experience qualifications, when requested by Engineer

1.6 QUALITY ASSURANCE

A. Conduct testing in accordance with PCI MNL-116

1.7 DELIVERY, STORAGE, AND HANDLING

A. Follow manufacturer's written instructions for handling and storage

B. Store units at the job site in a manner to prevent cracking, distortion, warping, staining, and other physical damage, and in a manner to keep markings visible

C. Lift and support the units only at designated lifting points or supporting points as shown on the approved Shop Drawings

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Firms specializing in providing precast prestressed concrete products and services normally associated with industry for at least 3 years

B. Manufacturers meeting requirements of PCI MNL-116

C. Manufacturers may be required to submit written evidence showing experience, qualifications, and adequacy of plant, facilities, and ability to perform Work

2.2 MATERIALS

A. Portland Cement: ASTM C150, Type I, II, or III

B. Aggregates:
   1. ASTM C33
   2. Natural materials
   3. Maximum 3/4 inch.

C. Water: Potable

D. Reinforcing Steel:
   1. Deformed Steel Bars: ASTM A615, Grade 60
   2. Welded Wire Fabric: ASTM A185
   3. Fabricated Steel Bar Mats: ASTM A184

E. Fiber Reinforcement:
   1. Manufacturers:
      a. W.R. Grace & Co.
      b. Fibermesh Co.
      c. Euclid Chemical Co.
   2. 1/2 inch to 3/4 inch collated fibrillated virgin polypropylene fibers
   3. ASTM C1116 Type III

F. Tendons: Uncoated, stress-relieved strand, ASTM A416, Grade 250K or 270K. Low relaxation strand conforming to Supplement 1 may be used.

G. Anchors and Inserts:
   1. ASTM A36 or ASTM A307
   2. Types as indicated on the Drawings or as approved by Engineer

H. Cement Grout: One part Portland cement and 3 parts sand

I. Bearing Pads:
   1. Hollow Core Plank: 1/8 inch thick tempered hardboard or high-density plastic

J. Welded Studs: AWS D1.1

K. Joint Sealants and Accessories: Conform to requirements of Section 07920

2.3 MIX DESIGN

A. Mix design shall be in accordance with manufacturer's recommendations

B. Concrete Properties:
   1. 28-Day Compressive Strength:
      a. Minimum 4000 pounds per square inch for hollow core plank

2.4 FABRICATION

A. Formwork:
   1. Construct forms to maintain units within specified tolerances with radius or chamfer corners
   2. Locate lifting devices to not harm appearance of unit in finished position
   3. Form treatments or curing compounds shall not contain ingredients which might stain concrete or reduce bond with subsequent coatings, finishes, etc.

B. Reinforcement:
   1. Pretension tendons in accordance with PCI MNL-116
   2. Provide reinforcement necessary to resist applied loads, handling and erection

C. Locate lifting devices to not harm appearance of unit in finished position

D. Accurately and rigidly position embedded items during concrete placement. Avoid contact of dissimilar metals.

E. Batch, mix, and handle concrete in accordance with ACI and PCI recommendations

F. Cure units in accordance with PCI MNL-116

G. Detensioning:
   1. Detension units after concrete has reached release strength in accordance with design
   2. If heat cured, perform detensioning while unit is still warm
   3. Detension tendons in gradual sequence to prevent shock and unbalanced loads

H. Finishes:
   1. Unexposed Areas: As cast
   2. Exposed Faces of Wet-Cast Units:
      a. PCI Grade B finish
      b. Surfaces concealed by materials other than paint: PCI Commercial finish
   3. Interior Exposed Faces of Floor and Roof Plank and Wall Panels (Dry Cast Units):
      a. Cast against concrete or steel casting beds maintained in accordance with industry practice
      b. Surface holes, chips, and spalls shall not exceed 1/4 inch
      c. Casting bed offsets and finish shall not exceed 1/8 inch
   4. Permanently exposed surfaces shall be consistent in appearance over entire area. Spotty coloring not accepted.

I. Fabrication tolerances shall conform to requirements of PCI MNL-116
   1. Edges of units shall be true and parallel and not vary from a straight line more than 1/8 inch at any point
   2. Edges shall be parallel within maximum variation of 1/8 inch at any point
   3. Faces shall not vary from flat plane more than 1/8 inch at any point
   4. Maximum warpage prior to installation shall not exceed that which can be corrected during installation

2.5 ANCHORS, HOLES, AND FRAMING

A. Provide pipes, sleeves, inserts, weld plates, anchor plates, anchor bolts, bolts, concrete anchors, and other embedded items shown and as required. Place dissimilar metals to avoid physical contact between them.

B. Furnish inserts, plates, fastening devices, and anchors to be set in supporting structure

C. Provide anchor straps, plates, angles, bolts, and other items as required to connect individual members to each other and supporting structure

D. Holes shall be formed during manufacture of units, or field cut or cored. Location shall be coordinated with manufacturer. Do not cut tendons without manufacturer's consent. Over cutting will not be allowed. Edges of holes shall be neat and square, spalled edges will not be allowed.

E. Large Openings:
   1. Design and provide steel headers
   2. Reinforce units adjacent to units with large openings to support additional dead and live load caused by opening

F. At holes and along cut edges of hollow core units, exposed cores shall be grouted solid within 6 inches of hole or cut edge

2.6 SOURCE QUALITY CONTROL

A. Comply with applicable requirements of PCI MNL-116

1. Make one compression test and absorption test for each day's production of each type of member
2. Test cylinders and absorption specimens shall be cast from the same materials and by the same methods as the precast units, and shall be cured in the same manner as the precast units
3. Compression test shall conform to ASTM C39

B. Failure of any member to come within tolerances specified herein shall be cause for rejection

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Erect units in accordance with manufacturer's written instructions

B. Do not bear units on cast-in-place concrete or masonry construction until support has reached 80% of design strength

C. Provide bearing pads set on level and uniform bearing surfaces

D. Do not place warped, cracked, or broken units

E. Ends of units may be saw cut if required for proper clearance. Do not break units with hammer to produce proper clearance

F. Set units straight, level, plumb, and square

G. Provide temporary supports and bracing as required to maintain position, stability, and alignment until units are permanently connected

H. Perform welding in accordance with AWS D1.1 and AWS D1.4

I. Remove lifting devices and grout flush with adjacent surface

J. Repair damaged surfaces to match adjacent surfaces

K. Anchor hollow core units to supporting members as shown. When approved by Engineer, anchors may be drilled and grouted into supporting structure.

L. Erection Tolerances:
   1. Roof Plank:

a. Alignment between units and along other structural elements: Maximum 1/8 inch per 10 feet, vertical and horizontal
b. Elevation between adjacent roof or floor members: Maximum difference 3/4 inch at any point
c. Gaps between adjacent roof or floor units: Maximum 1/4 inch

3.3 GROUTING, POINTING, AND CAULKING

A. Roof Units: Grout joints between hollow core roof units from top of unit, and finish on underside before hardening as follows:
   1. Where units to be exposed or painted as finished ceiling: Rake joints 1/2 inch deep and fill with sealant, finish smooth
   2. Unexposed areas and areas with suspended ceilings: Rough formed or rough broomed
   3. Trowel top of grout joints on roofs smooth to prevent unevenness interfering with placing of, or causing damage to, insulation or roofing. Slope due to differential elevations shall not exceed 1:12.
   4. Provide fire-stopping material in vertical joints of fire rated walls

3.4 CLEANING

A. Clean exposed surfaces with water, rinse thoroughly

END OF SECTION

SECTION 03600

NON-SHRINK GROUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Patching cavities in concrete

B. Setting equipment base plates

C. Other grouting specified or indicated on Drawings

1.2 RELATED SECTIONS

A. Section 03300 – Cast-In-Place Concrete

1.3 REFERENCES

A. American Concrete Institute:
   1. ACI 301 – Specifications for Structural Concrete
   2. ACI 318 – Building Code Requirements for Structural Concrete

B. American Society of Testing and Materials:
   1. ASTM C33 – Standard Specification for Concrete Aggregates
   2. ASTM C40 – Test Method for Organic Impurities in Fine Aggregates for Concrete
   3. ASTM C150 – Standard Specification for Portland Cement
   4. ASTM C191 – Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
   5. ASTM C307 – Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
   6. ASTM C531 – Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
   7. ASTM C579 – Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, monolithic Surfacings and Polymer Concretes
   8. ASTM C827 – Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

C. U. S. Army Corps of Engineers Concrete Research Division (CRD):
   1. CRD C621 – Non-Shrink Grout

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Product Data: Provide manufacturer's catalog sheet for material indicating test data and physical properties

1.5 QUALITY ASSURANCE

A. Conform to applicable industry standard, Corps of Engineers, Specification CRD-C 621 - Specification for non-shrink grout

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Non-Shrink, Non-Metallic Grout
   1. Master Builders - Masterflow 928
   2. Burke - Non-Ferrous Non-Shrink
   3. M.R. Meadows - Sealtight 588
   4. Sonneborn - Sonogrout G.P.
   5. Tamms - Tammsgrout 621
   6. Sika - SikaGrout 212
   7. Or accepted substitution

B. Epoxy Grout
   1. Burke - BurkEpoxy Anchoring Grout
   2. L&M Inc. - Epogrout
   3. Sika - Sikadur 42, Grout Pack
   4. Or accepted substitution

2.2 MATERIALS

A. Non-Shrink, Non-Metallic Grout: Factory premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 4000 psi in one day and 8000 psi in 7 days

B. Epoxy Grout: Three Component Epoxy Resin System
   1. Two liquid epoxy components
   2. One inert aggregate filtered component
   3. Each component furnished in separate package for mixing at job site

C. Water: Clean and free from deleterious substances

PART 3 EXECUTION

3.1 PREPARATION

A. Non-Shrink, Non-Metallic Grout
   1. Clean concrete surface to receive grout

2. Saturate concrete with water for 24 hrs prior to grouting and remove excess water just prior to placing grout
3. Cold weather conditions
   a. Warm concrete, substrate and base plate to 40 deg F, or above; store grout in warm area
   b. Follow manufacturer's recommendations for cold weather application
4. Hot weather conditions
   a. Use cold mixing water and cool base plate if possible; store grout in cool area
   b. Follow manufacturer's recommendations for hot weather application
5. Apply to clean, sound surface
6. Apply latex bonding agent to hardened concrete, mix-in-grout, or as directed by Engineer

B. Epoxy Grout: Apply only to clean, dry, sound surface

3.2 APPLICATION

A. Non-Shrink, Non-Metallic Grout
   1. Mix in a mechanical mixer
   2. Use no more water than necessary to produce flowable grout
   3. Provide air vents where necessary to eliminate air pockets
   4. Place in accordance with manufacturer's instructions
   5. Where exposed to view finish grout edges smooth
   6. Protect against rapid moisture loss by immediately covering with wet rags and polyethylene sheets or curing compound
   7. Wet cure grout for 7 days, minimum
   8. Maintain the temperature at a minimum of 40 deg F until grout reaches 3000 psi
   9. After placement of grout, eliminate excessive external vibration

B. Epoxy Grout
   1. Mix and place in accordance with manufacturer's instructions
   2. Completely fill all cavities and spaces around dowels and anchors without voids
   3. Obtain manufacturer's technical assistance as required to insure proper placement

3.3 SCHEDULE

A. Non-Shrink, Non-Metallic Grout: General Use
   1. Grouting of manhole covers, pipe inlets, and precast manholes and vaults

B. Epoxy Grout
   1. Patching cavities in concrete including, but not limited to, tie holes, and structural and equipment support

END OF SECTION

SECTION 04810

UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Flashing Materials.
6. Miscellaneous masonry accessories.

B. Related Sections:
1. Section 05120 Structural Steel for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
1. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

1.5 SUBMITTALS

A. Product Data for each different masonry unit, accessory, and other manufactured product specified.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Verification: For each type and color of the following:

1. Split Face CMU, Vertical Score CMU, and other Exposed CMU.
2. Pigmented or colored-aggregate mortar. Make samples using same sand and mortar ingredients to be used on Project.
3. Samples shall closely match in appearance that of the CMU used for the existing pump station.

D. Qualification Data: For testing agency.

E. Material Certificates: For each type and size of the following:

1. Masonry units.

   a. Include material test reports substantiating compliance with requirements.
   b. For exposed units, include test report for efflorescence according to ASTM C 67.

2. Cementitious materials. Include brand, type and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil

1.7 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place
2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface
2. Protect sills, ledges, and projections from mortar droppings
3. Protect surfaces of door frames, as well as similar products with painted and integral finishes, from mortar droppings
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work

2.2 CONCRETE MASONRY UNITS

A. Regional Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site

B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions
2. Provide square-edged units for outside corners unless otherwise indicated

C. CMUs: ASTM C 90

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi
2. Density Classification: Normal weight
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions
4. ASTM C 90 requires at least four units for sample, representing the range of color and texture permitted
5. Block shall be manufactured with water repellant admixture

D. Decorative CMUs (Vertical Score and Split Face units): ASTM C 90

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi
2. Density Classification: Normal weight
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions
4. ASTM C 90 requires at least four units for sample, representing the range of color and texture permitted
5. Vertical score units: Provide units with a single vertical score to closely match block used on the existing pump station
6. Split Face units: Provide units to closely match color and texture of block used on the existing pump station
7. Block shall be manufactured with water repellant admixture.

2.3 MASONRY LINTELS

A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated

B. Hydrated Lime: ASTM C 207, Type S

C. Self-Consolidating Grout (SCG): ASTN C 476-02, course masonry grout.

D. Ready-Mixed Mortar: Cementitious material, water, and aggregate complying with requirements specified in the Article; combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C 1142.

   1. Mortar color to match adjacent building mortar.

E. Aggregate for Mortar: ASTM C 144

   1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve
   2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color

F. Aggregate for Grout: ASTM C 404

G. Water: Potable

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M

   1. All Walls: Hot-dip galvanized**,** carbon steel
   2. Wire Size for Side Rods: 9 gauge.
   3. Wire Size for Cross Rods: 9 gauge.

4. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
5. Provide in lengths of not less than 10 feet with prefabricated corner and tee units

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods

2.6 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Postinstalled Anchors: Torque-controlled expansion anchors or chemical anchors.
1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 unless otherwise indicated.

2.7 FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual".
1. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.

B. Rubberized asphalt sheet flashing with metal drip edge.

C. Sheet Flashing:
1. Perm-A-Barrier as manufactured by W.R. Grace
2. Dur-O-Barrier as manufactured by Dur-O-wall
3. A self-sealing, self healing, fully adhered composite flexible, self-adhesive, cold applied sheet consisting of a minimum of 32 mils of rubberized asphalt bonded to an 3 mil high density cross laminated polyethylene film.

D. Metal drip edge shall be 24 gauge, G-90 galvanized commercial quality prefinished steel sheet, coated with a high performance flouropolymer coating (Kynar 500). Color as selected by Owner. Drip edge shall be minimum 2 ½ inches wide with 5/8 inch 13 degree drip and minimum ¼ inch hem along outside edge.

E. Accessories: Primer, conditioner, adhesive, and mastic compatible with the sheet flashing as recommended by the sheet flashing manufacturer.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep Products: Use the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity. Use only for weeps.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Advanced Building Products Inc.; Mortar Break
b. Archovations, Inc.; CavClear Masonry Mat
c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
d. Mortar Net USA, Ltd.; Mortar Net

2. Provide one of the following configurations:

a. Strips, full-depth of cavity and 10 inches (250 mm) high, with dovetail shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.
b. Strips, not less than 3/4 inch (19 mm) thick and 10 inches (250 mm) high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.
c. Sheets or strips not less than 3/4 inch (19 mm) thick and installed to full height of cavity with additional strips 4 inches (100 mm) high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from clogging with mortar.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.

d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.
e. Acceptable Substitution.

G. Exterior Masonry Sealer
1. Manufacturers:
a. Chemstop Heavy Duty by Euclid Chemical Co.
b. Dry-Block by W.R. Grace

2.9 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. For reinforced masonry, use portland cement-lime mortar.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.
3. For mortar parge coats, use Type N.

4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.

D. Pigmented Mortar: Use colored cement product.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
3. Mix to match Engineer's sample.
4. Application: Use pigmented mortar for exposed mortar joints

E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

F. Water Repellant admixture: Dry-Block by W.R. Grace

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, /8 inch in 20 feet or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet , or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
3. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 CONTROL JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 07920 Joint Sealants, but not less than 3/8 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.8 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.9 FLASHING, WEEP HOLES AND CAVITY DRAINAGE

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. Form 1/4-inch (6-mm) hook in edge of flashing embedded in inner wythe.
3. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 07920 Joint Sealants for application indicated.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes 24 inches (600 mm) o.c. unless otherwise indicated.
4. Space weep holes formed from wicking material 16 inches (400 mm) o.c.
5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
6. Trim wicking material flush with outside face of wall after mortar has set.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.10 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.11 SEALER

A. Apply 1 coat of exterior masonry sealer to exposed surfaces of concrete masonry.

B. Protect windows, doors, louvers, light fixtures, etc. during application.

C. Apply in accordance with manufacturer’s recommendations.

3.12 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Level 1 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

G. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer’s approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

2.1 SUMMARY

A. Provide miscellaneous metal work shown on the Drawings, as specified herein, and as needed for a complete and proper installation

B. Section Includes:
1. Concrete anchors
2. Aluminum handrail
3. Aluminum bar grating
4. Aluminum plank grating
5. Grating support frames
6. Stairs
7. Ladders.
8. Alternating Tread Ladder.
9. Lintels.
10. Floor access hatches
11. Miscellaneous items

2.2 DEFINITIONS

A. Submerged: At or below level 1 foot 6 inches above maximum water level in water holding structures

2.3 REFERENCES

B. AISC: American Institute of Steel Construction

C. AA: Aluminum Association

D. AWS: American Welding Society

E. ASTM: American Society for Testing and Materials

F. AISI: American Iron and Steel Institute

G. NAAMM: National Association of Architectural Metal Manufacturers

H. OSHA: Occupational Safety and Health Administration

2.4 SUBMITTALS

A. Shop Drawings:
   1. Indicate materials, sizes, connections, anchors, and finishes

B. Product Data:
   1. Manufacturer's catalog sheets on premanufactured items

C. Submit in accordance with Section 01340

2.5 QUALITY ASSURANCE

A. Perform shop and/or field welding required in connection with the work of this Section by certified welders in strict accordance with pertinent recommendations of AWS

B. Conform to AISC and AA standards

PART 2 GENERAL

2.1 MATERIALS

A. In fabricating items which will be exposed to view, limit materials to those which are free from surface blemishes, pitting, and roughness

B. Comply with following standards, as pertinent
   1. Steel plates and shapes: ASTM A36 or A992
   2. Stainless Steel:
      a. Exterior and submerged uses: AISI, Type 316
      b. Interior uses: AISI, Type 304 or Type 316
   3. Aluminum shapes and plates: Alloy 6061-T6 or 6063-T6
   4. Connection Bolts:
      a. For steel members: ASTM A325
      b. For aluminum and galvanized steel members: Stainless steel
   5. Cast-in-place Anchor Bolts:
      a. 1/2 inch minimum diameter
      b. Nonsubmerged: ASTM A307, galvanized
      c. Submerged: Stainless steel

2.2 CONCRETE ANCHORS

A. Wedge Anchors:
   1. Manufacturers:
      a. Power-Stud+ SD1 or SD2 by Powers Fasteners
      b. Kwik Bolt 3 or Kwik Bolt TZ by Hilti Corp
      c. Ankr-Tite CCAT Wedge Anchor by Wej-it Fastening Systems
      d. Strong-Bolt or Strong-Bolt 2 by Simpson Strong-Tie Co., Inc.

    e. Red Head Trubolt + or Trubolt Wedge Anchor by ITW Commercial Construction
  2. Usage: In concrete.
    a. 316 stainless steel
    b. Do not use when submerged or subjected to dynamic loads

B. Expansion Anchors:
  1. Manufacturers:
    a. Power-Bolt+ by Powers Fasteners
    b. HSL-3 by Hilti Corp
  2. Usage: In concrete
    a. 316 stainless steel
    b. Do not use when submerged, in overhead applications, or subjected to dynamic loads

C. Sleeve Anchors:
  1. Manufacturers:
    a. Lok-Bolt AS by Powers Fasteners
    b. HLC by Hilti Corp.
    c. Sleeve Anchors by Wej-it Fastening Systems
    d. Sleeve-All by Simpson Strong-Tie Co., Inc.
    e. Red Head Dynabolt Sleeve Anchor by ITW Commercial Construction
  2. Usage: In masonry
    a. 316 stainless steel

D. Adhesive Anchors:
  1. Manufacturers:
    a. HIT RE 500-SD or HY 150 MAX (MAX-SD) Epoxy Adhesive Anchor by Hilti Corp.
    b. AC100+ Gold or PE 1000+ by Powers Fasteners
    c. AT or SET-XP Epoxy Adhesive System by Simpson Strong-Tie Co., Inc.
    d. Red Head Epcon S7, A7, G5 or C6 Adhesives by ITW Commercial Construction
  2. Epoxy adhesive with 316 stainless steel stud assembly
  3. Usage:
    a. In concrete, submerged
    b. In masonry, provide tube screen inserts
    c. Do not use in overhead applications

E. Adjustable Anchors:
  1. Manufacturers:
    a. Deco
    b. Unisorb
  2. Usage: In concrete, for hanging monorail beams and supports from concrete ceilings

F. Hollow Core Plank Anchors:
  1. Manufacturers:
    a. Hollow-Set Dropin Anchor or Mini Dropin by Powers Fasteners

b. Short Drop-In Anchor by Simpson Strong-Tie Co., Inc.
c. Red Head Multi-Set II RX Short Drop-In Anchor by ITW Commercial Construction

2. Usage: In precast concrete hollow core plank
   a. Zinc plated carbon steel
   b. Overhead applications in interior locations for attachment of light duty pipe and equipment supports
   c. Do not use in corrosive or humid areas, tanks, when submerged, or subjected to dynamic loads
   d. For heavy duty pipe and equipment supports or when subject to dynamic loads, use anchors that completely penetrate the plank

2.3 FINISHES

A. Primer: Conform to requirements of Section 09900

B. Galvanizing Repair Paint: High zinc-dust content paint complying with MIL-P-21035

2.4 FABRICATION

A. Except as otherwise shown on the Drawings or the approved Shop Drawings, use materials of size, thickness, and type required to produce reasonable strength and durability in the work of this Section

B. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection

C. Fabricate with accurate angles and surfaces which are true to the required lines and levels, with projecting corners clipped, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible

D. Weld shop connections and bolt or weld field connections

E. Prior to shop painting or priming, properly clean metal surfaces as required for the applied finish and for the proposed use of the item. Conform to Section 09900
   1. Do not coat ferrous metal surfaces embedded in concrete
   2. Coating of cast iron or ductile iron floor access hatches and pressure relief valves not required
   3. On surfaces inaccessible after assembly or erection, apply two coats of the specified primer. Change color of second coat to distinguish it from the first
   4. Coat aluminum surfaces in contact with concrete in accordance with AA and Section 09900. Under no circumstances shall aluminum contact dissimilar metal

F. Galvanizing:
   1. Galvanize after fabrication
   2. Galvanize by hot-dip process conforming to ASTM A123 and AHDGA specifications

2.5 ALUMINUM HANDRAIL

A. Rails, Posts, and Formed Elbows: 1-1/2 inch diameter schedule 40 aluminum pipe (1.90 inch outside diameter, 0.145 inch wall thickness) alloy 6063-T6
   1. Clear satin anodized finish on extruded components: 0.7 mil
   2. Cleaersatin anodized finish on cast components: 0.4 mil
   3. Light brushed finish on pipe and fittings before anodizing

B. Fittings
   1. Riveted type fabricated from material similar to rails and posts
   2. Connections shall be continuous type to permit sliding of hands.
   3. Fittings for open railing extensions shall be welded construction and welded to posts to comply with OSHA loading requirements. Welds shall be ground smooth and finished to match adjacent finish
   4. Base plates and side mounted flanges shall be aluminum or stainless steel

C. Chain gates shall be 3/16 inch stainless steel link chain with stainless steel clasp capable of withstanding a 250 lb load

D. Toe plate shall be ¼ inch by 4 inches flat aluminum plate, alloy 6063-T6

E. Mechanical fasteners shall be stainless steel

F. Use materials of size, thickness, and type required to produce required strength and durability.

G. Form connections and changes in direction by using prefabricated fittings or redius bends.

H. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces.

I. Remove burrs from cut edges.

J. Close pipe ends using prefabricated fittings.

K. Fabricate joints for exterior units to exclude water or provide weep holes where water may accumulate.

L. Provide slip-fit sleeves for interior removable railings.

M. Coat surfaces to be in contact with concrete with bituminous paint.

2.6 ALUMINUM BAR GRATING

A. Manufacturers:
   1. IKG/Borden, Type BS
   2. Ohio Grating, Type 19-SG-4
   3. Barnett Bates, Type 19-AP-4

4. Klemp Grating, Type KRP-19-4

B. Materials:
1. Pressure locked serrated grating (expanded tube or swagged type)
2. Alloy 6061-T6 or 6063-T6
3. Bearing bars shall be spaced at 1-3/16 inch on center
4. Cross bars shall be spaced at 4 inch on center
5. Size bearing bars as follows unless noted otherwise:

Maximum Clear Span (ft - in.)	Bearing Bar Size (depth below serrations) (in.)
3 - 8	1-1/4 x 1/8
4 - 3	1-1/4 x 3/16
4 - 5	1-1/2 x 1/8
5 - 1	1-1/2 x 3/16
in.= inch ft = feet	

C. Provide shop-fabricated grating and accessories such as frames, support angles, fasteners, and treads

D. Grating and treads shall be serrated aluminum

E. Treads and exposed edges of grating platforms shall have corrugated or cast aluminum abrasive nosing

F. Provide fastening devices to firmly anchor grating and treads to supports. Sections designated as removable shall not be attached to supports
1. Minimum of 4 per panel
2. Shall allow for repeated removal
3. Saddle clip type
4. “G” clip type
5. Clamp type
6. Minimum 1/4 inch bolts or self tapping screws
7. 316 stainless steel

G. Provide trim banding or load carrying banding on edges and cutouts welded to grating.
1. Bearing bars not resting on supports shall have load carrying banding sized to span opening
2. Minimum banding thickness shall match bearing bar thickness
3. Banding shall be flush with top of grating
4. Banding depth shall be 1/4 inch less than bearing bar depth at supports

H. Cross bars shall not extend more than 1/8 inch past bearing bars at panel edges

I. Panels shall bear on supports a minimum length equal to bearing bar depth

J. Minimum width of panels shall be 16 inches except for locations requiring a single piece

K. Maximum width of panels shall be 48 inches

2.7 ALUMINUM PLANK GRATING

A. Manufacturers:
   1. IKG/Borden, Aluminum Plank.
   2. Ohio Grating, Aluminum Plank.

B. Design Loads:
   1. 100 pounds per square foot uniform live load.
   2. 400 lbs moving concentrated live load.

C. 1/4 inch maximum deflection under 100 pounds per square foot uniform live load.

D. Provide shop-fabricated grating and accessories such as frames, support angles, and fasteners.

E. Grating shall be aluminum alloy 6061-T6 or 6063-T6 diagonal punched panels with 8% open area and raised longitudinal ridges for skid resistance.

F. Provide fastening devices to firmly anchor grating and treads to supports. Sections designated as removable shall not be attached to supports.
   1. Minimum of 4 per panel.
   2. Shall allow for repeated removal.
   3. Minimum 1/4 inch bolts or self tapping screws.
   4. 316 stainless steel.

G. Provide trim banding or load carrying banding on edges and cutouts welded to grating.

H. Panels shall bear on supports a minimum of 1-1/2 inches.

I. Bolt or nest individual sections together to form larger panels.

J. Minimum width of panels shall be 16 inches except for locations requiring a single piece.

K. Max width of panels shall be 48 inches.

2.8 GRATING SUPPORT ANGLES AND FRAMING

A. Provide aluminum support angles embedded in concrete. Angles shall be 1/4 inch thick, inside depth shall equal depth of grating, inside length shall equal depth of grating, but not less than 1-1/4 inch. Provide 1 inch by 1/4 inch by 8 inches long strap anchors or 3/8 inch diameter by 6 inches long headed anchor studs welded to back of angles at 18 inches on center.

B. Provide aluminum angles, channels, and beams as noted bolted to concrete or masonry with concrete anchors as noted.

2.9 LINTELS

A. Provide steel lintels over openings in masonry walls as noted and wherever reinforced masonry or concrete lintels are not provided.

B. Fabricate lintels from structural steel shapes as detailed, selected for straightness of section, with minimum of 8 inches bearing each side of opening.

C. Openings 4 feet and less in width without lintel scheduled, shall have double steel angle lintels or reinforced masonry lintels. Total width of horizontal legs shall be 1 inch less than nominal thickness of wall. Weld angles together. Masonry lintels shall conform to requirements of Section 04810.

2.10 STAIRS

A. Construct stairs and platforms of steel channel stringers and framing members to support uniform live load of 100 pounds per square foot or a moving concentrated load of 1000 pounds, whichever produces the greatest stress

B. Close exposed ends of stringers with plates, continuously welded to main member

C. Provide grating treads and landing platforms. Conform to Section 05530

D. Hot-dip galvanize after fabrication.

2.11 LADDERS

A. Ladders shall conform to OSHA and local building code safety requirements.

B. Construct from steel members.
   1. Stringers: 3-1/2 inch by 3/8 inch bar.
   2. Rungs: 1 inch diameter deformed reinforcing rod.
   3. Other materials shall be minimum 1/4 inch thick.
   4. Punch stringers and pass rungs through stringers, weld on both sides.
   5. Fabricate brackets for fastening ladders to wall, weld to ladder.

C. Hot-dip galvanize after fabrication.

2.12 FLOOR ACCESS HATCHES

A. Prefabricated Standard Type:
   1. Manufacturers:
      a. Bilco Type K
      b. Halliday Type S1S
      c. Nystrom N Series

d. Or accepted substitution
2. Provide access hatches and frames of material, type, and size as shown on Drawings
3. Door leaves shall be 1/4 inch minimum diamond pattern plate with reinforcing on underside to withstand live load of 150 pounds per square foot with max deflection of 1/150 span
4. Frames shall be 1/4 inch minimum thick with strap anchors around perimeter
5. Equip hatches with stainless steel hinges bolted to underside and pivot on torsion bars that counterbalance leaf for easy operation
6. Equip hatches with hold-open arm with positive locking device with conveniently positioned release handle for easy and controlled closing
7. Provide 316 stainless steel snap lock mounted on underside of leaf with removable topside handle and socket recessed in cover
8. Hardware shall be stainless steel
9. Factory finish on aluminum surfaces shall be mill finish with bituminous coating applied to surfaces in contact with concrete
10. Manufacturer shall warranty in writing against defects in material and workmanship for 5 years

2.13 MISCELLANEOUS ITEMS

A. Fabricate miscellaneous framing, supports, and items of structural shapes, plates, bars, and tubing of sizes and arrangements indicated and as required

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
1. Set work accurately into position, plumb, level, true, and free from rack
2. Tolerance: 1/8 inch in 10 feet
3. Anchor firmly into position
4. Where field welding is required, comply with AWS recommended procedures for appearance and quality of weld and for methods to be used in correcting welding work
5. Grind exposed welds smooth, and touchup shop prime coats
6. Do not cut, weld, or abrade surfaces which have been hot-dip galvanized after fabrication and which are intended for bolted or screwed field connections
7. Perform cutting, drilling, and fitting as required for proper installation. Drill field holes for bolts, do not burn holes.

8. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint the exposed areas with same material used for shop priming.

B. Concrete Anchors:
   1. Do not install until concrete or masonry has reached its design strength
   2. Do not install closer than 6 bolt dia to edge of concrete or masonry, or closer than 12 bolt diameter to another anchor unless otherwise shown
   3. Minimum embedment shall be 8 bolt diameter
   4. Install in accordance with manufacturer's recommendations

C. Aluminum Handrail:
   1. Assemble and install in accordance with manufacturer's written instructions
   2. Set posts plumb and align in each direction to within 1/8 inch in 10 feet. Maximum post spacing shall be 6 feet on center.
   3. Set rails horizontal or parallel to slope of surface or rake of steps to within 1/8 inch in 10 feet
   4. Provide expansion joints in and toe place at 30 feet maximum on center. Locate within 12 inches of post.
   5. Support handrail on brackets having 2 inch clearance between handrail and wall spaced not more than 5 feet on center and within 12 inches of each end of rail. Return handrail ends to within 1/2 inch of wall.
   6. Locate chain gates as shown. Number of chains shall match number of horizontal rails. Chain drape shall not exceed 3 inches.
   7. Provide toe plate except on stairs and on top of walls that project above grade where foot traffic is not feasible.
   8. Bolt to top of stair stringers.

D. Aluminum Gratings:
   1. Install in accordance with manufacturer's written instructions
   9. Clearances:
      a. 1/4 inch maximum from metal sections
      b. 1/2 inch maximum from concrete or masonry walls
      c. 1/4 inch maximum between sections

3.3 ADJUSTING AND CLEANING

A. Clean exposed surfaces, removing dirt, dust, and other foreign matter

B. Prepare surfaces for finished painting as specified is Section 09900

C. Field Repair of Damaged Galvanized Coatings:
   1. Repair surfaces damaged during shipping, erection, or construction operations
   2. Use zinc rich paint
   3. Prepare surfaces and apply in accordance with ASTM A780, Annex A2

END OF SECTION

SECTION 05517

ALTERNATING TREAD SHIPS LADDERS

PART 1 GENERAL

1.1 SUMMARY

A. Provide aluminum alternating tread ships ladders as shown on the drawings, as specified herein, and as needed for a complete and proper installation.

1.2 REFERENCES

A. ASTM: American Society for Testing and Materials

1.3 PERMORMANCE REQUIREMENTS

A. Stair Treads and Landings: Concentrated 1000 pound load without deformation.

B. Handrail: 200 pounds applied in any direction at any point on the rail.

1.4 CONSTRUCTION REQUIREMENTS

A. Treads, and Mounting Base: Cast aluminum welded to single extruded box-like stringer. Treads shall have integrally cast handrail support arms.

B. Welds: Minimum of 8 welds per tread, and 12 welds each on the landing and mounting base. Each weld shall be quality controlled and be capable of withstanding a minimum of 2800 pounds in shear.

C. Pedestrian Surfaces: Punched through with upset non-skid openings.

D. Riser Spacing: Equally spaced to within 3/16 inches for adjacent risers and to within 3/8 inches for any two non-adjacent risers on a stair.

E. Landings:
   1. Single part units cut, formed, and punched diamond plate trays.
   2. Mounting brackets and kickplates shall be either formed or welded onto trays.

F. Handrails: Contoured for body guidance and underarm support and shall be attached to the outside stringers and landings by bolting.

G. Landing Reinforcement: 1/4 inch aluminum angle notched and punched and factory welded to the landing at the points of a handrail attachment.

H. Foot Divider: Rubber bumper strip shall be attached to the central stringer.

1.5 DIMENSIONS

A. Stair Angle: 68 degrees from horizontal.

B. Vertical Drop: as shown on the Drawings.

C. Overall Width: 23 inches.

1.6 SUBMITTALS

A. Shop Drawings:
   1. Indicate materials, sizes, connections, anchors, and finishes.

B. Product Data:
   1. Manufacturer's catalog sheets.

C. Submit in accordance with Section 01330.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Lapeyre Stair, Inc.

B. Or equal.

2.2 MATERIALS

A. Aluminum
   1. Treads & Foot Castings: Aluminum Alloy F356F.
   2. Landings: 1/4 inch diamond plate Alloy 3003-H22.
   3. Stringers:
      a. Aluminum Alloy 6063-T52 per ASTM B221.
      b. 1 3/4 inches x 4 inches x 1/8 inch box shape.
   4. Handrails:
      a. Aluminum Alloy 6063-T4 per ASTM B221.
      b. 1 1/2 inches x 1/8 inch tube.

B. Miscellaneous Material:
   1. Rubber Spine: Hollow neoprene
   2. Rubber Foot Divider: Solid neoprene

2.3 FINISHES

A. Mill finish.

2.4 FABRICATION

A. Fabricate alternating tread steel ships ladders to conform with performance and construction requirements, and in accordance with approved shop drawings.

PART 3 EXECUTION

3.1 PREPARATIONS

A. Coordinate start and installation of steel alternating treads with all other related and adjacent work. Installation shall not start until the construction has progressed to the point that weather conditions and remaining construction operations will not damage stair installation.

B. Verify that dimensions and angle are correct and that substrate is in proper condition for stair installation. Do not proceed to install until all necessary corrections have been made.

3.2 INSTALLATION

A. If bumper has not been installed at the factory, install the bumper in accordance with the manufacturer's instructions using glue supplied with the stair.

B. Prepare mounting holes.

C. Position stair with top tread at same elevation as upper finished floor or roof surface.

D. Secure stair with not less than 2 bolts or studs at top and with not less than 2 at bottom of stair.

END OF SECTION

SECTION 07200

BUILDING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. SECTION INCLUDES
1. Rigid board insulation at perimeter concrete foundation walls
2. Rigid board insulation in concrete decks

1.2 REFERENCES

A. ASTM: American Society for Testing and Materials

1.3 PERFORMANCE REQUIREMENTS

A. Materials of this section shall provide continuity of thermal barrier at building enclosure elements

1.4 SUBMITTALS

A. Product Data: Provide data on product characteristics, performance criteria, and limitations

B. Manufacturer's installation instructions

C. Submit in accordance with section 01340

1.5 ENVIRONMENTAL CONDITIONS

A. Do not install insulation adhesives when temperatures or weather conditions are detrimental to successful installation

PART 2 PRODUCTS

2.1 EXTRUDED POLYSTYRENE BOARD

A. Rigid, closed-cell, extruded, polystyrene insulation with integral high density skins

B. Minimum thermal resistance "R" per inch: 5.0

C. Minimum compressive strength:
1. 25 pounds per square inch for perimeter wall and cavity wall insulation
2. 100 pounds per square inch for sandwich slab insulation

D. Maximum water absorption by volume in accordance with ASTM C272: 0.1%

E. Manufacturer's recommended adhesive for insulation application

F. Minimum thickness: 2 inches unless otherwise noted. Reduce thickness of cavity wall insulation at concrete beams and columns to 1 ½ inches

G. Acceptable Manufacturers:
   1. Dow
   2. Owens Corning
   3. Tenneco
   4. Pactiv
   5. Or accepted substitution

PART 3 EXECUTION

3.1 INSTALLATION / EXTRUDED POLYSTYRENE BOARD

A. Extruded polystyrene insulation to be installed where shown on the drawings, in accordance with manufacturer’s instructions

B. Place boards in method to maximize contact bedding. Stagger side and end joints with edges butted tightly

C. Cut and fit boards tightly around penetrations and other openings as required

D. Perimeter insulation shall be set in adhesive applied to foundation wall in accordance with manufacturer’s recommendations

E. Cavity wall insulation shall be set in adhesive applied to exterior face of interior wythe in accordance with manufacturer's recommendations. Fit courses of insulation between wall ties between wythes

F. Where thickness exceeds 2 inches, install first layer of insulation as specified herein. Stagger side and end joints of finish layer.

SECTION 07215

FOAMED-IN-PLACE MASONRY INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. SECTION INCLUDES
1. Foamed-In-Place Insulation for exterior concrete masonry walls as noted on Drawings

1.2 REFERENCES

A. ASTM: American Society for Testing and Materials

1.3 SUBMITTALS

A. Product data, technical information, and installation instructions

B. Certified test reports showing compliance with specified performance values

C. Submit in accordance with Section 01340

1.4 QUALITY ASSURANCE

A. Provide insulation produced by a single manufacturer

B. Engage an experienced installer who has been trained and licensed by the product manufacturer and which has not less than three years experience in the installation of the product used

C. Provide insulation materials which meet fire performance characteristics listed
1. Fire Resistance Ratings: ASTM E-119
2. Surface Burning Characteristics: ASTM E-84
3. Combustion Characteristics: ASTM E-136

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Core-Fill 500 by Tailored Chemical Products

B. Tripolymer Foam Insulation by C.P. Chemical Co., Inc.

C. Thermco Foam Insulation by Thermal Corp. of America

D. Or accepted substitution

2.2 INSULATING MATERIALS

A. Provide insulating materials which comply with requirements indicated in referenced standards, and other characteristics.

B. Two component thermal insulation produced by combining a plastic resin and catalyst foaming agent which, when properly rationed and mixed, together with compressed air produce a cold-setting rigid foam insulation in the hollow cores of hollow unit masonry walls
   1. Minimum 2 hour fire resistance rating when tested as a wall system
   2. Maximum flame spread, smoke developed, and fuel contributed of 15, 75 and 0 respectively
   3. Minimum “R” Value: 4.7 inches. at 32°F; ASTM C-177
   4. Minimum Sound Transmission Class (“STS”) Rating: 50
   5. Dry Density: 0.7 to 1.3 per cubic feet
   6. Minimum Compressive Strength: 30 pounds per square inch
   7. Maximum Shrinkage: 2%

C. Foam must be a noncombustible, Class A building material, shall be non-corrosive, shall not conduct electricity, shall not absorb water, shall be non-toxic, and shall not contain or emit CFCs

PART 3 EXECUTION

3.1 INSTALLATION

A. Install foamed-in-place insulation prior to installation of interior finish work; comply with manufacturer’s instructions

B. Completely fill all open cells and voids in hollow concrete masonry walls where noted on Drawings

C. Allow foam to cure minimum of 2 weeks before coating or sealing walls

END OF SECTION

SECTION 07531

EPDM ELASTOMERIC MEMBRANE ROOFING

PART 1 GENERAL

1.1 SUMMARY

A. SECTION INCLUDES
1. UL Class A fire rated single-ply EPDM fully adhered membrane roofing and flashing system as shown and herein specified.

1.2 REFERENCES

A. ASTM: American Society for Testing and Materials

1.3 SUBMITTALS

A. Endorsement of Roofing Firm: System Manufacturer's endorsement of the installing firm

B. Shop Drawings:
1. Roof insulation plan
2. Insulation fastener pattern
3. Base flashings
4. Reglets
5. Membrane terminations
6. Roof projection flashings
7. Sheet metal components
8. Counterflashing

C. Samples:
1. Roof insulation: 8 inch x 10, inch 3 pieces
2. Insulation fastener: 3 of each
3. EPDM membrane: 8 inch x 10 inch, 3 pieces
4. Sheet metal components: 4 inch x 4 inch of each type, 3 pieces

D. Product Data:
1. Vapor barrier
2. System Manufacturer's specifications and details for roofing system
3. Roof insulation specifications
4. Sheet metal components

E. Submit in accordance with Section 01340

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. The installing contractor shall be approved or franchised by the roofing system manufacturer and shall have minimum 3 years experience installing the selected system

1.5 DELIVERY, STORAGE, AND HANDLING

A. Per roofing system manufacturer's recommendations

B. Deliver materials requiring fire resistant classifications packaged with labels intact and legible

1.6 WARRANTY

A. Roof shall be warranted for a wind speed (maximum peak gusts) of 90 miles per hour

B. 20 year “No Dollar Limit” complete system Roofing System Manufacturer's Warranty:
   1. The Manufacturer warrants to the Owner that, subject to the provisions of this document, the Manufacturer will, at its own expense, make or cause to be made all repairs necessary to maintain the roofing system in a watertight condition during the 20 year period following the date of Substantial Completion of the roofing system.
      a. System includes:
         i) Vapor barrier
         ii) Insulation
         iii) Membrane
         iv) Flashings
         v) Fasteners and adhesives
         vi) Sheet metal components

PART 2 PRODUCTS

2.1 MATERIALS

A. Provide adhesives, sealants, premolded and field fabricated flashings, fasteners, and other related components manufactured or recommended by the selected system manufacturer.

2.2 ACCEPTABLE ROOFING SYSTEM MANUFACTURERS

A. Carlisle SynTec Systems

B. Firestone Building Products Co.

C. Or accepted substitution

2.3 ACCEPTABLE SYSTEMS

A. Fully adhered minimum 0.060 inch EPDM membrane

1. Carlisle: Design "A"
2. Firestone: Rubbergard

2.4 ROOF INSULATION

A. The Contractor shall select a brand acceptable to the roofing system manufacturer

B. Materials:
1. Rigid, closed-cell, polyisocyanurate insulation
2. Minimum thermal resistance ”R” per inch: 6.0
3. Minimum compressive strength: 20 pounds per square inch

C. Tapered to provide minimum thickness and slopes as shown on the Drawings

2.5 INSULATION FASTENERS

A. Adhesive or mechanical fasteners as recommended by the system manufacturer

2.6 METAL FLASHINGS

A. Counterflashing: Mill Finish aluminum roll formed reglet and counterflashing in configurations shown on the drawings and as recommended by system manufacturer. Provide metal wedge inserts in wall conterflashings. Counterflashing is required over all termination bars.
1. 2-Piece Counterflashing by Metal-Era, 0.040 inch

B. Coping: Kynar 500 Finish galvanized steel, 24 gauge. Face dimension of, and in configuration, shown on the drawings and as recommended by the system manufacturer. Factory Mutual 1-90 approved.
1. Perma-Tite Coping by Metal Era

2.7 OTHER MATERIALS

A. Wood Nailers: Pressure treated

B. Vapor Barrier: Primer and membrane as recommended by the roofing system manufacturer

C. Ancillary Components: System manufacturer’s standard accessory items

PART 3 EXECUTION

3.1 ENVIRONMENTAL CONDITIONS

A. Install roofing only in dry weather

B. Comply with system manufacturer's climatic restrictions

3.2 INSPECTION

A. Examine all surfaces for inadequate anchorage, foreign material, moisture, unevenness, or other conditions which could prevent the best quality and longevity of roofing, flashing, and accessory components. Notify the Engineer of all deficiencies.

B. Do not proceed with the work until all deficiencies have been corrected to the satisfaction of the Engineer and the roofing system manufacturer

3.3 PREPARATION

A. Ensure that all surfaces are clean and dry before starting and during performance of work

B. Verify that all work of other contractors and subcontractors which penetrates the roof deck or requires men and equipment to traverse the roof deck has been completed

3.4 INSTALLATION

A. Install vapor barrier over all roof surfaces and sidewalls as recommended by the roofing system manufacturer

B. Install the roof insulation with end joints staggered at mid-point in each layer. Offset all joints between layers a minimum of six inches.
   1. Install adhesive adhered insulation or mechanical fasteners per system manufacturer's recommendations
   2. At penetrations, cut and fit insulation tightly to penetration
   3. At roof drains, taper insulation to provide sump

C. Install the roofing and flashing system and all accessory items in accord with the system manufacturer's printed instructions

D. Install all field seams using the system manufacturer's seam tape, primers, and cleaners, and in accord with the system manufacturer's recommendations. Minimum seam lap shall be 3 inches

E. Centered over all field seams, apply a minimum 6 inch wide strip of pressure sensitive, self-adhering EPDM

F. Install walkway pads along route shown on Drawings in accordance with system manufacturer’s instructions

3.5 FIELD QUALITY CONTROL

A. The roofing system manufacturer shall provide onsite observation and instruction as they deem necessary

3.6 ADJUST AND CLEAN

A. Carefully inspect all completed work and correct all defects

B. Remove from the job site and legally dispose of all debris

C. Prevent storage of materials and equipment on the completed roof

END OF SECTION

SECTION 07920

JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY

A. Preparation of joint substrates and installation of joint sealants, joint backer materials and accessories needed to ensure a complete and durable weathertight seal at locations indicated.

1.2 REFERENCES

A. ASTM: American Society for Testing and Materials

B. NSF: National Sanitation Foundation

C. USDA: United States Department of Agriculture

1.3 SUBMITTALS

A. Product Data:
   1. Manufacturer's specifications and other data needed to prove compliance with the specified requirements
   2. Manufacturer's recommended installation procedures
   3. Catalog illustrations in sufficient detail to show installation and interface of the Work of this Section with the Work of adjacent trades
   4. Standard color card showing full range of colors available for each product exposed to view

B. Miscellaneous:
   1. Written documentation of applicator's qualifications, including reference projects of similar scope and complexity, with current phone contacts of engineers and owners for verification
   2. Certification from sealant manufacturers that their products are suitable for the use indicated and comply with specification requirements

C. Submit in accordance with Section 01340

1.4 QUALITY ASSURANCE

A. Applicator shall be approved by sealant manufacturer and shall have at least three years of experience in installing materials of types specified and shall have successfully completed at least three projects of similar scope and complexity

B. Obtain joint sealants from single manufacturer for each different product required to ensure compatibility

1. Provide joint sealants, joint fillers and accessory joint materials that are compatible with one another and with joint substrates under Project conditions
2. Provide joint sealants, joint fillers and related joint materials that are nonstaining to visible joint surfaces and surrounding substrate surfaces
3. Manufacturer shall instruct applicator in procedures for intersecting sealants

C. Perform Work in accordance with ASTM C-1193 guidelines except where more stringent requirements are indicated or specified

D. Schedule applications of waterproofing, water repellents, and preservative finishes after sealant installation unless sealant manufacturer approves otherwise in writing. Ensure that installed sealant is allowed to cure sufficiently prior to subsequent applications.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the materials to Site in the manufacturer's unopened containers with all labels intact and legible at time of use

B. Maintain the products in a dry condition during delivery, storage, handling, installation, and concealment

1.6 SUBSTRATE CONDITIONS

A. Surfaces shall be broom clean, dry, sound, and free of voids, bugholes, rockpockets, honeycombs, protrusions, excessive roughness, foreign matter, frost, ice, and other contaminants which may inhibit application or performance of the sealant system

B. Provide joints properly dimensioned to receive the approved sealant system

1.7 WARRANTY

A. Furnish written warranties against adhesive and cohesive failure of the sealant and against infiltration of water and air through the sealed joint for a period of 3 years from date of substantial completion
1. Manufacturer's standard warranty covering materials
2. Installing Subcontractor's standard warranty covering workmanship

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Tremco

B. Sonneborn

C. Pecora

D. Polyspec

E. Or accepted substitution

2.2 SEALANTS

A. The sealant products listed are set as a standard of quality. Sealants of other manufacturers shall meet or exceed the characteristics of the products listed

B. Provide colors selected by Engineer from manufacturer's standard color range

C. Sealant Type B:
   1. For interior and exterior joints in vertical surfaces and non-traffic horizontal surfaces; such as:
      a. Control and expansion joints in concrete unit or brick masonry
      b. Metal panel joints
      c. Joints around frames of doors, windows, louvers, and other similar openings
      d. Under metal thresholds
      e. Joints in sheet metal flashings
      f. Trim or finish joints
   2. Single-component or multi-component, non-sag polyurethane sealant having 25% joint movement capability that is suitable for continuous immersion in water; comply with ASTM C920, Type S or M, Grade NS, Class 25
   3. Acceptable Sealants:
      a. Tremco - Vulkem 116
      b. Tremco – Dymeric 240/240FC

D. Sealant Type C:
   1. For interior and exterior joints in horizontal and sloped traffic surfaces; such as control, expansion, and isolation joints in concrete pavement and sidewalks
   2. Single-component or multi-component polyurethane sealant having a Shore A hardness of not less than 25 or more than 50 and 25% joint movement capability that is suitable for continuous immersion in water; comply with ASTM C920, Type S or M, Grade P or NS, Class 25
   3. Acceptable Sealants:
      a. Tremco - Vulkem 45/245

E. Sealant Type I:
   1. Interior and exterior joints in concrete tanks containing domestic wastewater
   2. Polysulfide sealant having a Shore A hardness of not less than 25 or more than 50 and 25% joint movement capability that is suitable for continuous immersion in water; comply with ASTM C920, Type S or M, Grade NS, Class 25
   3. Joints shall be primed
   4. Acceptable Primer
      a. As recommended by sealant manufacturer
   5. Acceptable Sealants:
      a. Pecora – Synthacalk GC2+
      b. Polyspec – Thiokol 2235M

2.3 ACCESSORIES

A. Joint Cleaner: As recommended by sealant manufacturer for substrates indicated

B. Joint Primer: As recommended by sealant manufacturer for substrates, conditions and exposures indicated

C. Bond Breaker: Polyethylene tape or other adhesive faced tape as recommended by sealant manufacturer to prevent sealant contact where it would be detrimental to sealant performance

D. Joint Backer: Polyethylene foam rod or other compatible non-waxing, non-extruding, non-staining resilient material in dimension 25% to 50% wider than joint width as recommended by sealant manufacturer for substrates, conditions and exposures indicated

E. Masking Tape: Non-staining, non-absorbent tape product compatible with joint sealants and adjacent joint surfaces that is suitable for masking

F. Premolded Joint Filler: Conform to requirements of Section 03300

2.4 2.04 OTHER MATERIALS

A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor and approved by the sealant manufacturer as compatible, subject to the approval of the Engineer

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which Work of this Section will be performed
   1. Verify conformance with manufacturer's requirements
   2. Report unsatisfactory conditions in writing to Engineer
   3. Correct conditions detrimental to timely and proper completion of the Work
   4. Do not proceed until unsatisfactory conditions are corrected

3.2 PREPARATION

A. Prepare surfaces to receive sealants in accordance with sealant manufacturer's instructions and recommendations except where more stringent requirements are indicated

B. Thoroughly clean joint surfaces using cleaners approved by sealant manufacturer whether primers are required or not
   1. Remove all traces of previous sealant and joint backer by mechanical methods, such as by cutting, grinding and wire brushing, in manner not damaging to surrounding surfaces

2. Remove paints from joint surfaces except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer
3. Remove wax, oil, grease, dirt, film residues, temporary protective coatings and other residues by wiping with cleaner recommended for that purpose. Use clean, white, lint-free cloths and change cloths frequently
4. Remove dust by blowing clean with oil-free, compressed air

C. Provide joint backer material to depth required by sealant manufacturer for proper joint design
1. Fit securely by compressing backer material 25% to 50% so no displacement occurs during tooling
2. Avoid stretching or twisting joint backer

D. Provide bond-breaker where indicated or recommended by sealant manufacturer, adhering strictly to the manufacturer's installation requirements

E. Prime joint substrates where required
1. Use and apply primer according to sealant manufacturer's recommendations
2. Confine primers to sealant bond surfaces; do not allow spillage or migration onto adjoining surfaces

F. Taping:
1. Use masking tape where required to prevent sealant or primer contact with adjoining surfaces that would be permanently stained or otherwise damaged by such contact or the cleaning methods required for removal
2. Apply tape so as not to shift readily and remove tape immediately after tooling without disturbing joint seal

G. Premolded Joint Fillers:
1. Where expansion joints having premolded joint fillers are scheduled to be sealed, provide a reservoir to accept the sealant such as by a molded breakaway joint cap or a removable block out
2. Joint fillers that may contact the sealant should not be impregnated with oil, bitumen, non-curing polymers or similar contaminants

3.3 INSTALLATION

A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the Work of this Section

B. Provide the approved sealant system where shown on the Drawings, and in strict accordance with the manufacturer's recommendations as approved by Engineer

C. Install sealants immediately after joint preparation

D. Mix and apply multi-component sealants in accordance with manufacturer's printed instructions

E. Install sealants to fill joints completely from the back, without voids or entrapped air, using proven techniques, proper nozzles and sufficient force that result in sealants directly contacting and fully wetting joint surfaces

F. Install sealants to uniform cross-sectional shapes with depths relative to joint widths that allow optimum sealant movement capability as recommended by sealant manufacturer

G. Tool sealants in manner that forces sealant against back of joint, ensures firm, full contact at joint interfaces and leaves a finish that is smooth, uniform and free of ridges, wrinkles, sags, air pockets and embedded impurities
   1. Dry tooling is preferred; tooling liquids that are non-staining, non-damaging to adjacent surfaces and approved by sealant manufacturer may be used if necessary when care is taken to ensure that the liquid does not contact joint surfaces before the sealant
   2. Provide concave tooled joints unless otherwise indicated to provide flush tooling or recessed tooling
   3. Provide recessed tooled joints where the outer face of substrate is irregular

H. Remove sealant from adjacent surfaces in accordance with sealant and substrate manufacturer's recommendations as work progresses

I. Protect joint sealants from contact with contaminating substances and from damages. Cut out, remove and replace contaminated or damaged sealants, immediately, so that they are without contamination or damage at time of Substantial Completion.

END OF SECTION

SECTION 08120

ALUMINUM DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. SECTION INCLUDES
   1. Exterior aluminum doors.

1.2 REFERENCES

A. ASTM: American Society for Testing and Materials

B. AAMA: American Architectural Manufacture’s Association

1.3 SYSTEM DESCRIPTION

A. Performance Requirements:

   1. Design and fabricate exterior assemblies to comply with requirements for system performance characteristics listed below as demonstrated by testing manufacturer's corresponding stock systems according to test methods designated.
      a. Thermal Movement: Allow for expansion and contraction resulting from ambient temperature range of 120°F.
      b. Wind Loading: Provide capacity to withstand loading indicated below, test in accordance with ASTM E330.
         i) Uniform pressure of 20 pounds per square foot inward and 20 pounds per square foot outward.
      c. Transmission Characteristics of Assemblies: Provide exterior doors with jamb and head frames complying with requirements indicated below for transmission characteristics and test methods.
         i) Air Leakage: Air infiltration/linear foot of perimeter crack of not more than 0.50 cubic feet per minute for single doors and 1.0 cubic feet per minute for pairs of doors per ASTM E283 at pressure differential of 1.567 pounds per square foot.
         ii) Condensation Resistance: Not less than 48 condensation resistance factor per AAMA 1502.7.
         iii) Thermal Transmittance: U-value of not more than 0.93 Btu/ (hour per square foot per °F) per AAMA 1503.1.

1.4 SUBMITTALS

A. Product Data: Manufacturer's specifications, standard details, and installation recommendations for components of aluminum doors and frames required for project

including test reports certifying products have been tested and comply with performance requirements.

B. Shop Drawings: Shop drawings for fabrication and installation of aluminum doors and frames including elevations, detail sections of typical composite members, hardware mounting heights, anchorages, reinforcement, expansion provisions, and glazing. Use same designation as indicated on Drawings.

C. Samples: Samples of each type and color of aluminum finish on 12-inch long sections of extrusions or formed shapes and 6-inch square sheets. Where normal color and texture variations to be expected, include 2 or more units in each set of samples showing limits of such variations.

D. Submit in accordance with Section 01330.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Special Lite, Inc.

B. Kawneer Company, Inc.

C. Cross Aluminum Products

D. Or equal.

2.2 MATERIALS AND ACCESSORIES

A. Aluminum Members: Alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish; ASTM B221 for extrusions, ASTM B209 for sheet/plate.

B. Fasteners: Aluminum, non-magnetic stainless steel, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum components.
   1. Do not use exposed fasteners except where unavoidable. Match finish of adjoining metal.
   2. Provide Phillips flat head machine screws for exposed fasteners.

C. Concealed Flashing: Dead soft stainless steel, 26 gauge minimum or extruded aluminum, 0.062 inch minimum of alloy and type selected by manufacturer for compatibility with other components.

D. Brackets and Reinforcements: Manufacturer's high strength aluminum units where feasible; otherwise, non-magnetic stainless steel or hot dip galvanized steel complying with ASTM A386.

E. Concrete/Masonry Inserts: Cast iron, malleable iron, or hot dip galvanized steel complying with ASTM A386.

F. Bituminous Coatings: Cold applied asphalt mastic.

G. Compression Weatherstripping: Manufacturer's standard replaceable stripping of either molded neoprene gaskets complying with ASTM D2000 or molded PVC gaskets complying with ASTM D2287.

H. Sliding Weatherstripping: Manufacturer's standard replaceable stripping of wool, polypropylene, or nylon woven pile with nylon fabric or aluminum strip backing, complying with AAMA 701.2.

I. Glass and Glazing Materials: Conform to requirements of Section 08800.

2.3 HARDWARE

A. Conform to requirements of Section 08700 unless otherwise noted herein.

B. Astragal: As recommended by manufacturer.

C. Weatherstripping: As recommended by manufacturer.

D. Door Bottom: As recommended by manufacturer.

2.4 FABRICATION

A. General:
1. Sizes and Profiles: Required sizes for door and frame units, including profile requirements, are indicated on Drawings.
2. Prefabrication: Complete fabrication, assembly, finishing, hardware application, and other work before shipment to project site to greatest extent possible. Disassemble components only as necessary for shipment and installation.
3. Preglaze door and frame units to greatest extent possible in coordination with installation and hardware requirements.
4. Do not drill and tap for surface-mounted hardware items until time of installation at Project site.
5. Perform fabrication operations including cutting, fitting, forming, drilling, and grinding of metal work preventing damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.

B. Welding: Comply with AWS recommendations to avoid discoloration. Grind exposed welds smooth and restore mechanical finish.

C. Reinforcing: Install reinforcing as necessary for performance requirements. Separate dissimilar metals with bituminous paint or other separator preventing corrosion.

D. Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.

E. Fasteners: Conceal fasteners wherever possible.

F. Weatherstripping: Provide compression weatherstripping against fixed stops for exterior doors. At other edges, provide sliding weatherstripping retained in adjustable strip mortised into door edge.
   1. Provide EPDM/vinyl blade gasket weatherstripping in bottom door rail, adjustable for contact with threshold.
   2. At interior doors and other locations without weatherstripping, provide neoprene silencers on stops to prevent metal-to-metal contact.

G. Rubber mat at monorail penetrations: 3/8” thick minimum, cut to fit profile of monorail. Anchor to door system as recommended by door manufacturer.

2.5 FRAMING SYSTEM

A. General: Provide inside/outside matched resilient flush glazed system with provisions for glass replacement. Shop fabricate and preassemble frame components where possible.

B. Thermal Break Construction: Fabricate aluminum framing system with integrally concealed, low conductance, thermal barrier located between exterior materials and exposed interior members eliminating direct metal-to-metal contact.

C. Fabricate frames from tubular box type members with four sides closed and min wall thickness of 0.125 inches. Open channel frames not acceptable.

2.6 FLUSH TYPE ALUMINUM DOORS

A. Systems:
   1. Special Lite SL-16 Series
   2. Kawneer Flushline Series
   3. Cross FL-400 Series
   4. Or equal

B. Frame: Provide tubular frame members fabricated with reinforced mechanical or welded joints in accordance with manufacturer's standard fabrication methods. Limit frame exposure to 3/4 inch maximum width on door faces.

C. Core: Fabricate core of resin impregnated kraft paper honeycomb, rigid, closed-cell polyurethane insulation or rigid, noncombustible mineral insulation board.

D. Faces: Fabricate faces of aluminum sheet of 0.064 inches minimum thickness, mechanically interlocked with frame members or laminated to core and framing with waterproof glue to form door thickness of 1-3/4 inch.

2.7 FINISHES

A. Class I Color Anodized Finish: AA-M12C22A42/A44 (non-specular as fabricated mechanical finish; chemical etch, medium matte; 0.7 mil minimum thick integrally or electrolytically deposited colored anodic coating).
   1. Provide color as selected by Architect from within standard industry colors and color density range.

2. Color: Dark Bronze.

B. Apply temporary protective coating of clear acrylic lacquer, complying with AAMA recomendations.

PART 3 EXECUTION

3.1 PREPARATION

A. Field Measurement: Wherever possible, take field measurements prior to preparation of Shop Drawings and fabrication to ensure proper fitting of work.

3.2 INSTALLATION

A. Comply with manufacturer's instructions and recommendations for installation of aluminum doors and frames.

B. Set units plumb, level, and true to line without warp or rack of framing members, doors or panels. Anchor securely in place, separating aluminum and other corrodible metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.

C. Drill and tap frames and doors and apply surface-mounted hardware items complying with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.

D. Set sill members and other members in bed of sealant as indicated or with joint fillers or gaskets as indicated to provide weathertight construction.

3.3 ADJUST AND CLEAN

A. Adjust operating hardware to function properly without binding, preventing tight fit at contact points and weatherstripping.

B. Clean completed system inside and out promptly after erection and installation of glass and sealants. Remove excess glazing and joint sealants, dirt, and other substances from aluminum surfaces.

C. Institute protective measures and other precautions required to ensure aluminum doors and frames will be without damage or deterioration other than normal weathering at time of acceptance.

END OF SECTION

SECTION 08700

DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Hardware for aluminum doors

1.2 RELATED SECTIONS

A. Section 01340 – Shop Drawings, Product Data and Samples

B. Section 01730 – Operation and Maintenance Data

C. Section 08100 – Steel Doors and Frames

D. Section 08331 – Overhead Coiling Doors

1.3 REFERENCES

A. NEMA: National Electrical Manufacture's Association

1.4 QUALITY ASSURANCE

A. Manufacturers: Companies specializing in manufacturing door hardware with minimum three years experience

1.5 SUBMITTALS

A. Submit in accordance with Section 01340

B. Shop Drawings

C. Product Data

1.6 DELIVERY, STORAGE, AND HANDLING

A. Package hardware items individually; label and identify package with door opening code to match hardware schedule

B. Protect hardware from theft by cataloging and storing in secure area

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

1. Entrance Lockset x lever action x stainless steel x US 32D x removable core x Box Strike
   a. L9453 x 03 — Schlage
   b. 8847 x CRE — Yale
   c. ML2048 x LSM — Corbin Russwin
   d. 3853 x William — Hager
2. Dummy Trim Lockset x lever action x stainless steel x US 32D. Do not provide lever on inside face
   a. L9176 x 03 — Schlage
   b. CRE — Yale
   c. LSM — Corbin Russwin
   d. 3827 x William — Hager

B. Hinges x 4-1/2 x 4-1/2 x US 32D
   a. BB 1191 — Hager
   b. FBB 191 — Stanley
   c. BB 4101 — Lawrence

C. Closers x delayed action x AL - size as recommended by manufacturer. Install closers on room side, using parallel arms where necessary
   a. DC6000 Series — Corbin Russwin
   b. 4010 / 4110 Smoothee Series — LCN
   c. 7500 Series — Norton
   d. 5100 Series — Hager

   HO - indicates hold open

D. Kick Plates – 10 inch x 2 inch LDW x US 32D x 16GA
   1. Brookline
   2. Ives
   3. Hiawatha
   4. Rockwood

E. Thresholds - set in sealant 5 inch x 1/2 inch Clear Anodized Aluminum Thermally Broken Saddle x frame width
   1. S282A x AL — Reese
   2. 252 x 3AFG x AL — Pemko
   3. 8425 x AL — National Guard
   4. 421S x AL — Hager

F. Flush Bolts with Dustproof Strike long enough to pass through threshold.
   1. FB458 x 26D — Ives
   2. 0600 x 26D — Baldwin
   3. 555 x 26D — Rockwood
   4. 282D x 26D — Hager

G. Overhead Stop – Hold Open.
   1. 70H x 26D Glynn Johnson

H. Door Bottom – As recommended by door manufacturer

I. Weatherstripping – As recommended by door manufacturer

J. Astragal – As recommended by door manufacturer

2.2 KEYING

A. Key in accordance with schedule provided by Owner

B. Supply 5 keys for each lock

C. Cylinder locks on doors to match existing master keying

2.3 FINISHES

A. Finishes are US 32 satin stainless steel unless otherwise noted. Closer finishes may be paint

PART 3 EXECUTION

3.1 INSPECTION

A. Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings

B. Beginning of installation means acceptance of existing conditions

3.2 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions

B. Use the templates provided by hardware item manufacturer

3.3 HARDWARE SCHEDULE

A. Set No. 5
   1-1/2 PR Butts x NRP
   1 Entrance Lockset
   1 Closer x 110 degrees x HO
   1 Kickplate
   1 Weatherstripping
   1 Door Bottom
   1 Threshold

B. Set No. 9.

4 PR Butts x NRP
1 Entrance Lockset + 1 Dummy Trim Lockset
1 Closer x 110 degrees x HO
1 Overhead Stop
2 Flushbolts (top & bottom)
2 Kickplates
1 Weatherstripping
2 Door Bottoms
1 Threshold
1 Astragal

END OF SECTION

SECTION 09900

PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surface preparation and field application of primer and finish coatings for all new surfaces

1.2 RELATED SECTIONS

A. Section 01080 – Identification Systems

B. Division 11 – Equipment

C. Section 15060 – Pipe and Pipe Fittings

D. Section 16050 – Basic Electrical Materials and Methods

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. D16 – Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products
   2. D2016 – Test Method for Moisture Content of Wood

B. NACE (National Association of Corrosion Engineers)
   1. Industrial Maintenance Painting

C. NPCA (National Paint and Coatings Association)
   1. Guide to U.S. Government Paint Specifications

D. National Science Foundation (NSF) – 61 Drinking Water System Components – Health Effects

E. PDCA (Painting and Decoration Contractors of America)
   1. Painting – Architectural Specifications Manual

F. SSPC (Steel Structures Painting Council)
   1. Steel Structures Painting Manual

1.4 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in the Section

1.5 SUBMITTALS

A. Submit under provisions of Section 01340

B. Product data: Provide data on all finishing products. Clearly identify paint type and intended use as outlined by schedules at the end of this section. Include material safety data sheets (MSDS).

C. Color samples
   1. Furnish color chips or color card for color selection by Owner
   2. Contractor will provide pipe colors in accordance with color Schedule herein

D. Manufacturer's instructions: Indicate special surface preparation procedures, substrate conditions requiring special attention

E. Maintenance data: Provide in Materials and Finishes Manual under provisions of Division 1 specifications

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years experience

B. Applicator: Company specializing in performing the work of this section with minimum three years experience and approved by manufacturer for surface preparation and application of similar coating systems

1.7 REGULATORY REQUIREMENTS

A. Comply with all health and fire regulations of agencies having jurisdiction for storage of materials

B. Comply with current state requirements for air quality control permit and OSHA standards for sandblasting

C. Comply with current state requirements for Volatile Organic Compounds (VOC’s) of less than 3.5 pounds per gallon for all coatings

1.8 PRE-APPLICATION CONFERENCE

A. Coating Manufacturer or Manufacturer’s representative will attend a site coordination meeting to establish specific surface preparation procedures acceptable to Engineer and application and protection procedures of finished surfaces

B. Contractor will coordinate meeting 7 days prior to the start of work in this section

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 01600

B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability. Maintain labels legible and intact.

C. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, Federal specification number, and instructions for mixing and reducing and VOC content

D. Store only acceptable project materials on project site

E. Store coating materials at minimum ambient temperature of 45°F and a maximum of 90°F, in ventilated area, and as required by manufacturer's instructions and acceptable to Engineer

F. Restrict storage area to paint materials and related equipment

1.10 ENVIRONMENTAL REQUIREMENTS

A. Comply with manufacturer's instructions as to environmental conditions under which coatings and coating systems can be applied

B. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the coating manufacturer's instructions and acceptable to Engineer

C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the coating manufacturer's instructions and acceptable to Engineer

D. Do not apply finish in areas where dust is being generated

E. Minimum application temperatures for epoxy paints: 50°F surface temperature for interiors, surface to be dry and at least 5°F above the dew point; 50°F surface temperature for exterior, surface to be dry and at least 5°F above the dew point; unless permitted otherwise by manufacturer's instructions and acceptable to Engineer

F. Relative humidity: 86 percent maximum

G. Maintain temperatures of painted surfaces to effect curing times recommended by paint manufacturer and the product applied

H. Provide lighting level of 80 ft-candles measured mid-height at substrate surface

I. Provide a designated area with adequate spill control for paint storage, mixing, and thinning

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Rust inhibitive Phenolic Aklyd primer: Tnemec Series 37H-77 Chem Prime

B. Rust inhibitive Modified Aromatic primer for polyurethane: Tnemec Series 1 Omnithane

C. Coal tar: Tnemec Series 46-465 H.B. Tnemecol

D. Concrete block filler – two component: Tnemec Series 130 Envirofill

E. Coal tar epoxy: Tnemec Series 46H-413 Hi-Build Tneme-Tar

F. Polyamide epoxy: Tnemec Series 20 Pota-Pox

G. Polyamidoamine epoxy: Tnemec Series N140/V140 Pota-Pox Plus

H. Gloss alkyd enamel: Tnemec Series 2H Hi-Build Tnemec-Gloss

I. Semi-gloss alkyd enamel (acrylic polymer): Tnemec Series 1029 Enduratone

J. Aliphatic Acrylic Polyurethane finish coating: Tnemec Series 1075 Endura-Shield II

K. Field-catalyzed Polyamidoamine epoxy primer and coating: Tnemec Series N69 Hi-Build Epoxoline II

L. Galvanized surface repair where directed by Engineer
   1. ZRC (Zinc Rich Compound) Cold Galvanizing Compound
   2. Tnemec Series 90G-1K97 Tneme-Zinc
   3. Brite Products – Brite Zinc Galvanizing Compound
   4. Or accepted substitution

M. Aluminum paint: Tnemec – Series 43-36 Chrome Aluminum

N. Products manufactured by Tnemec are indicated to establish level of quality. Other manufacturers will be considered

2.2 MATERIALS

A. Use product of single manufacturer for coating systems for each type of surface

B. Use paint compatible with shop coating or primer for field coating of shop painted or primed surfaces

C. Use only mercury-free, fume-proof paint for intermediate and finish coats.

D. Use only lead-free paint or paint that does not cause discoloration in water treatment plant atmosphere

E. NSF 61 certified paint, primer, and thinners to be used if to be in contact with water being treated or potable water

F. Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags

G. Accessory materials: Linseed oil, turpentine, paint thinners, methyl ethyl ketone (MEK), and other materials not specifically indicated but required to achieve the finishes specified, or commercial quality

2.3 FINISHES

A. Refer to schedule at end of section for surface finish schedule

B. Use paint by same manufacturer for successive field coats

C. Field coats to be compatible with shop applied undercoats

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and substrate conditions are ready to receive work as instructed by product manufacturer

B. Examine surfaces scheduled to be finished that will adversely affect execution, permanence, or quality of work and which will not allow preparatory work outlined in preparation of surfaces. Report any condition that may potentially affect proper application prior to commencement of work

C. Do not proceed with surface preparation or coating application until conditions are suitable

D. Test shop-applied primer for compatibility with subsequent cover material

E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
   1. Masonry, concrete, and concrete unit masonry: 8 percent
   2. Concrete floors: 8 percent

3.2 SANDBLASTING PROCEDURES

A. Steel. Structural, pipe, angles, beams, equipment, wall plates, pipe hangers, rods, pipe supports, stairs, platforms, handrails, plus steel accessories
   1. Non-submerged: SSPC-SP6
   2. Submerged or partially submerged (all interior tank surfaces): SSPC-SP10
   3. High temp surfaces to 1200°F: SSPC-SP10

B. Ductile iron, cast iron: Pipe, equipment, fittings, plus miscellaneous items
   1. Non-submerged: SSPC-SP6
   2. Submerged or partially submerged (all interior tank surfaces): SSPC-SP10

C. Mill coated steel pipe
   1. Exterior non-submerged: SSPC-SP6
   2. Exterior submerged or partially submerged: SSPC-SP10

D. Concrete: Floor, wall, channels and troughs
   1. Submerged or partially submerged: SSPC-SP13, to create ICRI CSP-3.

E. Profile of sandblasted surface: 2 mils

F. Do not allow surfaces to become wet after blasting and before painting

G. Apply primer same day as blasting

H. Air free of water and oil

I. Confine sandblast to area being prepared

J. Protect nameplates, valve stems, rotating equipment, motors and other damageable items

K. Do no reuse sand

L. Plug pipe, holes, or openings before sandblasting. Keep covered until sand is removed

3.3 PREPARATION OF SURFACES

A. Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing

B. Correct defects and clean surfaces of new and existing materials

C. Seal with shellac and seal marks which may bleed through surface finishes

D. Impervious surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

E. Aluminum surfaces scheduled for paint finish: Remove surface contamination by steam or high-pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.

F. Insulated coverings: Remove dirt, grease, and oil from canvas and cotton

G. Concrete floors: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.

H. Copper surfaces schedule for a paint finish: Remove contamination by steam, high-pressure water, or solvent washing. Apply vinyl etch primer immediately following cleaning

I. Copper surfaces scheduled for a natural oxidized finish: Remove contamination by applying oxidizing solution of copper acetate and ammonium chloride in acetic acid. Rub on repeatedly for required effect. Once attained, rinse surfaces with clear water and allow to dry.

J. Galvanized surfaces: SSPC-SP1; Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

K. Exterior uncoated steel and iron surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by power tool wire brushing or sandblasting where directed by Engineer; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.

L. Shop-primed steel surfaces: Sand and scrape to remove loose primer and rust by power tool wire brushing or sandblasting where directed by Engineer. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Reprime bare steel surfaces.

3.4 MIXING AND TINTING

A. Deliver paints and enamels ready-mixed to job site

B. Mix only in mixing pails, suitably sized, non-ferrous or oxide metal pans

C. Use tinting colors recommended by manufacturer for specific type of finish

D. Do not add any adulterants or unauthorized thinners

E. Thoroughly mix each time paint is withdrawn from container

F. Keep containers closed tightly except while paint is withdrawn

G. All paint factory mixed

H. Thinning only permitted to obtain recommended coverage at lower application temperatures

I. Complete all mixing, thinning, and cleanup in a designated location with proper spill control. Do not mix paints inside of treatment filter building

3.5 APPLICATION

A. Apply products in accordance with manufacturer’s instructions

B. Do not apply initial coating until moisture content of surface is within moisture limitations recommended by manufacturer’s instructions and acceptable to Engineer

C. Do not apply finishes to surfaces that are not dry. Comply with recommendation of manufacturer for drying time between succeeding coats

D. Apply each coat to uniform finish free of visible brush marks, streaks, laps, and missed areas

E. Vary slightly the color of successive coats. Apply each coat of paint slightly darker than preceding coat unless otherwise approved

F. Apply coating with suitable brushes, rollers, or spraying equipment
   1. Do not exceed rate of application recommended by manufacturer for the type of surface involved
   2. Keep brushes, rollers, and spraying equipment clean, dry, free from contaminants, and suitable for the finish required

G. Sand metal lightly between coats to remove defects, to achieve smooth uniform finish acceptable to Engineer

H. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.

I. Allow applied coat to dry and cure before next coat is applied

J. Provide tie coats where recommended by manufacturer's instructions and acceptable to Engineer

K. Do not apply additional coats until completed coat has been inspected by the Engineer
   1. Only inspected coats of paint will be considered in determining number of coats applied

L. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping

M. Rate of application
   1. Coverage not greater than value recommended by manufacturer's instructions
   2. Use of paint thinner not allowed as a means of extending coverage of paint

N. Refinish whole wall where portion of finish has been damaged or is not acceptable

O. Surfaces to be painted with water-thinned paint: Spot prime exposed nails and other ferrous metals with aluminum paint

P. Remove all dents from doors and frames and apply one coat of finish paint before installing hardware

3.6 PIPING COLOR SCHEDULE

A. Refer to Section 01080 for schedule of pipes and corresponding paint colors.

3.7 FIELD QUALITY CONTROL

A. Comply with inspection and film thickness testing requirements of this section, SSPC-Volume 1, Chapter 6 and SSPC-PA 2. Provide results under provisions of Section 01400.

B. General inspection sequence as follows:

1. Pre-surface preparation observation
2. Measurement of ambient conditions
3. Evaluation of compressor (air cleanliness) and surface preparation equipment
4. Determination of surface preparation cleanliness and profile
5. Review of application equipment
6. Witnessing of coating mixing
7. Observing coating application
8. Determination of wet film thickness (non-metallic substrates)
9. Determination of dry film thickness (metallic or non-ferrous metal substrates)
10. Pinhole and holiday testing of shop coatings as required
11. Adhesion testing as required
12. Evaluation cure

C. Wet film thickness (WFT) testing:
1. Standard "notch" configuration or circular dial gauges
2. Use for concrete, wood or other non-metallic substrates
3. Determine dry film thickness per the following:

$$\text{WFT} = \frac{\text{specified dry film thickness}}{\text{\% solids by volume}}$$

4. Decrease % solids by volume if coating is thinned per the following:

$$\text{WFT} = \frac{\text{specified dry film thickness}}{\text{\% solids by volume / (100\% + \% thinner added)}}$$

5. Calibrate gauge per manufacturer's instructions acceptable to Engineer

D. Dry film thickness (DFT) testing:
1. Type 1: Magnetic pull-off type gauge
2. Type 2: Fixed probe magnetic flux gauge with microprocessor
3. Calibrate gauge per manufacturer's instructions and SSPC-PA 2 acceptable to Engineer
4. Use eddy current type gauge or probe attachment for non-ferrous metal substrates
5. Gauge accuracy: $\pm$ 10%

E. Number of measurements and minimum thickness in accordance with SSPC-PA 2:
1. Make five (5) separate spot measurements (average three readings for each spot measurement) spaced evenly over each 100 square feet (9 square meters) of area to be measured
2. The average of five spot measurements for each such 100 square foot area shall not be less than the specified thickness
3. No single spot measurement in any 100 square foot area shall be less than 80% of the specified thickness
4. Any one of three readings which are averaged to produce each spot measurement may under-run by a greater amount
5. The five spot measurements shall be made for each 100 square feet of area as follows:

a. For structures not exceeding 300 square feet in area, each 100 square foot area shall be measured
b. For structures not exceeding 1,000 square feet in area, three 100 square foot areas shall be randomly selected and measured
c. For structures exceeding 1,000 square feet in area, the first 1,000 square feel shall be measured as stated above and for each additional 1,000 square feel of area or increment thereof, one 100 square foot area shall be randomly selected and measured

6. If the dry film thickness for any 100 square foot area is not in compliance with the requirements above, then each 100 square foot area shall be measured. Contractor shall reimburse Owner for additional time required to inspect each 100 square foot area in addition to the above spot measurement requirements. An additional coat may be applied in lieu of additional testing.

F. Other size areas or number of spot measurements may be adjusted as appropriate for the size and shape of the structure to be measured as determined by the Engineer

3.8 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Paint shop-primed equipment

B. Paint exposed conduit and electrical equipment occurring in finished office areas

3.9 CLEANING

A. Collect waste material which may constitute a fire hazard, place in close metal containers and remove daily from site.

B. Remove spilled or splattered paint from all finished surfaces

C. Do not mar or scratch surface finish of items being cleaned

3.10 PROTECTION OF FINISHED WORK

A. Use drop cloths, masking tape, and other measures to protect all surfaces from accidental spraying, spattering, or spilling of paint

B. Prepare surface and re-coat surfaces damaged during delivery and installation or by construction activity

C. Repair all damage caused by coating other items of work
1. Immediately remove paint deposited on surfaces not to be coated

D. Protect galvanized steel finishes. Repair damages surfaces as follows:
1. Power tool clean foreign matter, rust, slag residue, weld splatter from both damaged and contiguous undamaged area
2. Clean with phosphoric acid base
3. Brush apply two coats of cold galvanizing compound and overlap at least two inches onto contiguous undamaged area

3.11 SURFACES NOT TO BE PAINTED

A. Except as otherwise required or directed, do not paint the following surfaces:
   1. Any PVC piping and conduit
   2. Exposed surfaces of aluminum, except where in contact with concrete
   3. Polished or finished stainless steels. Unfinished or dull stainless steel shall be painted.
   4. Nickel or chromium
   5. Exposed galvanized surfaces, except submerged or buried piping, structural conduit, duct work, and other items specifically noted
   6. Rubber and plastics that flex
   7. Copper instrument or pressure gauge tubing
   8. Surfaces specified to be factory finished only

3.12 PIPING AND ACCESSORIES

A. Provide painted stenciled lettering (3-inch height, typical) and flow arrows on painted piping. Where PVC piping is exposed in buildings, provide stick-on labels (white background, black letters, 3-inch letter height, typical) to indicate service type and flow direction.

B. Coat all exposed piping and piping in accessible place in accordance with color schedule listed above

C. Coat any piping not scheduled to be color-coded according to the Ten State Standards with concurrence by the Engineer, include appropriate identification and flow direction arrows

D. Locate lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floor where pipe passes through, at each branch or tee and at intervals of approximately 25 feet in straight runs of pipe acceptable to Engineer

E. Provide metal tags instead of lettering for all pipes with outside diameter or pipe covering diameter 1-inch or smaller. Tags are to be of stainless steel or aluminum with identifying lettering stamped in and fastened to pipe with suitable chains

3.13 FINISH SCHEDULE – METAL SURFACES

A. All non-submerged surfaces of structural and miscellaneous steel exposed in interior locations including conduit, doors and frames, and supports. This includes all DIP and welded steel piping in the main filter building and backwash basin. All pumps and valves will be factory coated as well as field coated.
   1. Primer: One coat epoxy primer – 3 mils
   2. Second Coat: Once coat epoxy – 4 mils
   3. Finish: One coat polyurethane – 4 mils
   4. Total dry film thickness: 8 mils

B. All non-submerged surfaces of structural and miscellaneous steel exposed in exterior locations including conduit, doors, and frames.
   1. Primer: One coat epoxy primer – 3 mils

2. Finish: One coat polyurethane – 4 mils
3. Total dry film thickness: 7 mils

C. All submerged surfaces of structural and miscellaneous steel
1. Primer: One coat epoxy primer – 3 mils
2. Second Coat: One coat epoxy (white) – 4 mils
3. Finish: One coat epoxy – 4 mils
4. Total dry film thickness: 11 mils

D. All buried, submerged or partially submerged and exposed surfaces, including surface valves, stop gates, supports, fittings, flanges and bolts unless indicated otherwise
1. Primer: One coat coal tar epoxy – 10 mils
2. Finish: One coat coal tar epoxy – 10 mils
3. Total dry film thickness: 20 mils

E. All exposed surfaces of electrical conduit inside building office and control room spaces, including fittings, boxes, supports, and accessories, except banks of conduits in multiple layers hung from ceilings (within drop ceilings, non-exposed) in non-process areas
1. Primer: One coat rust inhibitive primer – 3 mils
2. Finish: Two coats semi-gloss alkyd enamel – 6 mils
3. Total dry film thickness: 9 mils

F. Miscellaneous castings, including manhole rings and covers
1. Primer: One coat coal tar or coal tar epoxy – 10 mils
2. Finish: One coat coal tar or coal tar epoxy – 10 mils
3. Total dry film thickness: 20 mils

3.14 FINISH SCHEDULE – CONCRETE SURFACES

A. All interior and exterior concrete floors and slab surfaces
1. Concrete sealer

B. All exterior, exposed, non-submerged, concrete surfaces
1. Grout rub – Section 03000

3.15 FINISH SCHEDULE – OTHER MISCELLANEOUS SURFACES

A. PVC – Do not paint. See Section 3.11 and 3.12 for special conditions

END OF SECTION

SECTION 09910

STRUCTURAL COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Coating of surfaces as noted on the Drawings and as specified herein, including:
   1. New surfaces described in Finish Schedules and notes on Drawings
   2. Interior masonry wall surfaces
   3. Exposed underside of precast concrete roof members
   4. Exposed interior and exterior ferrous metal, ductile iron, or cast iron piping, regardless of factory-applied finish
   5. Exposed interior and exterior structural steel surfaces
   6. Exterior and interior equipment, pumps, valves, motors, etc. and all appurtenances
   7. Concrete tank and channel surfaces only where noted on drawings
   8. Copper piping and galvanized steel piping and conduit mounted to painted surfaces
   9. Steel doors and frames

B. Labeling and directional arrows on piping, equipment, valves, and ducts whether coated or not coated is specified in Section 01080 – Identification Systems

C. Do not coat the following unless specifically noted otherwise:
   1. Factory-finished electrical motor control panels (MCC), main instrument panels (MIP), flow indicators, and related equipment
   2. Moving parts of operating units, electrical parts, linkages, sensing devices, and motor shafts
   3. Buried equipment and piping
   4. Surfaces above ceilings
   5. Factory-finished trim
   6. Stainless steel, chrome plate, copper, bronze, galvanized surfaces, and similar finished materials
   7. Aluminum ductwork or aluminum faced insulation
   8. Aluminum louvers and trim
   9. Concrete tanks
   10. Plastic and FRP piping, equipment, and ductwork

D. Do not coat over any code-required labels such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates

E. Equipment manufacturers are responsible for surface preparation and coating of equipment, motors, and appurtenances. Equipment to be coated and coating system is identified in the equipment specification sections.

1.2 DEFINITIONS

A. Definitions as used in Coating Schedule included herein

1. Coatings: Paint or heavy duty finishes for use on surfaces subject to interior and exterior exposure, submergence, high moisture, splash, or chemical environment, including primers, sealers, fillers, and intermediate and finished coats
2. Submerged P: Surfaces submerged in potable water plus 1 foot-6 inches above high water level
3. Submerged NP: Surfaces submerged in non-potable liquid plus 1 foot-6inches above high liquid level
4. First Coat: Field primer, factory primer, or shop primer. When only one coat is required, first coat is the finished coat
5. Second, Third, or Intermediate Coats: Successive finished coats applied over first coat
6. DFT: Dry film thickness (mils/coat)
7. sfpg: Square feet per gallon (per coat)

1.3 REFERENCES

A. MSDS: Material Safety Data Sheets

B. ASTM: American Society for Testing and Materials

C. SSPC: The Society for Protective Coatings

D. OSHA: Occupational Safety and Health Administration

E. NSF: National Sanitation Foundation

1.4 SUBMITTALS

A. Product Data:
   1. Manufacturer's literature including application recommendations and generic makeup for each coating scheduled
   2. Factory or shop-applied primer manufacturer's literature including application recommendations and generic makeup shall be submitted with all material and equipment submittals. All primers shall conform to the requirements of this Section.

B. Samples:
   1. Actual color samples available for each coating scheduled

C. Miscellaneous:
   1. Schedules:
      a. Schedule of proposed coating systems within 60 days after Notice to Proceed
      b. Schedule of proposed coating systems shall contain all information as indicated in Coating Schedule included herein
   2. Submit one copy of manufacturer's MSDS, for each type of coating, to Engineer's field office for information. Contractor shall post copy of MSDS on Site at all times coating is in progress.

D. Submit in accordance with Section 01340

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. All coatings shall conform to OSHA requirements for allowable exposure to lead and other hazardous substances
   2. All coatings in contact with potable water or within potable water reservoirs shall be NSF 61 approved

B. Applicator Qualifications:
   1. Engage an experienced field applicator with a minimum of 5 yrs successful experience and who has successfully completed coating system applications similar in material and extent to those indicated

C. Single-Scource Responsibility:
   1. Provide coating material produced by same manufacturer for each system

1.6 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered to site in original containers with labels intact and seals unbroken

B. Protect and heat or cool material storage location to maintain temperature ranges recommended by coating manufacturers, but not less than 55° F

C. Avoid danger of fire. Oily rags and waste must be removed from buildings each night or kept in appropriate metal containers. Provide fire extinguishers of type recommended by coating manufacturer's in areas of storage and where finishing is occurring. Allow no smoking or open containers of solvent.

D. Empty containers shall have labels canceled and clearly marked as to use

1.7 PROJECT / SITE CONDITIONS

A. Environmental Requirements:
   1. Dry-heat and ventilate areas to obtain conditions recommended by coating manufacturer
   2. Relative humidity conditions as specified by coating manufacturer shall be adhered to
   3. No unprotected, unheated exterior coating shall be undertaken when cold, damp, foggy, or rainy weather appears probable, nor when the temperature of the substrate is below 55° F, unless approved in writing by coating manufacturer
   4. Maintain manufacturer's environmental requirements until coating is fully cured
   5. Apply no coating in areas where dust is being generated
   6. Testing and disposal of any waste and coating shall be the responsibility of the Contactor

B. Protection:
   1. Drop cloths shall be provided in all areas where coating is done to fully protect other surfaces

2. Remove hardware, accessories, plates, lighting fixtures, and similar items or provide protection by masking. Upon completion, replace items or remove protection and clean

C. It is the intent of this Section that all ferrous metal items scheduled for coating be shop-primed. If items are not shop-primed, surfaces shall be prepared and coated in the field as specified

D. Upon Substantial Completion, remaining unused material will become property of Owner. Seal material as required for storage, mark contents with color, type, location, and shelf life, and store on Site where required by Owner. Provide minimum of two gallons of each system component and color used.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Tnemec

B. Or accepted substitution

2.2 MATERIALS

A. Coatings shall meet surface burning characteristics as required by code and established by ASTM E84

B. Coating products of Tnemec, listed in the Coating Schedule, are set as a standard of quality. Coatings of substitute manufacturers shall meet or exceed the characteristics of the products listed as established by the following ASTM standards; B117, C307, C413, C579, C580, C868, D870, D1014, D1653, D2047, D2240, D2370, D2794, D3363, D4060, D4141, D4541, D4585, D4587, and G85.

C. The Contractor and top coat coating manufacturer shall verify the compatibility of their products with the various primers used on shop primed materials and equipment

2.3 COLORS

A. Color shall be formed of pigments free of lead, lead compounds, or other materials which might be affected by presence of hydrogen sulfide or other gases likely to be present at Site

B. Colors shall be as selected by Owner.

C. Coat access doors of electrical distribution panels and grilles to match color of adjacent wall or ceiling surfaces

D. In areas scheduled for finishing, coat exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding

E. In areas where existing surfaces are finished, coat new exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding

F. Equipment Colors:
   1. Equipment includes pumps, blowers, valves, flow meters, etc, and associated motors, structural supports, hangers, and attached portions of electrical conduit, and other associated components
   2. Color of non-submerged equipment, including equipment with a manufacturer-applied finish coat, shall be same color as piping equipment serves; see Section 01080
   3. Color of submerged equipment can be manufacturer's standard color

2.4 THINNING, MIXING, AND TINTING

A. Where thinning is necessary, only the products of the manufacturer furnishing the coating will be allowed. All such thinning shall be done in strict accordance with coating manufacturer's recommendations.

B. Mix in accordance with manufacturer's recommendations

C. Each coat shall be slightly darker than preceding coat, unless otherwise noted. Tint undercoats similar to finish coat.

PART 3 PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions under which Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Materials removed and replaced to correct defects due to Work placed on unsuitable surfaces shall be at Contractor's expense.

3.2 SURFACE PREPARATION
   1. General:

B. All surfaces to be coated shall be prepared as specified herein and in accordance with coating manufacturer's recommendations. The object shall be to obtain a uniform, clean, and dry surface.

C. Quality of surface preparation described herein is considered a minimum. If coating manufacturer requires a higher degree of preparation, comply with coating manufacturer's recommendations.

D. Where surface dryness is questioned, test with dampness indicating instrument. Do not apply coatings over surfaces where moisture content exceeds that permitted by coating manufacturer.

E. Shop primed surfaces shall be scarified before applying top coats. Conform to top coat manufacturers recommendations.

F. If recoat time between application of primer and second coat or between top coats is exceeded, scarify surface before applying coatings. Conform to top coat manufacturers recommendations.

G. Workmanship for surface preparation shall conform to the following SSPC specifications:
   a. Solvent Clean: SP-1
   b. Hand Tool Cleaning: SP-2
   c. Power Tool Cleaning: SP-3
   d. White Metal Blast Cleaning: SP-5
   e. Commercial Blast Cleaning: SP-6
   f. Brush-Off Blast Cleaning: SP-7
   g. Pickling: SP-8
   h. Near-White Blast Cleaning: SP-10
   i. Power Tool Cleaning to Bare Metal: SP-11
   j. Surface Preparation by Water Jetting: SP-12
   k. Surface Preparation of Concrete: SP-13
   l. Industrial Blast Cleaning: SP-14
   m. Commercial Grade Power Tool Cleaning: SP-15
   n. Brush-Off Blast Cleaning of Non-Ferris Metals: SP-16

H. Ferrous Metal:
   1. Ferrous metal primed in the shop shall have all rust, dust, scale, and other foreign substances removed by abrasive cleaning conforming to SSPC SP-10. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent new rusting.
   2. Ferrous metal not primed in the shop shall be abrasive blast cleaned in the field prior to application of primer, pretreatment, or coating. Blast cleaning shall conform to SSPC SP-10 for submerged service. Blast cleaning shall conform to SSPC SP-6 for non-submerged service.
   3. Prior to finish coating, primed areas that are damaged shall be cleaned and spot primed

I. Concrete:
   1. Concrete must be at least 28 days old and shall pass the overnight visqueen test for dryness before applying coating
   2. Remove fins and other protrusions by grinding
   3. Repair surface defects/voids as recommended by coating manufacturer
   4. Concrete surfaces, including precast concrete, to be coated shall be cleaned of all form oil, curing compound, laitenance, and other foreign substances
   5. Surfaces shall be brush-off abrasive blast cleaned in accordance with SSPC-SP13/NACE 6 Surface Preparation of Concrete in order to remove laitance and efflorescence and to prepare the surface for adherence of the coating system. Acid etching will be allowed only where brush blasting is impractical. The following surface profiles are required:

      a. System No. 5– ICRI CSP2-4
      b. System No. 29– ICRI CSP3-5

6. After cleaning, surfaces shall be washed and all dust, sand, and loose particles removed by vacuuming. If Contactor elects to blow off the surfaces with air, it shall be oil-free air and the method shall conform to OSHA requirements.
7. Verify that pH of cleaned concrete surfaces to be coated is within range of 9 to 11. Application of coating materials outside this range will not be permitted without written approval from Engineer.

J. Masonry:
1. All masonry shall be aged a minimum of 28 days before application of coatings
2. Remove loose grit and mortar
3. Remove grease, oil, dirt, salts, or other chemicals, or other foreign substances by solvent, detergent, or other suitable cleaning methods

3.3 APPLICATION

A. Surfaces shall be dry at time of application

B. The minimum surface temperature shall be 55°F and rising. Some coatings are modified so that they may be applied at lower temperatures, conform to manufacturer's recommendations.

C. Apply in strict accordance with manufacturer's recommendations by brush, roller, spray, or other application method. The number of coats and thickness required is the same regardless of application method.

D. Each coat shall be allowed to dry in accordance with manufacturer's requirements. Drying time shall be construed to mean "under normal conditions". Where conditions other than normal exist, because of weather or because of confined space, longer times will be necessary. Units shall not be put in service until coatings are thoroughly dry and cured.

E. Surfaces to be coated that will be inaccessible in the completed work shall receive the final coat before enclosure

F. Coatings shall be applied to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable. Areas cut-in by brush prior to rolling shall have uniform appearance in comparison with adjoining surfaces.

G. Make edges of coating adjoining other materials or colors sharp and clean without overlapping

H. Concrete block walls shall be back-rolled in conjunction with application of sprayed prime coat

I. Crevices and other hard-to-apply areas shall be back-rolled/back-brushed in conjunction with application of field applied prime coat or intermediate coat. This includes, but is not limited to: between pipe flanges, pipe flange/barrel joints, equipment fittings, and other narrow openings.

J. Finish edges of doors as specified for faces. Apply first finish coat on edges before fitting. After doors fitted and hung apply second finish coat.

K. Manufacturer-Applied Coatings:
   1. Repair abraded areas on factory-finished items in accordance with equipment manufacturer's recommendations
   2. Blend repaired areas into original finish

3.4 FIELD QUALITY CONTROL

A. Examination of Work on Site by coating manufacturer's representative shall be performed when requested by Engineer

B. Sampling of Materials:
   1. Engineer reserves the right to select unopened containers of materials furnished for the Project and have the materials tested at an independent laboratory. Owner will pay for first tests.
   2. Retests of rejected materials and tests of replacement materials shall be paid for by Contractor
   3. Remainder of contents of containers not required for testing will be returned to Contractor

C. Coverage:
   1. 1. Before beginning Work, finish one complete room, space, surface, and item of each color scheme required, showing selected colors, finished texture, material, and workmanship. After approval, sample room, space, surface, and item shall serve as standard for similar Work.
   2. 2. If coverage is not acceptable to Engineer, Engineer reserves the right to require additional application of coating at no extra cost to Owner

D. Where coatings are to be applied at the Site, Engineer reserves the right to observe the Work. After surface has been prepared and before application of specified prime coat and each succeeding finish coat, Contractor shall provide three days notice to Engineer to allow the Engineer time to observe the Work. If notification is not provided, no credit for applied coat will be given and Contractor automatically assumes responsibility to recoat Work in question. Surfaces coated without notification shall be abrasive blast cleaned, re-prepared, and recoated at no addition cost to Owner.

3.5 FINAL TOUCH-UP AND CLEANING

A. Prior to Substantial completion, examine coated surfaces and retouch or refinish surfaces to leave in condition acceptable to Engineer

B. Remove masking, coatings, and other material from floors, glass, and other surfaces not scheduled to be coated

3.6 COATING SCHEDULE

A. Scheduled thickness or coverage rate is minimum as recommended by Tnemec. If other manufacturer is used, manufacturer's recommendations shall be followed, but in no case shall the thickness or coverage rate be less than scheduled.

B. Coatings shall conform to the following schedule and coating manufacturer's recommendations. Examples of surfaces to be coated may not be all inclusive.

COATINGS SCHEDULE

System No.	Generic Type	Application	Coating
1	Polyamidoamine Epoxy	Interior Concrete Block Walls / Satin	First Coat – Series N69 @ 90 sfpg, sprayed and backrolled Second Coat – Series N69 @ 130 sfpg Third Coat – Series N69 @ 140 sfpg
5	Polyamidoamine Epoxy	Exposed Concrete Ceilings / Satin	First Coat – Series N69, thinned 10%, @ 100 sfpg Second Coat – Series N69 @ 160 sfpg
7	Modified Aromatic Polyurethane - Polyamidoamine Epoxy	Ferrous Metal, Cast Iron, Ductile Iron / Submerged NP / Satin	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series N69 @ 5 mils DFT Third Coat – Series N69 @ 5 mils DFT
7 ALT	Modified Aromatic Polyurethane - Hydrophobic Aromatic Moisture-Cured Polyurethane	Ferrous Metal, Cast Iron, Ductile Iron / Submerged NP	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series 446 @ 7-9 mils DFT Third Coat – Series 446 @ 7-9 mils DFT
8	Modified Aromatic Polyurethane - Polyamidoamine Epoxy	Ferrous Metal, Cast Iron, Ductile Iron / Interior Non-Submerged / Satin	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series N69 @ 5 mils DFT Third Coat – Series N69 @ 5 mils DFT
10	Polyamide Epoxy – Polyamidoamine Epoxy	Doors, Frames, Motors and other Equipment with Non-Epoxy Primer / Interior / Satin	Lightly Hand Sand Solvent Clean SP-1 First Coat – Series 27-1255 Beige @ 3 mils DFT Second Coat – Series N69 @ 5 mils DFT
11	Polyamide Epoxy – Aliphatic Acrylic Polyurethane	Doors, Frames, Motors and other Equipment with Non-Epoxy Primer / Exterior / Gloss	Lightly Hand Sand Solvent Clean SP-1 First Coat – Series 27-1255 Beige @ 3 mils DFT Second Coat – Series 1074 @ 3 mils DFT
20	Polyamide Epoxy Coal Tar	Dissimilar Metal Protection / Semi-Gloss	Scarify the Surface, SP-1 First Coat – Series 46H-413 @ 20 mils DFT

Foot Notes:

1. Where an Alternative System No. (ALT) is noted the Contractor may substitute the ALT system when approved by the Engineer. If the ALT system is used, it shall be used for all work covered by that system.
2. Series N69 may be substituted for Series 1

END OF SECTION

SECTION 11273

MECHANICAL COURSE SCREEN AND WASHING COMPACTOR

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

1.2 DESCRIPTION

A. Scope: This section of the specifications covers the labor, materials, equipment and installation necessary to install one (1) course screen and one (1) washing compactor as shown on the Drawings and as specified herein. The course screen shall not operate on a continuous basis. The screen controls shall enable the screen to be operated based on the differential between the water levels upstream and downstream of the screen. Ultrasonic level detectors shall be located upstream and downstream of the step screen to monitor water levels in the channel and initiate an operating cycle through the PLC. Items of equipment include
   1. Course screen
   2. Course screen controls
   3. Washing compactor
   4. Washing compactor controls

B. All equipment items shall be provided by a single supplier to insure a complete working system.

C. All materials of construction for the course screen shall be corrosion resistant.

1.3 QUALITY ASSURANCE

A. The fine screen shall be furnished by a single manufacturer fully experienced in the manufacturer of the equipment to be furnished. The fine screen manufacturer shall have a minimum of 10 years of experience in the design and manufacturer of the automatic bar type fine screens.

B. All welding in the factory shall use shielded arc, inert gas, MIG or TIG method. Filler wire shall be added to all welds to provide for a cross section equal to or greater than the parent metal. Butt welds shall fully penetrate to the interior surface and gas shielding to interior and exterior of the joint shall be provided.

C. Bolts, nuts and washers shall be selected from AISI 304L or 316L stainless steel such that they are anti-seizing.

D. All welding is performed in accordance with American Welding Society (AWS) D1.1 Structural Welding Code, or equivalent.

E. Manufacturer shall provide screen, wash press, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

F. The contract documents provide details of a complete equipment installation for the purpose specified. It shall be the responsibility of the Contractor to coordinate all the details required for a complete operating system, such as screen, wash press, motors, gear reducers, controls, control panels, lifting attachments, protective coatings, piping, and wiring. The Contractor shall provide for all work required properly installing, adjusting, and placing into operation a complete working system.

G. Washed and Dewatered Screenings Quality: Screenings hall be capable of passing the US Environmental Protection Agency Paint Filter Test (EPA SW-846/9095) for disposal in a municipal landfill.

1.4 SUBMITTALS

A. Information required for approval by the Engineer prior to incorporation into the project shall include the following as a minimum requirement:
   1. Certified dimension prints detailing all required concrete block-outs, anchor bolt locations and conduit stub-outs.
   2. Product data including descriptive literature, motor characteristics, performance information, cut-sheets, gear reducer data including service factor, efficiency, torque rating, and materials, parts list including a list of recommended spare parts.
   3. Manufacturer's installation drawings and warranty information
   4. Specifications for all electrical and mechanical components and complete wiring diagrams for all the automatic functions.
   5. Equipment weights and lifting points.
   6. Manufacturer's recommended procedures for jobsite storage and handling of equipment.
   7. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001 and Environmental Protection Management System according to ISO 14001.
   8. A complete bill of materials of all equipment.
   9. Compliance Statement: With each submittal, include a Compliance Statement listing each Specification Section and Part 1, 2, and 3 Sub-Sections, stating paragraph-paragraph, compliance with the Specifications, each minor nonconformity that is within the intent of the Specification and proposed nonconformities. Provide short descriptions of minor nonconformities, and detailed explanation and drawings of other nonconformities.

B. Operation and Maintenance Manuals: Prior to delivery of equipment and updated as required during installation of the equipment, the manufacturer shall furnish complete

and detailed installation, operation and maintenance manuals which shall include the following as a minimum requirement:

1. Assembly, installation and adjustment instructions.
2. Maintenance instructions.
3. Complete descriptive literature of all materials and components furnished.
4. Erection drawings with equipment mark numbers.

1.5 WARRANTY

A. The manufacturer shall warrant the fine screens and other associated manufacturer supplied equipment against defects in material or workmanship for a period of two (2) years from the date of substantial completion.

1.6 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT

A. All equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.

B. The contractor shall be responsible for unloading of the machinery and shall have equipment on-site available at the time of delivery permitting proper hoisting of the equipment.

PART 2 PRODUCTS

2.1 SCREEN & WASHER COMPACTOR

A. The equipment basis of design is the Triden Screen and Washing Compactor as provided by Hydro-Dyne Engineering, Inc., Clearwater, FL.

B. Other Acceptable Manufacturers:
   1. Huber
   2. Vulcan
   3. IDI
   4. Duperon

C. If equipment other than the basis of design is used and it requires arrangement differing from that specified, prepare and submit for review complete structural, mechanical, and electrical drawings and equipment lists showing all necessary changes and embodying all special features of equipment proposed. Any changes are at no additional cost to the Owner. All additional costs are the responsibility of the Contractor and/or Manufacturer, if necessary.

2.2 COURSE SCREEN DESIGN

A. Site Conditions:

1. Installation Location: Indoor
2. Minimum Temperature: 40ºF
3. Area Hazardous Classification: Class 1 Division 2
4. Channel Width: 2’-0”
5. Channel Depth: 7’-0”

B. Design Data (System Performance) - The screening system will be designed to meet the following design parameters:

1. Number of screens: 1
2. Peak flow per screen: 8.4 MGD
3. Average flow to screen: 2.1 MGD
4. Screen grid opening: 1 inch (25 mm)
5. Head loss at peak flow: 7 inches @ 30% blinding
6. Structural design differential of frame/grid: 48 inches minimum @ 100% blinding
7. Drive design differential (operating): 48 inches minimum
8. Screen discharge height above top channel: 31 inches
9. Number of Washing Compactors: 1
10. Diameter of screw: 8 inches
11. Diameter of shaft: 2.375 inches
12. Compactor discharge height above grade: 117 inches
13. System wash water requirements: 14 GPM @ 40 PSI

C. System Description

1. The screen will have a continuous stainless steel belt that automatically rotates within the internal guide system of the static frame.

2. The screen herein specified will be of the straight through type that will present a clean screening grid to the influent flow at all times.

3. The solids will collect as a mat on the front face of the continuous belt. The belt will intermittently rotate and elevate the solids to the discharge point. Larger objects will be picked up by a series of hooks.

4. The solids will be automatically removed at the top of the screen into an internal hopper and be fed to the screening handling system.

5. The continuous belt will be directly driven by drive sprockets that shall support and rotate the grid assembly.

6. The screen will be totally enclosed and have access covers that will be lightweight and easily removable for maintenance.

7. The Washing Compactor will sit under the discharge point of the coarse screens.

8. The Washing Compactor will be adequately sized to handle all the screenings and wash water that will be generated by the screen at peak flow. The system will be required to wash the screenings to reduce the organic content and compact the remaining solids into a dry plug.

9. The Washing Compactor will generally comprise of a screw auger rotating within the washing and drainage trough, a wash water system, a compaction zone and an outlet chute arrangement.

10. All stainless steel (including frame, grid, and drive components) mentioned below as stainless steel shall be T304 stainless steel. All hardware shall be T316 stainless steel.

2.3 COURSE SCREEN DESIGN SPECIFICATIONS

A. Laced Link Grid - The Continuous Screening Belt

1. The screenings belt will consist of heavy duty stainless steel laced links connected in parallel and separated by Delrin spacers to maintain specified opening. Each laced link hook element shall be fabricated from 10 gauge (minimum) stainless steel. Each straight element shall be fabricated from 12 gauge (minimum) stainless steel. All elements shall be a minimum of 1 inch wide forming a slotted opening of the specified width and minimum 1 inch deep in the direction of flow. Hooks on elements shall form horizontal lifting trays or shelves for removing large solids and rags every 8 inches.

2. Links, hooks and screening lifting members must be manufactured out of stainless steel. Plastic is not acceptable.

3. The stainless steel laced links will be connected by heavy duty stainless steel axles every 8 inches to form a continuous belt that will rotate within the frame's guide system. The axle design will allow the row of laced links to pivot. The links shall support the screening grid and bear tension loads across the entire width and length of the screen belt.

4. The axles will be extended to fix a UHMWPE guide link to the side of each row of laced link elements. These guides will interlock to create a continuous guide link system that will slide within the frame.

5. The heavy duty guide links will be minimum 2 inches thick to protect against undue wear from grit and will be specially machined to form a closure seal between the rotating belt and the static frame.

6. The seal shall be continuous from grade level through the water flow forming an uninterrupted closure between the traveling screen grid and the stationary frame. The seal shall be fixed to the screen frame and be adjustable so that it will remain in contact with the rotating screen belt at all times.

7. Guide systems that use rollers, stainless or hardened steel chains will not be acceptable.

8. Grid sealing systems that use neoprene seals or stainless steel hinges will not be acceptable.

9. Grid to frame sealing systems that use adjustable UHMWPE strips attached to the frame will not be acceptable.

10. The bottom of the grid shall be sealed with a replaceable front lower seal brush with a stainless steel holder and polypropylene bristles.

11. Intermittent stainless steel laced link elements that form sharp hooks will be regularly placed along the face of each row of the grid to effectively remove larger particles.

B. The Frame

1. The continuous belt will rotate within a heavy duty stainless steel static support frame that shall stand at a 75 degree angle in the channel.

2. The screen will not be fixed within the channel to allow the entire machine, including screen grid, to lift out of the channel for repair or bypass. All routine maintenance will be achieved without removing the screen from the channel and shall be performed at grade level.

3. The guide link system will travel around a guide wear track that is integral to the support frame.

4. The design will ensure that the support frame meshes with the closure seal on each guide link to prevent passage of screening material and grit particles.

5. The frame shall accommodate stainless steel protective covers designed to prevent leakage and contain spray wash. All access covers for maintenance will be lightweight and easily removable. Screens with covers requiring neoprene, rubber or plastic seals are not acceptable.

6. If required the screen manufacturer will supply the stainless steel angled filler plates with neoprene seals to connect from the upstream corners of the support frame to the channel walls.

C. The Offloading of Screenings

1. A stainless steel spray wash header will be located in the head space of the screen to offload the screenings from the continuous belt.

2. The spray bar will incorporate brass nozzles at 2 inch spaces that can easily be replaced or removed for cleaning.

3. The spray bar will be positioned behind the rotating belt and will backwash the solids into a discharge hopper manufactured from stainless steel. The wash water will be used to continuously flush the screenings from this hopper into the extended sluice or directly into the Washing Compactor.

4. The addition of a mechanically rotating brush system to aid offloading will not be acceptable.

D. The Drive Mechanism

1. Each screen will have a single 3/4 hp, continuous duty electric motor suitable for a 460/3/60 supply and rated for a Class 1 Div. 1 explosion proof environment. The motor will be TEFC NEMA rated. The motor will be located outside of the screen covers and above the top of the channel.

2. The gear reducer shall be directly coupled to a heavy duty shaft machined from stainless steel.

3. The continuous belt will be supported and rotated around heavy duty stainless steel sprockets located on the drive shaft in the head space of the screen.

4. These sprockets will have lugs that transmit torque directly from the gear reducer to notches on the underside of the UHMWPE guide links. Driving forces shall be transmitted to areas located behind the screen's grid to prevent solids from contacting drive surfaces.

5. Chain driven systems or screens with wheels submerged in the wastewater are not acceptable.

2.4 WASHING COMPACTOR DESIGN SPECIFICATIONS

A. The Washing Compactor

1. The main body will be the washing trough that will receive screenings and wash water directly from the discharge point of the screen.

2. The washing trough will house the screw auger and provide a dedicated section to reduce organic content. It will comprise of angled side walls manufactured from 10 gauge stainless steel that will direct the screenings on to the screw auger, and a drainage section in which the screw auger will ride.

3. The drainage section will be manufactured from stainless steel that has been machined with 5mm slots. The slots will be perpendicular to the direction of the

screw so that the shearing action will prevent material collecting in the slots. The screw will not require stiff nylon brushes to keep the section clean.

4. The underside of the washing trough will be a catch pan that will collect the contaminated water that passes through the drainage section. The catch pan will feed a 6 inch diameter outlet connection. The Main Contractor will connect the pipe to take the water back to the main flow.

5. The stainless steel screw auger will sit in the washing trough. Washing compactors with shaft less screws are not acceptable as a shaft is required to support the flight and provide necessary torque and compaction.

6. The auger will be a full pitch screw supported at the compaction end by minimum 5” wide UHMWPE Flight Support Bearing that creates a supporting collar around the screw flight. Each bearing ring will be designed to rotate through 180 degrees to provide a second wear surface below the screw. Each wear surface shall be fitted with a set screw that can be removed for inspection. The operator will be able to inspect and rotate the bearing by removing the outside cover without disassembling the equipment.

7. The end of the screw shall be reinforced with a triangular shaped stainless steel gusset welded behind the final screw flight to provide protection in this high wear/high torque area and to assist in compression of the screenings.

8. The screw will rotate allowing wash water and free organic/fecal material finer than trough openings to escape and return to the influent flow. The wash water system will flush the separated organic material through the drainage section in solution or as small particles.

9. A portion of the washing water will enter the washing trough with the screenings. This will be supplemented by spray nozzles that will direct water on to the screenings prior to compaction. They will be individually set at different angles to maximize the washing opportunity. The nozzles will be recessed into the side wall of the washing trough to protect from ragging and blockage.

10. The screw will transfer the washed screenings into the compaction zone. This will be a section of stainless steel pipe followed by the UHMWPE flight support bearing. The total length of this section will at a minimum equal two full pitches of the screw flight.

11. The compacted screenings will be pushed through the compaction zone and pass through a 45 degree elbow. The outlet chute will be tapered at 1 degree along the full length and will elevate the dewatered screenings to discharge by gravity into a waste receptacle (by others).

B. The Drive Mechanism

1. Each Washing Compactor will have a single 2 hp (minimum), continuous duty electric motor suitable for a 460/3/60 supply and rated for a Class 1 Div. 1 explosion proof environment. The motor will be TEFC NEMA rated.

2. There shall be the ability to change the height of the screw within the washing trough by using adjustment bolts on the gearbox plate. This will prevent excess wear of the screw

2.5 CONTROL PANEL DESIGN SPECIFICATIONS

A. General Information - The manufacturer will supply one UL listed 508A stainless steel main control panel and one local panel that shall automatically control the equipment offered in this section.

B. The controls shall be incorporated into a single control panel to operate both the screen and washing compactor. The enclosure shall be NEMA 4X, stainless steel 304 with continuous hinge and lockable door latch. The control panel shall consist of the following components:

1. Main lockout/disconnect switch
2. Fused disconnect
3. Recycle timer
4. Fuses and breakers
5. Motor overload sensor
6. Panel power light
7. Screen run/fault lights
8. Washing Compactor run/fault lights
9. Terminal Blocks
10. Control power transformer, single phase, 480 – 120 V AC with branch circuit fuses
11. IEC type motor starters with Circuit Breaker Branch Circuit Protection
12. Panel heater with thermostat
13. Current Monitor: overload protection providing a discrete output that can be used to stop the operation of the unit in the event of a jam.
14. Transient voltage surge surpressor TVSS, 120 V AC single phase
15. Programmable controller: Allen Bradley Micrologix 1400
16. Operator interface: Allen Bradley Panelview C400
17. Intrinsically Safe Circuits for proximity switch
18. Elapsed time meter displayed at operator interface
19. Remote dry contacts: remote start/failure indication/indicating screen is running
20. Failures indicated by text messages which get displayed at operator interface
21. UL labeled

C. Door mounted equipment:
   1. Indicator lights:
      a. Power on (white)
      b. Screen drive running (red)

    c. Screen fault (amber)
    d. Screen torque fault (amber)
2. E-stop push button
3. Selector switches:
    a. Screen drive: forward – OFF
    b. Screen drive: Hand – OFF – Automatic
4. System Reset push button

D. Ancillary Control Components -

1. Ultrasonic level transducer
2. Local control station (LCS) shall be provided for each piece of equipment. The enclosure shall be NEMA 7, cast aluminum.
3. Each local control panel shall consist of the following components:
    a. NEMA 7 enclosure
    b. Hand/Off/Auto switch for each motor
    c. Emergency stop

E. Ultrasonic level monitor

1. Bar screen manufacturer shall provide one Miltronics HydroRanger 200 with (2) STH transducers for continuously monitoring of the upstream and downstream water levels for control of screen operation. The transducers shall be rated for Class 1 Division 2 hazardous locations and shall be intrinsically safe without the use of additional barriers. The transmitter shall be mounted next to the main control panel. Contractor shall install the transducers and provide wiring to the control panel.

F. Sequence of operation –Screen

1. Screen is operated based on the differential level measurement. The screen starts when the differential level exceeds the start set point. The screen will continue to run until the level drops below the start level.

2. Operation based on timer only is not acceptable.

3. The set points are adjustable at the HMI (operator interface).

G. Sequence of operation – Washing Compactor

1. Sequence of operation for Washing Compactor (WC) is operated based on the run time of the associated screen. The control panel of the WC shall receive a signal from screen panel when in operation and accumulate the time the screen is in operation. The WAP starts wash cycle when the accumulated screen operation time reaches the set point.

2. Wash cycle:

a. Wash water supply is activated: ON/OFF mode with adjustable timers for each operational condition
b. Drive runs forward also controlled by timers with adjustable ON / OFF sequence
c. Wash cycle is followed by discharge cycle: screw is running forward for an adjustable time
d. Pan wash is activated
e. Wash cycle finished

3. High screening load condition: screen is discharging very high amount of screenings the WC is switching into discharge mode; this condition is determined by the accumulated run time of the screen.

4. WC shall have the ability to clear blocking automatically: if current monitoring relay senses high load condition the screw stops and a clearing cycle is initiated: the screw stops immediately and reverses (time is adjustable at operator interface) and starts running forward. The number of attempts to clear the blocking is also adjustable – if screw is not cleared after allowed number of attempts or the overload is sensed during reversing the system stops immediately and an alarm signal is rendered.

2.6 SPARE PARTS

A. The following Spare Parts shall be included and supplied together with the equipment:

1. Ten (10) hook links and elements spacers
2. Two (2) grid axles
3. Two (2) guide links
4. One (1) brush for the screen

2.7 ACCESSORIES

A. The manufacturer will supply the following accessories, with the equipment:

1. One (1) 1” explosion proof brass body solenoid valve
2. One (1) 1.5” wash water strainer
3. One (1) wash water pressure gauge
4. One (1) Optional freeze protection on Compactor chute

2.8 SURFACE PREPARATION AND PAINTING

A. All stainless steel materials, including hardware, shall be acid passivated for quality control, removal of heat affected discoloration, surface treatment for corrosive environments and to provide a uniform finish to stainless surfaces.

B. All ferrous surfaces (except stainless steel) shall be coated with a pre-primer, primer, and an exterior top coating, or fusion bonded polyester coating suitable for humid/wet environments for superior corrosion protection.

C. Motor and gearbox shall be manufacturer's standard coating for humid/wet environments for superior corrosion protection.

PART 3 EXECUTION

3.1 FIELD PREPARATION AND PAINTING

A. Contractor shall touch-up all shipping damage to the paint and stainless steel as soon as the equipment arrives on the job site.

B. Contractor shall supply paint for field touch-up and field painting.

C. Contractor shall coat all stainless steel bolts and nut threads with a non-seizing compound prior to final assembly.

3.2 FACTORY TESTING

A. The screening system and all components shall be factory assembled and operationally tested prior to shipment. The equipment shall be shipped fully assembled and shall be capable of being set in place and field erected by the Contractor with minimal field assembly.

B. During the factory test period the screening system shall be adjusted as required assuring proper operation on completion of the field installation. The Manufacturer shall supply a certification of the completion of the factory testing of the assembled screening system and appurtenances and shall certify as to the equipment being in satisfactory operating condition at time of shipment. The Engineer and/or Owner may, at their own option and expense, witness the factory test.

3.3 INSTALLATION

A. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify Engineer of significant deviations.

B. Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the manufacturer's recommendations

C. Supplier shall furnish the services of a factory-trained Service Engineer for one trip including two (2) days to inspect the installation, observe start up, and provide operator training.

1. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.

2. The Service Engineer shall make all necessary adjustments and settings to the controls. In particular, Service Engineer shall verify the measurement relay setting and the initial water level differential setting for the screen.

3. The Service Engineer shall demonstrate proper and sequential operation of the screen. The screen shall operate automatically based on the water level differential.

END OF SECTION

SECTION 14620
MANUAL HOISTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:
   1. Hand-operated chain hoists and trolleys.

Location	Capacity (Tons)	Operating Lift (Feet)	Trolley Type	Chain Container
Headworks Building	1.5 Ton	30	Plain Push Type	Yes

1.2 REFERENCES

A. ANSI: American National Standards Institute

B. AMSE: American Society of Mechanical Engineers

C. OSHA: Occupational Safety & Health Administration

1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Design and fabrication of hoists and trolleys shall be in accordance with the applicable requirements Of ASME HST 2.
   2. Operating chains of hoists and trolleys shall loop not more than 4 feet above the finished operating floor.

1.4 SUBMITTALS

A. Product Data:
   1. Details of hoists and trolleys.
   2. Operation and Maintenance data.

B. Submit in accordance with Section 01340.

1.5 QUALITY ASSURANCE

A. Proportion parts of mechanism for stresses that occur during continuous operation, during installation, and during fabrication.

PART 2 PRODUCTS

2.1 HOISTS

A. Lightweight chain hoist, hook suspended type, with rated capacity and operating lift as noted.

B. Compatible with trolley.

C. Provide chain container where noted.

D. Operating chain and lift chain shall be 304 SST

E. Hoist shall have corrosion resistant finish for installation in a Class 1, Division 2 environment

2.2 TROLLEYS

A. Plain push type where noted.

B. Hand-geared pull chain type where noted.

C. Compatible with monorail beam.

D. Trolley shall have corrosion resistant finish for installation in a Class 1, Division 2 environment

2.3 MARKING

A. Permanently mark capacity of hoists and trolleys on each hoist and trolley.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install hoists and trolleys as shown on Drawings and in accordance with approved submittals and manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

A. Field load test hoists and trolleys in accordance with OSHA, ANSI, and local requirements.

END OF SECTION

SECTION 15060

PIPE AND PIPE FITTINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping complete with all fittings, jointing materials, expansion joints, hangers, supports anchors and necessary appurtenances for interior installations:
   1. Water treatment process piping
   2. Chemical piping
   3. Air piping
   4. Water piping

1.2 RELATED SECTIONS

A. Section 02300 – Earthwork

B. Section 03000 – Concrete

C. Section 03600 – Grout

D. Section 15100 – Valves, Cocks, and Hydrants

1.3 REFERENCES

A. American National Standards Institute (ANSI)
   1. B1.1 – Unified and American Screw Threads
   2. B16.1 – Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
   3. B16.5 – Steel Pipe Flanges and Flanged Fittings
   4. B16.24 – Cast Copper Alloy Pipe Flanges and Flanges Fittings
   5. B18.2 – Square and Hexagon Bolts and Nuts
   6. B31.1 –Power and Process Piping

B. American Society of Mechanical Engineers (ASME)
   1. B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings
   2. B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
   3. B16.26 – Cast Copper Alloy Fittings for Flared Copper

C. American Society of Testing and Materials (ASTM)
   1. A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   2. A134 – Standard Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)
   3. A135 – Standard Specification for Electric-Resistance-Welded Steel Pipe
   4. A139 – Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

5. A181 – Standard Specification for Carbon Steel Forgings for General-Purpose Piping
6. A193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
7. A194 – Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
8. A234 – Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
9. A283 – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
10. A307 – Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
11. A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
12. B32 – Standard Specification for Solder Metal
13. B75 – Standard Specification for Seamless Copper Tube
14. B88 – Standard Specification for Seamless Copper Water Tube
15. D1785 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
16. D2464 – Standard Specification for Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
17. D2467 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
18. F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

D. American Water Works Association (AWWA)
1. C200 – Standard for Steel Water Pipe 6 Inch and Larger
2. C203 – Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines – Enamel and Tape – Hot Applied
3. C206 – Standard for Field Welding of Steel Water Pipe
4. C207 – Standard for Steel Pipe Flanges for Waterworks Service – Sizes 4 Inch Through 144 Inch
5. C209 – Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
6. C900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inch through 12 Inch, for Water Distribution
7. M11 – Steel Water Pipe: A Guide for Design and Installation

E. National Science Foundation (NSF)
1. 61 – Drinking Water System Components – Health Effects

F. National Fire Protection Association (NFPA)

G. International Plumbing Code (IPC)

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Shop Drawings:
   1. Provide piping layout fabrication and assembly Drawings with fittings dimensions. Provide sufficient information to verify compliance with specification including, but not limited to, the following:
      a. Layout of pipe Drawings
      b. Pipe and joint details
      c. Specials, fittings, and coupling details
      d. Specification data sheets
      e. Certificates of compliance with applicable standard and specification and testing certificates
      f. For steel pipe show weld locations and installation of pipe, fittings, specials and connections
         i) Complete data of materials proposed
         ii) Do not manufacture until approved
         iii) Show where each numbered pipe fitting or special is to be installed
         iv) Numbers correspond to those painted on pipe
   2. Provide additional detailed information including elevations, fittings, specialty materials or fabrications for special or custom features, structures, junctions and/or pipes
   3. Specifications, data sheets and affidavits of compliance for coatings and linings
   4. Provide pipe-laying and installation schedule

C. Product Data: Provide sufficient data on features, pipe, joints, gasket material, lubricant and accessories to verify compliance with specifications

D. Manufacturers Certificate and affidavits:
   1. Furnish the following prior to fabrication
      a. Details: Pipe, joint, special, fitting and coupling
      b. Shop coating
      c. Shop coatings and linings: specifications, data sheets, and compliance affidavits
   2. Furnish the following prior to shipment
      a. Compliance affidavit for applicable standards
      b. Test certificates

E. Test Reports: Submit all shop and field test reports in accordance with Division 1 Specifications as Product Data

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 Specifications

B. Accurately record actual locations of piping, valves, connections, centerline of pressure pipe elevations, and top of gravity pipe elevations

C. Identify and describe unexpected variations to building conditions or discovery of unknown utilities

1.6 REGULATORY REQUIREMENTS

A. In accordance with all municipal codes and ordinances, laws and regulations of the State

B. In case of apparent conflict, State and local requirements govern over these specifications

C. In absence of State and local regulations, International Plumbing Code applies

1.7 DELIVERY, STORAGE AND HANDLING

A. For steel pipe: comply with AWWA C203 Section 2.14
   1. Handling and Storage:
      a. Use wide canvas slings and wide padded skids.
      b. Do not use bare cables, chains, hooks, metal bars, or narrow skids
      c. Do not store directly on ground, provide proper blocking
      d. Do not roll on enameled surface
      e. Do not expose enameled pipe to temperature below 0 Degrees F
      f. Do not handle enameled pipe below 10 Degrees F
   2. Shipment
      a. Ship steel pipe supported on padded saddles not less than 12-inches wide, securely fasten load to prevent movement in transit. For pipes coated with fusion bonded epoxy use nylon straps
      b. Laterally support ends of pipe, fittings, special, to maintain shape during shipment
      c. Separate materials during shipment to prevent materials bearing against each other
   3. Delivery
      a. Products with dents, kinks, abrupt changes of curvature or other injuries shall be rejected upon delivery
      b. Products dropped from truck or crane shall be rejected
      c. Rejected items shall be replaced or reconditioned at the expense of the contractor. Reconditioning shall only be permitted at approval of Engineer and with replacement coatings as originally specified on the reconditioned pipe

B. For all other pipe
   1. Deliver, store, protect and handle products to site under provisions of Division 1 Specifications
   2. Delivery
      a. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat and the direct sunlight
   3. Storage
      a. Store pipe, fittings and gaskets in clean locations protected from environmental conditions such as: direct sunlight, mud, etc.
      b. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months
      c. Store pipe on a flat surface which provides even support for the barrel with bell ends overhanging
      d. Do not stack pipe higher than 5 feet
   4. Storage: Use the following precautions for valves, during storage:

a. Do not remove end protectors unless necessary for inspection; then reinstall for storage
    i) Protect valves from weather by storing indoors or support valves off ground or pavement in watertight enclosures when outdoor storage is necessary
5. Handling
    a. Handle so as to insure installation in sound undamaged condition
    b. Use equipment, tools and methods for unloading, reloading, hauling and laying that do not damage pipe or cause an impact. Damaged pipe will be cause for rejection
    c. Use hooks or straps with broad, well padded contact surfaces for lifting sections of pipe
6. Preparation for Transport:
    a. Prepare valves, for shipping as follows:
        i) Ensure that valves and pilotry are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends, flange faces, and weld ends. Set valves in best position for handling. Set valves closed to prevent rattling
7. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C500
8. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation
9. Seal pipe and fittings to prevent entry of foreign materials into pipe and fittings
10. During loading, transporting and unloading, exercise care to prevent damage to material
    a. Use nylon slings only
    b. Do not drop pipe or fittings
    c. Do not roll or skid against pipe already on ground
    d. Repair any damage done to coating or lining
    e. Handle per manufacturer's recommendations
    f. Store rubber gaskets in cool dark location
    g. Store all material on wood pallets or timbers
11. Adequately tag or otherwise mark all piping and fittings as to size

PART 2 PROCESS PIPING PRODUCTS

2.1 STEEL PIPE – 6-INCHES AND LARGER

A. Pipe: AWWA C200
    1. Fabricated or mill type
        a. ASTM A53 Type E or S Grade B
        b. Or ASTM A134 made from:
            i) Steel plate: ASTM A283, Grade C, with maximum carbon content of 0.30 percent and maximum manganese content of 1.2 percent, or ASTM A570, Grade 30
        c. Or ASTM A139, Grade B, 21000
        d. Or ASTM A135, Grade B

2. Wall thickness: 1/4 inch minimum continuous spiral seam welded on inside and outside of pipe
3. Specified pipe size:
   a. 12-inches or smaller, nominal inside diameter
   b. 14-inches or larger, actual outside dimension
4. Stab joint pipe specified diameter, nominal diameter
5. Reinforce or increase shell thickness of pipe, fittings and specials to maintain combined stress due to internal pressure and bending below 20,000 psi
6. Shop testing per AWWA C200 Section 4.3
7. For pipe with mechanical couplings, the space between pipe ends shall be at least 1/2 inch, but not greater than the manufacturer's recommendations

B. Fittings and Specials: fabricated or wrought seamless
   1. AWWA C200, Section 4, or ASTM A234, Grade WPA, unless otherwise required
      a. Steel plate: Same as for pipe specified above
   2. Wrought seamless: short or long radius, Contractor's option

C. End of Sections
   1. Field butt welding: outside be beveled to 37-1/2 degrees $\pm$ 1/32 inch
   2. Welded bell and spigot: AWWA C200
   3. For fitting with slip on flanges: AWWA C200
      a. Slip-on flanges may be used in lieu of weld neck flanges shown on Drawings, except on short radius fittings
   4. For mechanical couplings, plain end types per AWWA C200 shall be used
      a. Welds shall be ground flush on ends without pipe stops to permit slipping the coupling in at least one direction to clear pipe joint
      b. The outside diameter and out-of-round tolerances shall be within the limits of the coupling manufacturer
   5. For victaulic couplings, shall be grooved or collared type, per size and thickness of pipe, fitting, or special and maximum working pressure consistent with manufacturer's recommendations
      a. Grooving dimensions shall conform to rigid/standard grooving dimensions

D. Flanged Joints
   1. Shall be flanged where indicated on Drawings and in accordance with ANSI B16.1
      a. Flanges: Slip-on or welding neck, except where otherwise indicated
         i) Material: ASTM A181, Grade 1 or ASTM A283, Grade B or C
         ii) Dimensions and drilling: AWWA C207, Class D, Table 1 or 2
            a) Coordinate flange dimensiosn and drillings among piping, valves,a and equipment
         iii) Bore weld neck flange to ID of pipe
         iv) Faces shall be finished to a plane surface within a maximum tolerance of 0.010 inch
         v) Diameter shall have a maximum tolerance of 0.005 inch/foot for flange faces from the normal with respect to axis of pipe
         vi) Flanges shall be tested for true plane after welding, reface if necessary
         vii) Flange dimensions and drillings shall be coordinated between piping, valves and equipment

b. Blind Flanges
   i) Conform in diameter, drilling and thickness with flanges where they attach
   ii) Shall be reinforced as required
c. Flange bolting
   i) Material: ASTM A307
   ii) Type: Bolt and nut, bolt-stud and 2 nuts permitted for 1 inch and larger
   iii) Bolts and bolt-studs
      a) Length: Ends project ¼ inch to ½ inch beyond nuts
      b) Ends: Chamfered or rounded
      c) Threading: ANSI B1.1, coarse thread series, Class 2A fit. Bolt studs may be threaded full length. Studs for tapped holes threaded to match holes
   iv) Bolt heads
      a) Shape: Hexagonal or square
      b) Dimensions: ANSI B18.2 heavy pattern for hexagonal, regular pattern for square
   v) Nuts
      a) Dimensions: ANSI B18.2 heavy, semi-finished pattern
      b) Threading: ANSI B1.1 coarse thread series, Class 1B fit

E. Shop Welded Joints
   1. Provided joints shall be water tight and sound and free from embedded scale and slag
   2. Tensile strength across the weld shall not be less than that of the thinner of connected sections
   3. Yield point of the welded joint shall be tested by independent laboratory at contractor's expense
   4. Butt welds shall be used for all welded joints in line pipe assemblies and in fabrication of fittings and other specials
   5. For slip-on flange attachments, fillet welds shall be used per AWWA C207
   6. Back-up welding strips or rings shall not be allowed for shop welds

F. Coupled Joints
   1. Mechanical couplings
      a. Provide couplings with a middle ring length not less than 7-inches
      b. Where couplings are used for closures or where union connections are required omit pipestop from inner surface of middle rings
      c. Couplings shall be cleaned and shop primed with manufacturer's standard rust inhibitive primer
      d. Insulating
         i) Dresser “Style 39”
         ii) Rockwell “416”
         iii) Or accepted substitution
      e. Reducing
         i) Dresser “Style 62”
         ii) Rockwell “415”
         iii) Or accepted substitution
      f. Transition coupling
         i) Dresser “62”

ii) Rockwell “413”
iii) Or accepted substitution

g. Others
i) Dresser “Style 38”
ii) Rockwell “411 Flexible Coupling”
iii) Or accepted substitution

2. Joint harness
a. Bolts: ASTM A193, Grade B7, or Ryerson Stress-Proof, minimum yield point 100,000 psi
i) Provide two (2), double nut bolts per harness
ii) Design bolts based on 40,000 psi maximum stress at hydrostatic test pressure after installation
iii) Threading: ANSI B1.1, Class 2A fit, coarse thread series for 1 inch and smaller and 8 thread series for 1-1/8 inch and larger
iv) Ends: Chamfered or rounded
b. Nuts: Hexagonal ASTM A194, Grade 2H or better
i) Threading: As specified for bolts except Class 2B fit
ii) Dimensions: ANSI B18.2 heavy, semi-finished pattern
c. Washers: Hardened steel, ASTM A325
d. Provide joint harnesses as indicated on the Drawings per Figure 13-17 of AWWA M11
e. All lugs shall be shop welded to pipe, except where Drawings require a sleeve welded to the pipe and lugs welded to the sleeve
f. Provide for coupling to be slipped clear of joint in at least one direction by placing harness lugs and bolts of sufficient length

3. Flange coupling adapters
a. Provided per coupling manufacturer's recommendations
b. Determine adapter location and drill anchor stud holes after pipe placement
c. Provided restraints for all flanged coupling adapters
d. Stud holes diameter shall not be more than 1/8 inch larger than diameter of stud projection
e. Nitrile (Buna N) follower gasket and nitrile o-ring
f. 4-inches thru 12-inches
i) Rockwell “912”
ii) Dresser “127” with anchor lugs
iii) Smith-Blair “912” with anchor studs
iv) Romac "FCA501"
v) Or accepted substitution
g. 12-inches and larger
i) Romac "FC400" with anchor bosses and anchor studs
ii) Or accepted substitution

4. Dismantling joint
a. Provided per coupling manufacturer's recommendations
b. Determine and install dismantling joint after equipment and pipe placement
c. Provide restrained dismantling joint where indicated
d. Nitrile (Buna N) follower gasket
e. 4-inches thru 24-inches

i) Smith-Blair “971” or “975” as required
ii) Or accepted substitution

5. Victaulic Couplings:
   a. Size couplings for proper installation on ends provided
   b. Victaulic "Style 22" or "77" as required
   c. After fabrication, housing clamps shall be hot-dipped galvanized, cleaned, and primed, per coupling manufacturer

G. Small branch connections
1. Pipe nipples: Seamless black steel pipe, ASTM A53, standard weight (Schedule 40)
2. For 2-1/2 inches and smaller, welded fittings and threaded outlets shall be provided
3. Provide 1-inch outlet and reducers for outlets known to be less than 1inch
4. Three through 12 inches, provide pipe nipples or fittings welded to pipe shell and reinforced as required
5. Connections shall be located to avoid interference with joints, supports, or other details
6. Welding fittings
   a. Threaded outlets:
      i) Bonney “Threadolets”
      ii) Porter “W-S Teelets”
      iii) Vogt “Weld Couplets”
      iv) Or accepted substitution
   b. Welded outlets:
      i) Bonney “Weldolets”
      ii) Porter “W-S Teelets”
      iii) Vogt “Weld Couplets”
      iv) Or accepted substitution

H. Gaskets
1. Ring type, 1/8-inch rubber per AWWA C200
2. Gasket compound
   a. Garlock “Compound No. 1”
   b. Titeseal T25
   c. Or accepted substitution
3. Rubber gaskets for bell and spigot pipe: Continuous O-ring, AWWA C300, Section 3.04, except minimum tensile strength of 2100 psi and basic polymer of neoprene or other synthetic rubber. Do not use natural rubber.

I. Coatings
1. Interior and exterior primer, submerged: SSPC-SP10/NACE 2 Near-White Blast Cleaning for proper finish coat adhesion prior to shipment
   a. Polyamidoamine epoxy, per Section 09900, one coat 5 mils dft
      i) Tnemec "Series N140 Pota-pox Plus"
      ii) Or accepted substitution
2. Exterior primer, non-submerged: SSPC-SP6/NACE 3 Commercial Blast Cleaning for proper finish coat adhesion prior to shipment
   a. Rust inhibitive primer for polyurethane, per Section 09900, one coat 3 mils dft
      i) Tnemec "Series 1 Omnithane"

ii) Or accepted substitution

3. Interior finish coat, submerged: Factory applied after proper cure of first coat
   a. Polyamidoamine epoxy, per Section 09900, one coat 5 mils dft
      i) Tnemec "Series N140 Pota-pox Plus"
      ii) Or accepted substitution
4. Exterior finish coat, submerged: Field applied
   a. Polyamidoamine epoxy, per Section 09900, one coat 5 mils dft
      i) Tnemec "Series N140 Pota-pox Plus"
      ii) Or accepted substitution
5. Exterior finish coat, non-submerged: Field applied
   a. Aliphatic Acrylic Polyurethane Enamel Finish, per Section 09900, one coat 3-5 mils dft
      i) Tnemec "Series 1075 Endura-Shield II"
      ii) Or accepted substitution

J. Pipe supports, anchors, blocking and hangers
   1. Provide supports, anchors, blocking and hangers as specified on Drawings and in Section 15090
   2. Shall be provided with concrete bases, anchor bolts and nuts, plates, rods, and other accessories as specified
   3. For longitudinal and lateral anchorage shop weld lugs shall be required
   4. Modifications shall be subject to Engineer's approval
   5. Anchor bolts: ASTM A307

2.2 PVC PIPING

A. The following piping shall be PVC pipe as indicated on Drawings and provided for locations specified herein:
   1. Chemical service
      a. Interior, pressure pipe
   2. Drain, vent, and carrier pipe
      a. Interior, non-pressure pipe
   3. Contractor shall submit complete process piping Drawings and shall include all location and dimensions of piping, fittings, valves, and couplings

B. PVC Process Piping (Pressure)
   1. Pipe and Fittings:
      a. Pipe: ASTM D1785, Schedule 80 PVC 1120, with NSF seal, shall conform to AWWA C900
         i) Pipe shall have cast iron pipe equivalent outside diameters
      b. Flanges: Diameter and drilling per ANSA B16.5, 150 lbs
      c. Flange bolts and nuts: ASTM A307, Grade B, galvanized, install such that bolts project 1/8-inch to 3/8-inch beyond the outer face of the nut
      d. Flange gaskets: Full face, 1/8-inch neoprene or plasticized PVC and shall be in conformance with AWWA C900 and ASTM F477
      e. Fittings: ASTM D2464 or D2467, PVC I
         i) Manufacturer:
            a) Same as pipe manufacturer

b) Celanese
c) Chemtrol
d) Or accepted substitution

f. Expansion joint manufacturers:
i) Belmost "Style 3915"
ii) Resistoflex "Style R6905"
iii) Molded Expansion joint
iv) Or accepted substitution

g. Grooved couplings:
i) Gustin-Bacon "Gruvagrip Series 100"
ii) Victaulic "Style 78"
iii) Or accepted substitution

C. PVC Drain, Vent, or Carrier Pipe (Non-Pressure)
1. Pipe and fittings: Schedule 40 in accordance with ASTM D2466, ASTM D2122, F412
2. Joints:
a. Solvent weld per manufacturer's recommendation
b. Threaded: ANSI 82.1

2.3 COPPER TUBING

A. Water tubing: ASTM B88; FS WW-T-799, Type K; or FS WW-T-775

B. Instrument tubing
1. Provide 1/2-inch copper tubing for air valve actuation piping
2. Material: ASTM B75, hard-drawn, with polyethylene or PVC jacket except where buried
3. Minimum wall thickness
a. ¼ inch O.D.: 0.030 inches
b. 3/8 inch O.D.: 0.032 inches
c. ½ inch O.D.: 0.032 inches
d. ¾ inch O.D.: 0.040 inches
e. Minimum PVC jacket thickness: 0.032 inches
4. Air instrument piping shall be painted in accordance with Section 09900

C. Fittings
1. Flared: ASME B16.26
2. Solder: ASME B16.18 or B16.22
3. Compression:
a. Crawford "Swagelok"
b. Hoke "Gryolok"
c. Imperial "Hi-Seal"
d. Parker-Hannifin "CPI"
e. Weatherhead "Self Align"
f. Or accepted substitution
4. Insulating
a. Threaded:

i) PSI “Delrin Insulating Couplings”
ii) Vallet “V-Line Insulating Couplings”
iii) Or accepted substitution

b. Flanged:
i) Epco “Dielectric Flange Unions”

c. PSI “Type E Flange Insulation”

d. Or accepted substitution

D. Solder: Solid wire, ASTM B32, Alloy Grade SN95 Lead Free Solder

E. Soldering flux: Paste Type, FS O-F-506, Type I, Form A

F. Brazing filler metal: ASTM C260, BCuP
1. Engelhard “Silvaloy 15”
2. Goldsmith “gb-15”
3. Handy and Hardman “Sil-Foss”
4. Or accepted substitution

G. Brazing flux: Paste Type, Federal Specification (FS) O-F-499, Type B

H. Flanges: Cast bronze, 150 lb, brazed joints, ANSI B16.24

I. Flange bolts and nuts: As specified for steel pipe

J. Flange gaskets: As specified for steel pipe, except full face

K. Expansion joints
1. Flexonics “Model HB Expansion Compensators”
2. Mercer
3. Or accepted substitution

2.4 TUBING

A. Provide 3/8 inch polypropylene resin tubing sufficient in length for transport of chemical from each metering pump to application point
1. Natural translucent
2. 0.062 inch wall thickness
3. Pressure: 172 psi (at 73ºF)

B. Manufacturers:
1. Ryan Herco Flow Solutions "Herco-Pro Polypropylene Tubing"
2. Or accepted substitution

2.5 ACCESSORIES

A. Watertight and dust-tight pipe sleeves:
1. O-Z Electrical Manufacturing Company
2. Thruwall and Floor Seals
3. Or accepted substitution

B. Modular, rubber, sealing elements:
   1. Thunder Line Corporation “Link Seal”
   2. Or accepted substitution

C. Thread tape: Teflon
   1. John Crane “Thread Tape”
   2. Garlock “Plasti-Thread”
   3. Hoke “EZ Seal”
   4. Or accepted substitution

D. Sealant: Silicone sealant as specified in caulking section

E. Pulsation Snubbers:
   1. Operating and Maintenance Specialties “Ray Pressure Snubbers”
   2. Ashcroft “Snubber Series 25-255”
   3. Or accepted substitution

F. Gauge cocks: Bronze, tee handle
   1. Lunkenheimer 1178
   2. Powell 915
   3. Or accepted substitution

G. Concrete for supports and other locations as shown on Drawings: Concrete type specified in Section 03000

2.6 PRESSURE GAUGES

A. Provide 4-1/2 inch diameter pressure gauges that are bottom connected with white laminated dials and black graduations. Accuracy of pressure gauges shall be within 1/2 percent

B. Gauges shall include a blowout disc and safety glass that is encased in phenolic, steel or cast iron

C. Stainless steel bourbon tube with welded, stress-relieved joints shall be provided for the measuring element

D. Socket shall have wrench flats

E. Pressure gauge movement shall be rotary geared and stainless steel material

F. All provided pressure gauges shall be provided with a pulsation snubber constructed of 316 stainless steel and an isolation valve.

G. Manufacturers:
   1. Ashcroft "1279"
   2. Ametek “Series 1900 SOLFRUNT”
   3. Or accepted substitution

PART 3 EXECUTION

3.1 INSTALLATION

A. Install as specified and indicated on Drawings

B. Remove dirt, rocks, debris, and other foreign materials from all pipelines

C. Keep interior of pipe and fittings thoroughly clean before installation and until work is accepted

D. Take precautions to prevent entrance of foreign material during jointing, lining repair, and inspection operation

E. Seal open end of line with watertight plug if pipe laying stopped

F. Provide and install sufficient copper tubing to run instrument air to all pneumatic actuators

G. Provide a shutoff valve and union at the water and air supply connections to each fixture and unit of equipment, whether shown on the Drawings or not

H. Provide a union within 2 feet of each threaded end valve unless other means for easy removal of the valve are available

I. Provide unions where required for equipment removal, indicated on the Drawing or specified

J. Do not install piping to obstruct openings and passageways

K. Cut pipe to measurement taken at the site, not from the Drawings

L. Layout piping to provide for expansion and contraction

M. Provide taps for pressure gauge connections with a nipple, snubber, and gauge cock

N. Securely anchor piping at the midpoints between expansion joints

O. Provide air supply piping with sectionalizing valves and valved air inlet connections to isolate portions of system for periodic testing

P. Grade all air piping to points of drainage; provide driplegs on drain valves at drainage points

Q. Uniformly grade all piping serving metering equipment and provide complete venting to eliminate air traps

R. Pipe stuffing box leakage from water sealed pumps to nearest point of drainage

S. Provide insulating fittings and dielectric isolation in all piping except air and gas piping wherever copper tubing or fittings are connected to iron or steel pipe or fittings

T. Provide expansion joints at not greater than 60-foot intervals in exposed or submerged PVC piping

3.2 CONNECTION TO EXISTING PIPELINES

A. Make connections between new and existing piping with suitable fittings

B. Schedule connection to minimize inconvenience to the Owner

C. Undertake connections in order to disturb the system as little as possible

D. Where connection involves potable water systems, provide disinfection methods as prescribed in these Specifications

E. Once tie in to existing system is initiated, continue Work continuously until tie-in is made and tested

3.3 STEEL PIPE

A. Flanged joints
   1. During bolting avoid restraint on opposite end on opposite end that would prevent uniform pressure application on gasket
   2. Pipe or fitting shall be free to move in any direction while bolting
   3. Tighten bolts gradually, in turn, at uniform rate
   4. Stresses shall not be transmitted during installation to equipment flanges by connecting pipe
   5. Equipment shall be permanently supported to pipe to obtain accurate matching of bolt holes and uniform contact over surface of flange, before installing bolts
   6. While bolts are tightened equipment connection piping shall be free to move longitudinally
   7. To fit connecting pipe, level, align and wedge equipment into position
   8. Equipment shall not be grouted until connecting piping is properly aligned
   9. Equipment connections shall be tested by loosing flange bolts. No movement of piping relative to equipment or opening of equipment connection joints shall occur when flange bolts are loosened

B. Field welded joints:
   1. Install per AWWA C206
   2. Test specimens shall be furnished as requested by Engineer

C. Couplings
   1. Prior to installation, remove dirt or foreign material from pipe ends and couplings.
   2. Gaskets shall be kept clean during installation
   3. Only use wrenches which have been recommended by coupling manufacturer
   4. All bolts shall be tightened the same amount with parts square and symmetrical
   5. Installed couplings shall be re-primed or touched up after installation

D. Anchorage shall be provided in exposed locations and where subject to internal pressure block, anchor or harness piping with mechanically coupled, push-on or similar joints to prevent separation of joints

E. Miter cutting
   1. By cutting one end: up to 4-1/2 degrees
   2. By cutting two adjacent ends: up to 22-1/2 degrees
   3. Fabricated bends: greater than 22-1/2 degrees

3.4 JOINTS

A. Make pipe joints carefully and neatly

B. Connect piping in accordance with manufacturer recommendations

C. Threaded
   1. ANSI B2.1, NPT fully and cleanly cut with sharp dies
   2. No more than 3 threads exposed after installation
   3. Ream pipe ends after threading to remove burrs
   4. Apply Teflon thread tape to joints in all plastic and stainless steel piping
   5. Apply thread tape or joint compound to joints in other piping
   6. Apply Teflon thread tape or litharage and glycerine paste to joints on steel piping for chlorine service

D. Compression
   1. Cut pipe ends squarely, remove burrs
   2. Clean contact surfaces with steel wool

E. Flared
   1. Cut tubing ends squarely, remove burrs
   2. Scratches or grooves in flared ends are not allowed

F. Soldered and brazed
   1. Braze joints in 2 inch or larger copper tubing
   2. Solder or braze lines smaller than 2 inch where solder fittings are specified
   3. Thoroughly clean joint surfaces with flint paper and coat with thin film of flux
   4. Install tubing to full depth of socket
   5. Do not overheat metal or flux
   6. Uniformly heat joint to melt filler metal on contact
   7. Remove surplus filler metal and flux while joint is still hot

G. Solvent welded
   1. Cut PVC pipe ends square and smooth, wipe clean
   2. Remove all burrs and filings
   3. Using a small brush, apply cement primer to the outside of pipe and the inside of the fitting socket
   4. Using a small brush, apply solvent cement to outside of pipe and inside of the fitting socket

a. Solvent cement to be specifically rated for use with chlorine or hypochlorite solutions for piping and fittings that will be used to convey these solutions

5. To ensure uniform cement distribution, push the coated surface snugly together and rotate approximately 1/2 turn
6. Remove excess cement by wiping

H. Grooved couplings
1. Cut grooves with grooving tool
2. Groove to rigid grooving dimensions
3. Groove cleanly and sharply without burrs or check marks
4. Form rounded bottom "radius grooves" in plastic piping

I. Welded: ANSI B31.1, and per “Code for Pressure Piping”

J. Push on
1. Per recommendations of pipe manufacturer
2. Bevel each spigot end to facilitate assembly
3. Lubricate with a heavy vegetable soap solution immediately before joint is completed
4. Store lubricant in closed containers, keep clean, suitable for use in potable waters

K. Mechanical Joints
1. If an effective seal is not obtained, disassemble joint, clean thoroughly, and reassemble
2. Do not over tighten bolts to compensate for poor installation
3. Carefully align holes in mechanical joints with restraint device to permit installation of the harness bolts
4. Install flange and mechanical joint pieces so the four mechanical joint holes, as well as the flange holes, straddle the top centerline for horizontal piping, or the side centerline for vertical piping

L. Flanged joints
1. Take care when bolting flanges to insure that there is no restraint on the opposite end of the pipe which would prevent gasket compression or cause unnecessary stress in flanges
2. Leave one flange free to move in any direction while tightening flange bolts
3. Do not pack or assemble bell and spigot joints until all flanges affected thereby have been tightened
4. Tighten bolts gradually at a uniform rate to compress gaskets uniformly

3.5 PIPE SLEEVES

A. Provide for pipes passing through concrete or masonry

B. Install before concrete is placed

C. Through ceramic or vinyl-tile floors, install sleeves flush with finished floor and provide nickel or chromium plated floor plates

D. Where passing through all other floors, install so the sleeve projects between 1 and 2 inches above the floor

E. Seal sleeves passing through slabs with 1 side against soil with a modular sealing element or a watertight pipe sleeve

F. If insulated, extend insulation through sleeves

G. For future pipe installation, provide sleeves and seal ends with plastic caps or plugs

H. For piping through interior walls and floors with special finish provide pipe sleeves or holes drilled with rotary drill

I. Make dust and gas tight through room walls and floor

J. Six inch or smaller; special dust-tight sleeves

K. Greater than 6 inches, seal with modular sealing elements or caulk with backer rod and seal both sides with non-sag silicone sealant
   1. For pipe sleeves located in water bearing walls provide wall pipes or sleeves with dual modular sealing elements as shown on the Drawings

3.6 CHEMICAL PIPING

A. Install so that the lines are readily accessible for cleaning

B. At each point where flexible tubing is connected to rigid piping, provide a union or quick disconnect coupling

C. Provide crosses with threaded plugged openings at changes in direction

3.7 PROTECTIVE COATING

A. Paint exposed threaded of submerged galvanized steel piping with zinc-rich paint

3.8 CLEANING

A. General
   1. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when erected
   2. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system
   3. Flush or blow all lines thoroughly before placing in service
   4. At completion of Work and prior to final acceptance, thoroughly clean Work installed under these specifications
      a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sand and dirt which may have accumulated by operation of system, from testing, of from other causes

b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner

3.9 FIELD QUALITY CONTROL

A. General
1. Utilize pressures, media, and pressure test durations as specified on Piping Schedules
2. Isolate equipment which may be damaged by the specified pressure test conditions
3. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates. Select each gauge so that the specified test pressure falls within the upper half of the gauge range. Notify Engineer 24 hours prior to each test
4. Completely assemble and test new piping systems prior to connection to existing pipe systems
5. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance
6. Provide all necessary equipment, materials, tools, appliances, devices, and perform all work required in connection with the tests and inspections
7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination

B. Steel pipe leaks
1. All joints and seams whether tested or not shall be watertight and airtight
2. Inspect all exposed shop and field welded seams
3. Leaks shall be clearly marked
4. Welded joints shall be repaired by chipping out defective parts and rewelding. Welds shall not be hammered
5. Leaks discovered by Owner within 1 year of final acceptance shall be repaired by the Contractor at no additional expense to the Owner

C. Test each line at the Contractor expense in the presence and to the satisfaction of Engineer

D. General testing methods and criteria
1. Types of pressure testing and inspection to be employed include hydrostatic pressure testing, cylinder water pumped compressed air or cylinder nitrogen testing, low pressure air testing and hydrostatic exfiltration/infiltration testing
2. Air systems
   a. Utilize the following testing medium for air systems

Pipeline Size	**Specified Test Pressure**	**Testing Medium**
2 IN and smaller	Greater than 75 PSI	Water
Greater than 2 IN	3 PSI or less	Air or water
Greater than 2 IN	Greater than 3 PSI	Water

b. The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include chlorine gas systems.
c. The allowable leakage rate for systems tested with air shall be based on a maximum pressure drop of 5 percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, ensure air is at ambient temperature and specified test pressure

3. Liquid systems
   a. The following liquid piping systems shall have zero allowable leakage at the specified test pressure throughout the specified duration of 2 hours: exposed piping and buried or exposed piping carrying liquid chemicals or water
   b. Hydrostatic pressure testing
      i) For exposed piping: Prepare each section for testing, using adequate bracing and protect system equipment susceptible to damage by test pressures. Do not paint or insulate exposed piping until successful performance of pressure test.

E. Dielectric Testing Methods and Criteria
   1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained
   2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition
   3. Check the integrity of each cad-welding connection using a light hammer blow at a 45 degree angle

3.10 DISINFECTION OF WATER PIPING SYSTEM

A. After favorable performance of pressure test and prior to final acceptance, thoroughly flush entire water piping system, including supply, source and any appurtenant devices and perform disinfection as prescribed

B. Flush and disinfect each segment of system in accordance with Section 02676

3.11 PIPING SCHEDULE

A. Install pipes as scheduled in the pipe schedule provided below

Description	**Size (inches)**	**Material**	**Maximum Test Pressure (psi)**
Air/Compressor Pipe	Varies see plans	Stainless steel & Schedule 40 PVC	25
Forcemain	14	DIP	200
Forcemain	8	DIP	200
Potable Water	Varies see plans	Copper	100

END OF SECTION

SECTION 15090

SUPPORTS AND ANCHORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe and equipment hangers and supports

B. Equipment bases and supports

C. Flashing and sealing equipment

1.2 RELATED SECTIONS

A. Section 03000 – Concrete

B. Section 05501 – Anchor Bolts and Expansion Anchors

C. Section 05590 – Miscellaneous Metal

D. Section 09900 – Painting

E. Section 15060 – Pipe and Pipe Fittings

1.3 REFERENCES

A. American Society of Testing and Materials (ASTM)
   1. F708 – Design and Installation of Rigid Pipe Hangers

B. International Building Code (IBC)

C. Manufacturers Standardization Society (MSS)
   1. SP58 – Pipe Hangers and Supports – Materials, Design and Manufacturer
   2. SP69 – Pipe Hangers and Supports – Selection and Application
   3. SP89 – Pipe Hangers and Supports – Fabrication and Installation Practices

1.4 SYSTEM DESCRIPTION

A. Provide complete system of pipe supports and anchors for all piping

B. Support all piping to prevent undue strain on any valve, fitting or piece of equipment

C. Provide support and anchors at changes in direction, change in elevation, adjacent to flexible couplings, and where valve actuators/positioners add additional weight and stresses

D. Do not install in equipment access areas

1.5 PERFORMANCE REQUIREMENTS

A. Pipe support system components to withstand total dead load
   1. Dead load: Weight of pipe filled with water plus any insulation
      a. Dead load defined as weight of pipe filled with water plus any insulation
   2. Factor of safety: 5 minimum

B. Pipe restraint system components to withstand thrusts created by fluid pressure within pipes
   1. Factor of safety: 5 minimum

C. Do not exceed manufacturers' recommended loads

D. Brace all piping 2½ inch and larger for Seismic Zone B forces in accordance with International Building Code

1.6 SUBMITTALS

A. Submit under provisions of Section 01340

B. Shop drawings: Indicate system layout with location and detail of trapeze hangers. Include location of pipe supports

C. Product data: Provide manufacturers catalog data including load capacity

D. Design data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers

E. Manufacturer's installation instructions: Indicate special procedures and assembly of components

PART 2 PRODUCTS

2.1 MATERIALS

A. Not submerged: Galvanized steel except where otherwise indicated or specified

B. Submerged: Stainless steel, 304L

C. Use stainless steel materials for stainless steel pipe or galvanized steel with non-conductive isolation gaskets to prevent electrolytic corrosion

2.2 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Anvil International
   2. Unistrut Corporation
   3. Elcen Metal Products Co.
   4. PHD Manufacturing, Inc

5. Or accepted substitution

B. Plumbing piping – water:
1. Conform to requirements of Section 15060
2. Hangers for pipe sizes ½ to 1½ inch: Stainless steel, adjustable swivel, split ring
3. Multiple or trapeze hangers: Steel channels with welded spacers and hanger rods
4. Wall support for pipe sizes to 3 inches: Cast iron hook
5. Vertical support: Stainless steel riser clamp
6. Copper pipe support: Stainless steel ring, adjustable, copper plated

2.3 ACCESSORIES

A. Hanger rods: ASTM A307, Grade R. Mild steel threaded both ends, threaded one end, or continuous threaded

B. Isolation pads: neoprene waffle type
1. Manufacturers: Mason Industries "Type W", Fabreka Production Company "Fabcel", or accepted substitution

C. Insulation protection shield: ANSI/MSS SP-58

2.4 FLASHING

A. Metal flashing: 26 gauge galvanized steel

B. Metal counter flashing: 22 gauge galvanized steel

C. Flexible flashing: 0.125 inch thick sheet butyl-isoprene; compatible with roofing

D. Caps: Steel, 22 gauge minimum

2.5 SLEEVES

A. Sleeves for round ductwork: Galvanized steel

B. Sleeves for rectangular ductwork: Galvanized steel or wood

C. Sealant: Refer to Section 07900

2.6 FINISHING

A. All hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories: Galvanized Steel unless otherwise indicated or specified

B. For stainless steel components: none required

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions

B. Pipe supports and anchors are not indicated on drawings in all locations; supports are indicated for most larger pipes

C. Provide system of pipe supports and anchors for all piping

D. Provide additional supports as required adjacent to couplings

E. Pipe supports shall be provided at all changes in direction and adjacent to flexible couplings

3.2 PIPE HANGERS AND SUPPORTS

A. For designated pipe supports located adjacent to equipment and other locations requiring vibration isolation, provide isolation pad

B. Support horizontal piping as scheduled

C. Install hangers to provide minimum ½ inch space between finished covering and adjacent work

D. Brace all piping 2-1/2 inch and larger for Seismic Zone B forces in accordance with local building codes

E. Place hangers within 12 inches of each horizontal elbow

F. Use hangers with 1½ inch minimum vertical adjustment

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers

H. Support riser piping independently of connected horizontal piping

I. Design hangers for pipe movement without disengagement of supported pipe

J. Piping connections to equipment: Provide pipe support adjacent to equipment. Pipes shall not be supported on equipment

K. Do not support lower pipe from pipe above

L. Support pipe 1½ inch minimum from walls and 3 inch minimum below ceilings

M. From framing strut systems, cut ends and paint exposed metal with galvanized paint

N. Prime coat exposed steel hangers and supports. Refer to Section 09900. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed

O. Do not install pipe supports in equipment access areas

3.3 EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment. Refer to Drawings for location of pads

B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment

C. Construct supports of steel members. Brace and fasten with flanges bolted to structure

D. Provide rigid anchors for pipes after vibration isolation components are installed

3.4 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs

B. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb

3.5 SCHEDULES

A. Maximum hanger spacing and rod size for cast iron, ductile iron, steel and PVC:

Pipe size (inches)	**Max. hanger spacing (feet)**	**Hanger rod diameter (inches)**
1½ and smaller	6	3/8
1 ½ to 2	8	3/8 to 1/2
2 ½ to 3	10	1/2 to 5/8
4	10	5/8
6 and 8	12	3/4
10 and 12	14	7/8
14 and16	16	1
18	16	1-1/8
20 and larger	18	1-1/4
PVC (all sizes)	6	Same as for steel

B. Maximum hanger spacing and rod size for copper and stainless steel piping
   1. Spacing:
      a. 1 inch and smaller: 5 feet maximum
      b. 1¼ inch and larger: 2 feet less than maximum spacing for steel pipe of same size
   2. Hanger rod size: Same as for steel

END OF SECTION

SECTION 15100

VALVES, COCKS, AND HYDRANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Valves indicated on the drawings specified or required for proper operation of equipment or systems

1.2 RELATED SECTIONS

A. Section 09900 – Painting

B. Section 15060 – Pipe and Pipe Fittings

1.3 REFERENCES

A. American National Standards Institute (ANSI)
   1. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings

B. American Society for Testing and Materials (ASTM)
   1. A48 – Standard Specification for Gray Iron Castings
   2. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

C. American Water Works Association (AWWA)
   1. C500 – Metal-Seated Gate Valves for Water Supply Service
   2. C504 – Rubber Seated Butterfly Valves
   3. C508 – Swing Check Valves for Waterworks Service, 2 in through 24 in NPS
   4. C512 – Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
   5. C550 – Protective Epoxy Interior Coatings for Valves and Hydrants

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Product Data: Provide data on valves and accessories. Provide manufacturer's catalog information with dimensions, materials, and assembled weight. Indicate valve data and pressure ratings

C. Manufacturer's Instructions: Provide complete manufacturer's installation instruction

1.5 PROJECT RECORD DOCUMENTS

A. Record actual size, type and locations of valves

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01730

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views

1.7 QUALITY ASSURANCE

A. Manufacturer's name and pressure rating marked on valve body

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience

1.9 REGULATORY REQUIREMENTS

A. Conform to all municipal codes and ordinances, laws and regulations of the State

B. In case of apparent conflict, state and local requirements govern over these specifications

C. In absence of state and local regulations, International Plumbing Code will apply

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 01600

B. Prepare valves and accessories for shipment according to AWWA C500

C. Accept valves on site in shipping containers with labeling in place. Inspect for damage

D. Provide temporary protective coating on cast iron and steel valves

E. Seal valve ends to prevent entry of foreign matter into valve body

PART 2 PRODUCTS

2.1 GENERAL

A. Construction
   1. Actual valve length within ± 1/16" of specified or theoretical length
   2. Ends, except as otherwise specified
      a. 3" and smaller, threaded or soldered ends
      b. 4" and larger, flanges, ANSI 125 lb
      c. Wafer style valves designed for installation between ANSI 125 lb flanges

B. Actuators
   1. Manual actuators:

a. Provide manual actuators for all valves not specified to be power actuated or designed for automatic operation
   1) General use: Handwheel
   2) Seven feet or more above the floor or grade unless otherwise indicated: Chain wheel with operating chain
      a) Equipped with chain guide to permit rapid chain handling of the chain without “gagging” the wheel and to permit reasonable side pull on the chain
      b) With extensions as required to prevent interference with adjacent piping or equipment
      c) Chain heavily zinc or cadmium-plated and looped to extend between 3' and 4' of the floor or grade below valve
b. Buried valves specified in Section 02616
c. Rotation
   1) Counter clockwise (to the left) to open
   2) The word “OPEN” and an arrow indicating the direction to open cast on each valve body or operator
   3) Position indicator clearly visible from operating floor
d. Extension stems
   1) Provide where indicated on drawings, specified, or required for proper operation
   2) Non-rising stems
      a) Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
      b) Connected to the valve by a flexible socket coupling
      c) All other connections pinned, keyed, or socket
   3) Rising stem
      a) Stainless steel or carbon steel shafting with O.D. not less than O.D. of valve stem
      b) Bronze or stainless steel sleeves securely attached to stem
      c) Sleeve length and location to extend through each stem guide throughout the full vertical travel of the stem
e. Stem guides
   1) Cast iron, bronze brushed, adjustable in two directions
   2) If extension stem length exceeds 10' or the weight exceeds 50 lbs., design top guide to carry the stem weight and provide a collar on the stem to bear against the thrust guide
   3) Max spacing
      a) Non-rising stems: 100 times stem O.D.
      b) Rising stems: 60 times stem O.D.
      c) Ten foot maximum
f. Operating Stands
   1) Provide as indicated on drawings
   2) Fabricates steel or cast iron
   3) Support the handwheel or lever approximately 36" above the floor
   4) Handwheel diameter: 8" minimum
   5) Provide a standard weight galvanized pipe sleeve for opening in the floor

6) For longer than 10' and without stem guides with thrust bearings, provide a suitable thrust bearing in each stand to carry extension stem weight

2. Electric Actuators
   a. Provide motor actuators as indicated on Drawings
   b. Each motor actuator to consist of motor, actuator unit gearing, handwheel, limit and torque switches, mechanical position indicator, lubricants, heating element, wiring, terminals and integral reversing controller on capacitance starter as indicated, constructed as a self-contained unit
   c. Housing: Cast, weatherproof, NEMA 4 unless indicated otherwise
      1) Operating time from fully open to fully closed or the reverse:
      2) For open/close valves: 30 seconds
      3) For modulating valves: adjustable from 15 seconds to two minutes
   d. Motors
      1) Mounted horizontally adjacent to or vertically above gearing
      2) Do not mount with motor vertical below gearing
      3) Totally enclosed, high torque, designed expressly for valve operator service
      4) Service rating:
         a) Open/close service motors shall be rated for 15 minute continuous duty
         b) Modulating service motors shall be rated for a minimum of 600 starts/hour
         c) Designed in accordance with NEMA Standards
         d) Insulation: Class F or better
         e) Bearings: Permanently lubricated
         f) Voltage tolerance: +/- 10 percent
         g) Voltage rating: 480 Volt, 60 Hz, 3 phase
         h) Conform to AWWA C540
      5) Gearing
         a) All grease lubricated
         b) Service factor: 2.0
         c) Effectively sealed against entrance of foreign material
         d) AGMA nameplate not required
         e) Supported by anti-friction bearings
      6) Designed so motor comes up to speed before stem load is encountered in opening and closing direction
      7) Self locking worm gear drive with alloy bronze worm gear and hardened steel worm
      8) Handwheel/Chainwheel mechanism
         a) Designed to handwheel/chainwheel does not operate during motor operation
         b) Designed so motor does not rotate when handwheel/chainwheel is rotated after declutching
         c) Provide declutching extensions to allow declutching of all electric actuators from floor level
         d) Actuator responsive to electrical power and control at all times, instantly disengaging handwheel/chainwheel
         e) Shall meet all requirements for manual actuator
      9) Torque switches
         a) Provide opening and closing torque and thrust limit switches

b) Micrometer adjustment on each switch
c) Reference setting indicator
d) Variability 40 percent
e) Contact rating: 6 amp inductive at 120 Vac

10) Geared limit switches
a) Space for 4 geared limit switch assemblies
b) Each assembly with 2 sets of NO contacts and 2 sets of NC contacts
c) Each assembly geared to driving mechanism and independently adjustable to transfer at any point between fully open and fully closed valve position
d) Contact rating: 6 amp inductive at 120 Vac
e) Provide three limit switch assemblies

11) Heating element
a) Provide in actuator housing
b) Rated 120 Vac
c) Continuously energized

12) Terminal facilities: Provide for connection to motor leads, switches, heating elements, control and power supply

13) Controller
a) Integrally mounted solid state reversing controller for modulating operators, integrally mounted electromechanical controller for open-close operators
b) Motor overload protective device
c) Electrically interlocked
d) Provided with the necessary direct operated auxiliary contacts for required interlocking and control

14) Pilot devices, Modulating Service
a) In a weatherproof enclosure close-coupled to actuator housing
b) Open-stop-close maintained contact push buttons
c) Hand-Auto maintained selector switch
d) Red “Open” and green “Closed” indicating lights
e) Auto position of selector allows 4-20 ma input proportional to required valve position

15) Pilot Devices, Open/Close Service
a) In a weatherproof enclosure close-coupled to actuator housing
b) Local Open/Close maintained pushbuttons
c) Local Hand-Auto maintained selector switch
d) Local red “Open” and green “Closed” indicating light
e) Auto position of selector allows open or close operation from remote un-powered contact from maximum distance of 300 feet

16) NEMA Size 1 minimum

17) Action on loss of command signal shall be selectable to include open, close, or last position

18) Controller for modulating service shall include provisions for zero, span gain, opening and closing speed potentiometer and deadband adjustment

C. Pneumatic Operators
1. Provide factory mounted to valve body with external valve position indicator. All accessories shall be assembled and tested prior to shipment

2. Provide ball valve on each air actuation line for isolation
3. Pressure rating shall be 125 psi, minimum
4. Actuator: rack and pinion style
5. Open and close travel shall be provided with speed control adjustments
6. Provide with factory mounted solenoid valve, 120 VAC, NEMA 4. Solenoid valve shall close butterfly valve on power load, manual override lever provided
7. One compressed air filter shall be provided with each pneumatic valve operator, filter shall be:
   a. 40 micron, polycarbonate bowl
   b. Automatic drain, 1/4 inch pipe size, 150 psi working pressure
   c. 0-27 cfm capacity
   d. Manufacturers: McMaster Carr "#4274K14" or accepted substitution

2.2 BUTTERFLY VALVES

A. Manufacturers:
   1. Dezurik
   2. Mueller
   3. Bray
   4. Milliken
   5. Valmatic
   6. Or accepted substitution

B. Process valves provided with treatment unit are specified in Section 11301

C. Design Conditions
   1. Valves shall be one piece shaft and one piece body construction
   2. Bi-directional and tested to 110% of full rating
   3. Through stem direct drive double “D” design requiring no disc screws or pins
   4. Tongue-and-groove seat design, molded in O-ring with no flange gaskets required
   5. 100 psi max operating pressure
   6. Rubber seat, tight closing discs seat at 90 degree with pipe axis
      a. Drop tight service to 150 psi in both directions
   7. Minimum operator torque rating: 150% of valve unseating torque, or operating torque, if higher

D. Valve Design
   1. Shall be in conformance with AWWA C504 and C540
   2. Conform to Valve Schedule criteria in this section
   3. Body: Shall be cast iron, one piece shaft and body construction, ASTM A126, Class B
   4. Shaft shall be stainless steel
      a. Keys and pins to secure disc to shaft shall be 18-8 stainless steel or monel
   5. Valve ends: Shall be ANSI B16.1 Class 125 for cast-iron body valves, Class 25A through Class 150B
   6. Joints:
      a. Shall be mechanical type rubber-gasket joint ends or flanged
      b. Shall conform to AWWA C111

7. The use of a stop or lug cast integrally with or mechanically secured to the body for the purpose of limiting disc travel by means of direct contact or interference with the valve disc (in either the open or closed position) will not be acceptable

E. Materials
1. Body: Cast iron for Class 25A through Class 150B valves
2. Disc: Cast iron, ASTM A48 Class 40C, with electroless nickel-plated edge or ductile iron for Class 25A through Class 150B valves
3. Seats:
   a. EPDM for services up to 250 Deg F
   b. Shall be body mounted
   c. Provide field replaceable and adjustable seat accessible from downpressure side of valve for sizes 30-inch and larger
   d. Mating seat surface shall be stainless steel or monel, sprayed or plated mating surfaces are not acceptable
      1) Resilient seat, tight closing
   e. Discs seat at 90 degrees with pipe axis
4. Shaft seals:
   a. Shall be designed for use of standard self-adjusting split-V-type packing or standard O-ring seals
   b. Pull down packing is not acceptable

F. Valve position indicators
1. Provide position indicators on all exposed operators
2. Provide on each extension stem operating nut
3. Identify open position of valve, 0-100%
4. Manufacturers:
   a. Mills Engineering "Indico Model 128"
   b. Pratt "Diviner"
   c. Or accepted substitution

G. Operator locking devices
1. Modulating and throttling service: Infinitely variable locking device or a totally enclosed geared operator as indicated
2. Other lever operators: Readily locked in the open, closed, and not less than five intermediate positions
3. Effluent service non-modulating

2.3 CHECK VALVES

A. Provide external lever and weight style with external adjustable air cushion/pneumatic cylinder in accordance with AWWA C508

B. Manufacturers:
1. Mueller "A-2606-6-01"
2. Golden Anderson "Fig. 250D"
3. Or accepted substitution

C. Design
   1. 175 psi working pressure
   2. Conform to Valve Schedule criteria in this section
   3. Adjustable weight position
   4. Body: Shall be cast iron
   5. Furnish with extended stainless steel hinge with outside lever and weight
   6. Horizontal installation
   7. Resilient seat or rubber disc facing
   8. Flanges: Shall be ANSI B16.1 Class 125

2.4 AIR RELEASE AND VACUUM RELIEF VALVES

A. Manufacturer
   1. Val-Matic
   2. Crispin
   3. Or accepted substitution

B. General
   1. Provide as indicated on Drawings
   2. Water working pressure: 125 psi
   3. Provide a shutoff valve: Ball valve, globe valve, eccentric action cock
      a. Manufacturers:
         1) Nibco "U-Valve"
         2) Dyna-Quip "Combo Valve"
         3) Or accepted substitution

C. Clean Water Service
   1. Individual air release valves:
      a. Provide air release valves at vertical turbine pump discharge as indicated on the drawings
      b. Inlet and outlet size as indicated on Drawings
      c. Manufacturers:
         1) GA "Figure AR"
         2) Val-Matic "Model 38"
         3) APCO "200A"
         4) Or accepted substitution
   2. Combination air release and vacuum relief valves: 3-inches and smaller
      a. Provide integral type that functions as both an air vacuum valve and an air release valve
      b. Inlet and outlet size as indicated on Drawings
      c. Manufacturers:
         1) GA "Figure CAV"
         2) Val-Matic "200C Series"
         3) APCO "140C Series"
         4) Or accepted substitution
   3. Combination air release and vacuum relief valves: 4-inches and larger
      a. Provide air and vacuum valve with externally mounted air release valve
      b. Inlet and outlet size as indicated on Drawings

c. Manufacturers:
   1) GA "Figure CAV"
   2) Val-Matic "Combination Air Valve"
   3) Valve and Primer "APCO Custom Combination Air Release"
   4) Or accepted substitution

2.5 BALL VALVES

A. Manufacturers for air and water service 2-inches and larger:
   1. Crane "Hiflex 81202"
   2. Jamesbury "D150F"
   3. Walworth "C4100F"
   4. Or accepted substitution

B. Manufacturers for air and water service 2-inches and smaller:
   1. Jamesbury "A-11"
   2. Lunkenheimer "707-XLB"
   3. Nibco "T-590W"
   4. Jenkins "30-A"
   5. Or accepted substitution

C. Application
   1. Except as otherwise indicated or specified, provide ball valves for all 2-1/2" or smaller shutoff valves
   2. Provide additional ball valves as indicated on drawings or as specified
   3. Ball valves for chemical and chlorine service are specified in Section 11245 and 11355 respectively

D. Fabrication
   1. Handles showing direction of opening
   2. Ball design which does not allow media contact with stem
   3. Balancing stop for all applications

2.6 PRESSURE RELIEF AND SURGE ANTICIPATOR VALVE

A. Manufacturers
   1. Cla-Val
   2. Or accepted substitution

B. Design
   1. Quantity: One (1), for high service discharge line
   2. Size: 10-inch angle pattern body, full internal port size
   3. Maximum suggested flow: 4,900 gpm
   4. Maximum suggested surge: 11,000 gpm

C. Performance
   1. Provide quick opening at pre-set (adjustable) over pressure and dissipate surge
   2. Close slowly when normal line pressure is restored

3. Anticipate surge and open quickly on pre-set duration and then close slowly
4. Provide time delay pilot to close main valve after surge is dissipated to prevent dewatering of system

D. Materials
1. End Connections: Flanged ANSI B16.1 125 lb
2. Valve body and cover:
   a. Cast Steel, ASTM A216-WCB
   b. Cast iron, ASTM A536
   c. Cast Bronze, ASTM B62
3. Trim: Bronze ASTM B62
4. Pilot Control: Bronze, ASTM B62 with Stainless Steel 303 Trim
5. Rubber and Disc: Buna-N synthetic
6. Stem, Nut & Spring: Stainless Steel
7. Diaphragm: Nylon Reinforces Buna-N rubber
8. 1-1/2 inch and Larger: Cla-Val "50-01" or accepted substitution
9. 3/4 inch and smaller: Cla-Val "55F" or accepted substitution

E. Construction
1. Cast iron, conforming to ASTM Specification A-126 Class B
2. Bronze mounted
3. Shall be of 10 degrees offset seat design with offset single pivoted hinge
4. Length suitable for concrete wall thickness

2.7 SOLENOID VALVES

A. Solenoid Valves: Smaller than 1-inch
1. Manufacturers:
   a. ASCO "8600"
   b. Fisher "260"
   c. Hoffman "420"
   d. OPW Jordan "811 VP"
   e. Or accepted substitution
2. Bronze bodies and bonnets
3. Valves shall be packless construction without packing box or sliding seal
4. 120 VAC encapsulated Class F coils in NEMA 1 enclosures, spade type terminals
5. Enclosures for outdoors, above water surfaces, and in treatment building process area shall be NEMA 4 with conduit hubs. All areas, enclosure shall be NEMA 1 with conduit hubs
6. Design pressure for water and air service: 125 psi
7. Maximum required differential for 1/4 inch valves: 0 psi
8. Maximum required differential for 3/8-inch to 1-inch valves: 5 psi
9. Provide a bronze bodied upstream Y-strainer with monel or stainless steel screens for water service applications

B. Solenoid Valves: 1-inch and Larger
1. Manufacturers:
   a. Cla-Val Company "Model 136 G-01"

b. GA "Fig. 69D" or "7100D"
c. Or accepted substitution

2. Provide cast iron, globe type valves with a resilient disc
3. Horizontal or vertical installation
4. Provide voltages as required by electrical drawings
5. Design pressure: 125 psi

2.8 BACKFLOW PREVENTER

A. Provide a dual check valve assembly with reduced pressure zone and inlet and outlet isolation valves

B. Manufacturers:
1. Febco "RP Type 825"
2. Cla-Val "RP"
3. Or accepted substitution

C. Design
1. Provide cast iron body, bronze mounted valves

2.9 CORPORATION STOPS

A. Manufacturers:
1. Mueller
2. Ford
3. Or accepted substitution

B. Design:
1. Material shall be bronze unless otherwise noted
2. Design pressure: 150 psi

2.10 CORROSION CONTROL

A. Shop paint all ferrous metal surfaces of valves and accessories, both interior and exterior for corrosion protection

B. Manufacturer's standard paint will be acceptable if it is functionally equivalent to the specified paint and compatible with the specified field painting

C. Materials:
1. Bituminous varnish: ANSI-A21.4, AWWA C104
2. Coal tar manufacturers:
   a. Koppers "Bitumastic Super Tank Solution”
   b. Tnemec
   c. Or accepted substitution
3. Epoxy manufacturers:
   a. Mobil “78-D-7 Tank Lining Epoxy”
   b. Tnemec “Hi-Build Epoxoline”
   c. Or accepted substitution

4. Rust-inhibitive primer manufacturers:
   a. Mobil “13-R-50 Chromox Q.D. Primer"
   b. Tnemec ”77H Chem-Prime”
   c. Or accepted substitution
5. Rust-preventive compound manufacturers:
   a. Houghton “Rust Veto 344”
   b. “Rust-Oleum R-9”
   c. Or accepted substitution

D. Surfaces to be painted
   1. Unfinished surfaces:
      a. Interior: Bituminous varnish (2 coats), coal tar, or epoxy
      b. Exterior to be buried, submerged, or located in manholes: coal tar epoxy
      c. Other exterior: rust inhibitive primer
   2. Polished or machined surfaces: Rust-preventive compound
   3. Operators and accessories: rust-inhibitive primer

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
   1. Carefully inspect valve before installation. Clean interior. Operate valve to determine parts in proper working order, with valves seating and drain valve operating properly
   2. Install valves and accessories in accordance with the manufacturer's recommendation and in accordance with referenced standards and specifications and shown on Drawings
   3. Provide a union or flanged connection within 2 feet of each threaded end valve unless the valve can otherwise be easily removed from piping
   4. Set valve and valve boxes plumb
   5. Install valve box directly over the valve it serves with the top of the box flush with finish grade
   6. Fill around box with earth and thoroughly tamp on all sides

B. Check valves: Install ball check valves in vertical piping

C. Air release and Vacuum-Relief Valves:
   1. Provide exhaust piping to a suitable disposal point

3.2 ADJUSTMENT

A. Check and adjust valves, actuators, and accessories for smooth operation in accordance with manufacturer's instructions

END OF SECTION

SECTION 15145

WATER PIPING SPECIALTIES

GENERAL

1.1 SECTION INCLUDES

A. Backflow Preventers

B. Pressure Reducing Valves

1.2 RELATED SECTIONS

A. Section 01340 – Shop Drawings, Product Data, and Samples

B. Section 15060 – Pipe and Pipe Fittings

C. Section 15090 – Valves, Cocks, and Hydrants

1.3 REFERENCES

A. American Society of Sanitary Engineering (ASSE)
1. 1001 - Pipe Applied Atmospheric Type Vacuum Breakers
2. 1003 - Water Pressure Reducing Valves
3. 1010 - Water Hammer Arresters
4. 1011 - Hose Connection Vacuum Breakers
5. 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers
6. 1052 - Hose Connection Backflow Preventers
7. 1056 - Spill Resistant Vacuum Breakers

B. ASME International (ASME)
1. A112.1.2 - Air Gap Fittings in Plumbing Systems
2. A112.18.1 - Plumbing Fixture Fittings
3. B1.20.7 - Hose Coupling Screw Threads (Inch)

C. American Society for Testing and Materials (ASTM)
1. B62 - Composition Bronze or Ounce Metal Castings
2. B88 - Seamless Copper Water Tube
3. A48/A48M - Gray Iron Castings
4. A53/A53M - Pipe, Steel, Black and hot-Dipped, Zinc-Coated, Welded and Seamless
5. A532/A532M - Abrasion-Resistant Cast Irons
6. B584 - Copper Alloy Sand Castings for General Applications

D. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
1. SP-80 - Bronze Gate, Globe, Angle and Check Valves

2. SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

E. National Fire Protection Association (NFPA)
1. 70 - National Electrical Code

F. NSF International (NSF)
1. 14 - Plastics Piping Components and Related Materials
2. 61 - Drinking Water System Components - Health Effects; Sections 1 through 9

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Shop Drawings: Provide piping layout fabrication and assembly drawings with fittings dimensions. Provide sufficient information to verify compliance with specifications

C. Product Data: Provide sufficient data to verify compliance with specifications

D. Test Reports: Submit all shop and field test reports in accordance with Division 1 Specifications Product Data

PART 2 PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Manufacturers
1. Ames Co.
2. Conbraco Industries, Inc.
3. FEBCO; SPX Valves & Controls.
4. Flomatic Corporation.
5. Watts Industries, Inc.; Water Products Div.
6. Zurn Plumbing Products Group; Wilkins Div.
7. Or accepted substitution

B. Design
1. Shall be suitable for continuous-pressure applications
2. Shall be for horizontal straight through flow
3. 12 psig maximum pressure loss through middle 1/3 of flow range
4. 2-inch (NPS 2) and smaller:
   a. Body: Bronze
   b. End Connections: Threaded
5. 2-1/2-inch (NPS 2-1/2) and larger:
   a. Body: cast iron with interior lining complying with AWWA C550
   b. End Connections: Flanged
6. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection

7. Conform to ASSE 1013

2.2 PRESSURE REDUCING VALVES

A. Manufacturers
1. Cash Acme.
2. Conbraco Industries, Inc.
3. Honeywell Water Controls.
4. Watts Industries, Inc.; Water Products Div.
5. Zurn Plumbing Products Group; Wilkins Div.
6. Or accepted substitution

B. Design
1. Shall be designed for 175 psi working pressure (all sizes)
2. Conform to ASSE 1003
3. Design Inlet Pressure: 170 psig
4. Design Outlet Pressure Setting: 75 psig
5. Bronze for NPS 2 and smaller; cast iron for NPS 2-1/2 and NPS 3.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install as specified and indicated on drawings

B. Test each reduced-pressure-principle backflow preventer according to manufacturers recommendations, authorities having jurisdiction, and the reference standard

C. Set field-adjustable pressure set point of pressure reducing valves

END OF SECTION

SECTION 15400

PLUMBING FIXTURES AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hose Bibs

B. Wall Hydrants

C. Utility Sinks

D. Emergency Eye Wash

E. Submersible Sump Pumps

1.2 RELATED SECTIONS

A. Section 01340 – Shop Drawings, Product Data, and Samples

B. Section 01600 – Materials and Equipment

C. Section 01730 – Operation and Maintenance Data

D. Section 03300 – Concrete

E. Section 15060 – Pipe and Pipe Fittings

F. Section 15090 – Valves, Cocks, and Hydrants

G. Section 16050 - Basic Electrical Materials and Methods

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. A48/A48M - Gray Iron Castings
   2. A53/A53M - Pipe, Steel, Black and hot-Dipped, Zinc-Coated, Welded and Seamless
   3. A532/A532M - Abrasion-Resistant Cast Irons
   4. B584 - Copper Alloy Sand Castings for General Applications

B. Hydraulic Institute (HI)
   1. 1.1-1.2 - Centrifugal Pumps for Nomenclature and Definitions
   2. 1.3 - Centrifugal Pumps for Design and Applications
   3. 1.4 - Centrifugal Pumps for Installation, Operation, and Maintenance

C. National Electrical Manufacturers Association (NEMA)
   1. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

D. National Fire Protection Association (NFPA)
   1. 70 - National Electrical Code

E. Underwriters Laboratories Inc. (UL)
   1. 778 - Motor Operated Water Pumps

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Shop Drawings: Provide piping layout fabrication and assembly drawings with fittings dimensions. Provide sufficient information to verify compliance with specifications

C. Product Data: Provide sufficient data on pumps, controls, discharge piping, and accessories to verify compliance with specifications

D. Test Reports: Submit all shop and field test reports in accordance with Division 1 Specifications Product Data

1.5 HOSE BIBS

A. Manufacturers
   1. Woodford Manufacturing Company
   2. Chicago Faucets
   3. Or accepted substitution

B. Design
   1. Ball-Valve-Type, Hose-End Drain Valves:
      a. Conform to MSS SP-110 for standard-port, two-piece ball valves
      b. 400-psig minimum pressure rating
      c. Size: NPS 3/4
      d. Body: Copper alloy
      e. Ball Chrome-plated brass.
      f. Vacuum Breaker: Integral
      g. Seats and Seals: Replaceable
      h. Handle: Vinyl-covered steel wheel
      i. Inlet: Threaded or solder joint
      j. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Gate-Valve-Type, Hose-End Drain Valves:
   1. Conform to MSS SP-80 for gate valves
   2. Class 125 Pressure Rating
   3. Size: NPS 3/4
   4. Body: ASTM B 62 bronze
   5. Vacuum Breaker: Integral
   6. Handle: Vinyl-covered steel wheel
   7. Inlet: NPS 3/4 threaded or solder joint
   8. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain

1.6 FREEZELESS WALL HYDRANTS

A. Manufacturers
   1. Woodford Manufacturing Company
   2. Kay R. Smith
   3. Zurn
   4. Or accepted substitution

B. Design
   1. Type: Non-freeze, automatic draining with vacuum breaker
   2. Valve Seat: Permanent type brass valve body with hemispherical seating surface
   3. Drain: Under nozzle away from hands of operator and with a lip to divert water away from building
   4. Vacuum Breaker: Anti siphon, 3/4-inch male hose thread outlet
   5. Key: Loose tee key operates hydrant, provide one per hydrant
   6. Operating Rod: 3/8-inch solid brass operating rod
   7. Exterior Finish: Chrome Plated
   8. Inlet: 3/4-inch copper water tube
   9. Verify wall thickness with drawings

1.7 UTILITY SINKS

A. Manufacturers
   1. Florestone
   2. American Standard
   3. Crane
   4. Williams
   5. Or accepted substitution

B. Design
   1. Material: Fiberglass reinforced polyester resins
   2. Mounting: Free standing utility sink
   3. Faucet: Chicago Faucet 891-LB with integral stops and vacuum breaker
   4. Drain: Stainless steel, dome strainer and lint basket, 3" IPS on integral molded drain
   5. Legs: Heavy duty molded legs
   6. Color: White

1.8 EMERGENCY EYE WASH

A. Manufacturers
   1. Bradley Corporation
   2. Encon Safety Products
   3. Guardian Equipment Co
   4. Western Emergency Equipment
   5. Or accepted substitution

B. Design

1. Type: plumbed, freestanding, pedestal eye/face wash equipment
2. Capacity: Shall deliver potable water at a rate not less than 3.0 gpm for at least 15 minutes
3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve
4. Control-Valve Actuator: Paddle
5. Receptor: Plastic Bowl
6. Drain Piping: NPS 1-1/4 minimum, chrome-plated brass, receptor drain, P-trap, waste to wall and wall flange complying with ASME A112.18.2. Include galvanized-steel indirect connection to drainage system

1.9 TRENCH DRAINS

A. Manufacturers
1. Zurn
2. J.R. Smith
3. Or accepted substitution

B. Model
1. Design Basis: Zurn Z886-8602

C. Design
1. HDPE structural composite trench drain
2. Pre-sloped channel with 0.75% minimum slope
3. Width: 6"
4. Capacity: 120 gpm
5. Minimum depth: 4"
6. Heavy-duty cast iron grate with corrosion resistant coating

1.10 SUBMERSIBLE SUMP PUMPS

A. Manufacturers
1. Float-operated, duplex pumping system and control panel to be supplied by single manufacturer
   a. ABS Pumps
   b. Aurora
   c. Goulds Pumps
   d. Zoeller

B. Model
1. Design Basis: Zoeller Series 267 submersible, Duplex

C. Motor
1. Submersible, capacitor-start type with built in overload protection
2. 460V / 60Hz / 3ph
3. 1725 RPM

D. Power Cable

1. UL Listed, 3-conductor waterproof neoprene jacketed chord of required length

E. Seal
1. Watertight and dust tight hermetically sealed
2. Carbon and ceramic rotary face with stainless steel wetted parts

F. Cast Iron Base and Impeller

G. Valves
1. Discharge piping from EACH pump shall have double check valves in series

H. Control System
1. Hand-Off-Auto (HOA) Toggle Switch on control panel for each pump
2. Green pump run pilot light for each pump
3. Alarm test and silence switches
4. Red pilot light and audible alarm for high water condition
5. Auxiliary Dry Contact/high Water Alarm
6. Magnetic starter for each pump
7. Alternate mechanism for duplex operation
8. Numbered terminal strip for connecting pumps and variable level float switches
9. Nema 1 - general purpose available
10. Integral auxiliary terminal board connections (dry contact) for remote alarm devices
11. Three (3) variable level float switch control operation
12. UL listed
13. 2 year warranty
14. The use of off-the-shelf components provide for relatively easy field maintenance and repair

2.1 INSTALLATION

A. Install as specified and indicated on drawings

B. Provide union in discharge piping above floor for easy sump pump removal

C. Provide double check valves in series for each sump pump discharge

D. Provide unions where required for equipment removal, indicated on the drawing or specified

E. Install Pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings and accessories

F. Support piping so weight of piping is not supported by pumps

END OF SECTION

SECTION 15517

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   Pressure Plates: Carbon steel.
2. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 15517

SECTION 15523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron swing check valves with closure control.
7. Bronze gate valves.
8. Iron gate valves.
9. Bronze globe valves.
10. Iron globe valves.
11. Chainwheels.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.2 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

2.2 BRASS BALL VALVES

A. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kitz Corporation.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.

c. Body Design: One piece.
d. Body Material: Forged brass.
e. Ends: Threaded.
f. Seats: PTFE or TFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group;
b. DynaQuip Controls.
c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
d. Hammond Valve.
e. Jomar International, LTD.
f. Kitz Corporation.
g. Legend Valve.
h. Marwin Valve; a division of Richards Industries.
i. Milwaukee Valve Company.
j. NIBCO INC.
k. Red-White Valve Corporation.
l. RuB Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

C. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hammond Valve.
b. Jamesbury; a subsidiary of Metso Automation.
c. Legend Valve.
d. Marwin Valve; a division of Richards Industries.

e. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Regular.

2.3 BRONZE BALL VALVES

A. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE or TFE.
g. Stem: Bronze.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Hammond Valve.

e. Lance Valves; a division of Advanced Thermal Systems, Inc.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

C. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group;.
d. DynaQuip Controls.
e. Hammond Valve.
f. Lance Valves; a division of Advanced Thermal Systems, Inc.
g. Milwaukee Valve Company.
h. NIBCO INC.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Regular.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
   d. Crane Co.; Crane Valve Group;
   e. DeZurik Water Controls.
   f. Flo Fab Inc.
   g. Hammond Valve.
   h. Kitz Corporation.
   i. Legend Valve.
   j. Milwaukee Valve Company.
   k. NIBCO INC.
   l. Norriseal; a Dover Corporation company.
   m. Red-White Valve Corporation.
   n. Spence Strainers International; a division of CIRCOR International, Inc.
   o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
   d. Crane Co.; Crane Valve Group;
   e. DeZurik Water Controls.
   f. Flo Fab Inc.
   g. Hammond Valve.

h. Kitz Corporation.
i. Legend Valve.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Norriseal; a Dover Corporation company.
m. Red-White Valve Corporation.
n. Spence Strainers International; a division of CIRCOR International, Inc.
o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
e. Crane Co.; Crane Valve Group;
f. DeZurik Water Controls.
g. Flo Fab Inc.
h. Hammond Valve.
i. Kitz Corporation.
j. Legend Valve.
k. Milwaukee Valve Company.
l. Mueller Steam Specialty; a division of SPX Corporation.
m. NIBCO INC.
n. Norriseal; a Dover Corporation company.
o. Spence Strainers International; a division of CIRCOR International, Inc.
p. Sure Flow Equipment Inc.
q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated or -coated ductile iron.

D. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. American Valve, Inc.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
e. Crane Co.; Crane Valve Group;
f. DeZurik Water Controls.
g. Flo Fab Inc.
h. Hammond Valve.
i. Kitz Corporation.
j. Legend Valve.
k. Milwaukee Valve Company.
l. Mueller Steam Specialty; a division of SPX Corporation.
m. NIBCO INC.
n. Norriseal; a Dover Corporation company.
o. Spence Strainers International; a division of CIRCOR International, Inc.
p. Sure Flow Equipment Inc.
q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated or -coated ductile iron.

2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Crane Co.; Crane Valve Group;
c. Hammond Valve.
d. Kitz Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Red-White Valve Corporation.
i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
j. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group;
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Red-White Valve Corporation.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Crane Co.; Crane Valve Group;
    b. Hammond Valve.
    c. Kitz Corporation.
    d. Legend Valve.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Powell Valves.
    h. Red-White Valve Corporation.
    i. Sure Flow Equipment Inc.
    j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    k. Zy-Tech Global Industries, Inc.

2. Description:

    a. Standard: MSS SP-71, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Clear or full waterway.
    d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    e. Ends: Flanged.
    f. Trim: Bronze.
    g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Crane Co.; Crane Valve Group;

2. Description:

    a. Standard: MSS SP-71, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Clear or full waterway.
    d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    e. Ends: Flanged.
    f. Trim: Composition.
    g. Seat Ring: Bronze.
    h. Disc Holder: Bronze.
    i. Disc: PTFE or TFE.
    j. Gasket: Asbestos free.

2.7 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. NIBCO INC.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
   h. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Crane Co.; Crane Valve Group;.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
   h. Closure Control: Factory-installed, exterior lever and weight.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Valve, Inc.
    b. Crane Co.; Crane Valve Group;
    c. Hammond Valve.
    d. Kitz Corporation.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Powell Valves.
    h. Red-White Valve Corporation.
    i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    j. Zy-Tech Global Industries, Inc.

2. Description:

    a. Standard: MSS SP-80, Type 1.
    b. CWP Rating: 200 psig.
    c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    d. Ends: Threaded or solder joint.
    e. Stem: Bronze.
    f. Disc: Solid wedge; bronze.
    g. Packing: Asbestos free.
    h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Valve, Inc.
    b. Crane Co.; Crane Valve Group;
    c. Hammond Valve.
    d. Kitz Corporation.
    e. Milwaukee Valve Company.
    f. NIBCO INC.
    g. Powell Valves.
    h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    i. Zy-Tech Global Industries, Inc.

2. Description:

    a. Standard: MSS SP-80, Type 2.
    b. CWP Rating: 200 psig.
    c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    d. Ends: Threaded or solder joint.
    e. Stem: Bronze.
    f. Disc: Solid wedge; bronze.

g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.9 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group;
b. Flo Fab Inc.
c. Hammond Valve.
d. Kitz Corporation.
e. Legend Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
k. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group;
b. Flo Fab Inc.
c. Hammond Valve.
d. Kitz Corporation.
e. Legend Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Red-White Valve Corporation.
j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

k. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.10 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group;
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Powell Valves.
g. Red-White Valve Corporation.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
i. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, Bronze Globe Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group;
b. NIBCO INC.
c. Red-White Valve Corporation.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.11 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group;
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Powell Valves.
g. Red-White Valve Corporation.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
i. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

2.12 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly gate and globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

1. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
2. Throttling Service: Globe or ball valves.
3. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.
c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Two piece, full port, brass or bronze with bronze trim.
4. Bronze Swing Check Valves: Class 125, bronze disc.
5. Bronze Gate Valves: Class 125, NRS.
6. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring weight.
5. Iron Gate Valves: Class 125, NRS.
6. Iron Globe Valves: Class 125.

END OF SECTION 15523

SECTION 15529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 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: Pregalvanized 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. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. 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.

2.2 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.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 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 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.

2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. 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.

B. 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 A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches 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.

E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. 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.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. 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.

M. 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 NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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.

3.3 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.

3.4 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 1-1/2 inches.

3.5 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 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections**.**

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. 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 noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

K. 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 NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. 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 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

M. 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. 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.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. 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.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. 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.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 15529

SECTION 15553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, 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, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.

3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, 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 8-1/2-by-11-inch 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.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, 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.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover 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 1-1/2 inches high.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations 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 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Compressed-Air Piping:

   a. Background Color: Yellow.
   b. Letter Color: White.

2. Domestic Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

3. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Green
   b. Letter Color: White.

END OF SECTION 15553

SECTION 15700

PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Flexible elastomeric.
   b. Mineral fiber.
   c. Polyolefin.
   d. Polystyrene.

2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Sealants.
6. Factory-applied jackets.
7. Field-applied fabric-reinforcing mesh.
8. Field-applied jackets.
9. Tapes.
10. Securements.
11. Corner angles.

B. Related Sections include the following:
   1. Division 23 Section "HVAC Insulation."

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

D. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Johns Manville; HTB 23 Spin-Glas.
    b. Owens Corning; High Temperature Flexible Batt Insulations.

H. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Fibrex Insulations Inc.; FBX.
    b. Johns Manville; 1000 Series Spin-Glas.
    c. Owens Corning; High Temperature Industrial Board Insulations.
    d. Rock Wool Manufacturing Company; Delta Board.
    e. Roxul Inc.; Roxul RW.
    f. Thermafiber; Thermafiber Industrial Felt.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Fibrex Insulations Inc.; Coreplus 1200.
    b. Johns Manville; Micro-Lok.
    c. Knauf Insulation; 1000 Pipe Insulation.
    d. Manson Insulation Inc.; Alley-K.
    e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal

conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Armacell LLC; Tubolit.
   b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
   c. RBX Corporation; Therma-cell.

L. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Dow Chemical Company (The); Styrofoam.
   b. Knauf Insulation; Knauf Polystyrene.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Insulco, Division of MFS, Inc.; SmoothKote.
   b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
   c. Rock Wool Manufacturing Company; Delta One Shot.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements provide one of the following:

a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 97-13.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide the following:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-10.
    b. Foster Products Corporation, H. B. Fuller Company; 35-00.
    c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    d. Marathon Industries, Inc.; 550.
    e. Mon-Eco Industries, Inc.; 55-50.
    f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-76.
    b. Foster Products Corporation, H. B. Fuller Company; 30-45.
    c. Marathon Industries, Inc.; 405.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Pittsburgh Corning Corporation; Pittseal 444.
    f. Vimasco Corporation; 750.

2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-70.
    b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
    c. Marathon Industries, Inc.; 405.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-76-8.
    b. Foster Products Corporation, H. B. Fuller Company; 95-44.
    c. Marathon Industries, Inc.; 405.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, provide one of the following:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for equipment and pipe.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

2. Sheet and roll stock ready for shop or field sizing.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:

   a. Same material, finish, and thickness as jacket.
   b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   c. Tee covers.
   d. Flange and union covers.
   e. End caps.
   f. Beveled collars.
   g. Valve covers.
   h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Pittsburgh Corning Corporation; Pittwrap.

b. Polyguard; Insulrap No Torch 125.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
        2) GEMCO; Perforated Base.
        3) Midwest Fasteners, Inc.; Spindle.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) GEMCO; Nylon Hangers.
        2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

    b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
    c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.

2) GEMCO; Press and Peel.
3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide one of the following:

1) GEMCO.
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping".

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket

flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Equipment and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Heat-Exchanger (Water-to-Water for Domestic Water Heating Service) Insulation: Mineral-Fiber Pipe and Tank: 2 inches thick.

D. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Pipe and Tank: 1 inch thick.
3. Polyolefin: 1 inch thick.

E. Domestic Hot-Water Storage Tank Insulation: Mineral-Fiber Pipe and Tank: Of thickness to provide an R-value of 12.5.

F. Piping System Filter-Housing Insulation: Mineral-Fiber Pipe and Tank: 2 inches thick.

3.13 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold, Hot and Recirculated Hot Water: Insulation shall be one of the following:
1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Chilled Water (Potable): Insulation shall be the following
1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Stormwater and Overflow: Insulation shall be one of the following:

1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies: Insulation shall be one of the following:
1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:

1. Flexible Elastomeric: 1/2 inch thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed: Insulation shall be one of the following:
1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Sanitary Waste Piping Where Heat Tracing Is Installed: Insulation shall be one of the following:
1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.16 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.

3.17 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
1. PVC: 20 mils thick.
2. Aluminum, Stucco Embossed: 0.016 inch

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
1. Aluminum, Stucco Embossed: 0.032 inch thick.

F. Piping, Concealed:

1. None.

G. Piping, Exposed:
1. PVC 20 mils thick.
2. Aluminum, Stucco Embossed: 0.016 inch thick.

3.18 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:
1. Aluminum, Stucco Embossed: 0.024 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Stucco Embossed: 0.024 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Stucco Embossed 0.032 inch thick.

3.19 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 15700

SECTION 15756

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Specialty valves.
3. Flexible connectors.
4. Water meters furnished by utility company for installation by Contractor.
5. Water meters.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components.

C. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
5. Copper Pressure-Seal-Joint Fittings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Elkhart Products Corporation; Industrial Division.
        2) NIBCO INC.
        3) Viega; Plumbing and Heating Systems.

    b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
    c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

6. Copper Push-on-Joint Fittings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) NVent LLC.

    b. Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
2. Copper Pressure-Seal-Joint Fittings:

    a. Manufacturers: Subject to compliance with requirements,[provide products by one of the following:

        1) Elkhart Products Corporation; Industrial Division.
        2) NIBCO INC.
        3) Viega; Plumbing and Heating Systems.

b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
c. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.

a. Gaskets: AWWA C111, rubber.

2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.

a. Gaskets: AWWA C111, rubber.

2.4 PEX TUBE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

1. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.
2. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Description:

a. Galvanized-steel coupling.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Female threaded.
d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:

1. Description:

a. Electroplated steel nipple complying with ASTM F 1545.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Male threaded or grooved.
d. Lining: Inert and noncorrosive, propylene.

2.8 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.9 WATER METERS

A. Displacement-Type Water Meters:

1. Description:

a. Standard: AWWA C700.
b. Pressure Rating: 150-psig working pressure.
c. Body Design: Nutating disc; totalization meter.
d. Registration: In gallons or cubic feet as required by utility.
e. Case: Bronze.
f. End Connections: Threaded.

B. Compound-Type Water Meters:

1. Description:

a. Standard: AWWA C702.
b. Pressure Rating: 150-psig working pressure.
c. Body Design: With integral mainline and bypass meters; totalization meter.
d. Registration: In gallons or cubic feet as required by utility company.

e. Case: Bronze.
f. Pipe Connections: Flanged.

C. Remote Registration System: Remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

G. Install domestic water piping level and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping adjacent to equipment and specialties to allow service and maintenance.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install PEX piping with loop at each change of direction of more than 90 degrees.

S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

T. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump.

U. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

V. Install thermometers on outlet piping from each water heater.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. PEX Piping Joints: Join according to ASTM F 1807.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.
2. NPS 2 and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 to NPS 6: Use dielectric flange kits.

3.7 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 WATER METER INSTALLATION

A. Rough-in domestic water piping for water meter installation, and install water meters according to utility company's requirements.

B. Water meters will be furnished and installed by utility company.

C. Install water meters according to AWWA M6, utility company's requirements, and the following:

D. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

E. Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.

F. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

3.9 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

3. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.

J. Install hangers for vertical PEX piping every 48 inches.

K. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:

      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.14 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 6, shall be the following:

1. Push-on-joint, ductile-iron pipe; standard- or compact- pattern push-on-joint fittings; and gasketed joints.

E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and brazed joints.

F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L; copper push-on-joint fittings; and push-on joints.
4. PEX Tube, NPS 1 and smaller; fittings for PEX tube; and crimped joints.

G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

H. Aboveground domestic water piping, NPS 5 and NPS 6, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
2. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
3. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

3.15 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 15756

SECTION 15777

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

B. Related Section:

1. Division 22 Section "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

C. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Dallas Specialty & Mfg. Co.
c. Fernco Inc.
d. Matco-Norca, Inc.
e. MIFAB, Inc.
f. Mission Rubber Company; a division of MCP Industries, Inc.
g. Stant.
h. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Clamp-All Corp.
c. Dallas Specialty & Mfg. Co.
d. MIFAB, Inc.

e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Stant.
g. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Solvent Cement: ASTM D 2564.

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Dallas Specialty & Mfg. Co.
2) Fernco Inc.
3) Mission Rubber Company; a division of MCP Industries, Inc.
4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

b. Standard: ASTM C 1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company; a division of MCP Industries, Inc.

b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

M. Install aboveground PVC piping according to ASTM D 2665.

N. Install underground PVC piping according to ASTM D 2321.

O. Plumbing Specialties:

1. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Sanitary Waste Piping Specialties."
2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 VALVE INSTALLATION

A. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.

K. Install supports for vertical PVC piping every 48 inches.

L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Not allowed in ceilings used as return air plenums.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Not allowed in ceilings used as return air plenums.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Not allowed in ceilings used as return air plenums.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Not allowed in ceilings used as return air plenums.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; coupled joints.
3. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings Shielded, nonpressure transition couplings.

END OF SECTION 15777

SECTION 15795

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

B. Related Section:

1. Division 33 Section "Storm Utility Drainage Piping" for storm drainage piping outside the building.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

C. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Dallas Specialty & Mfg. Co.
c. Fernco Inc.
d. Matco-Norca, Inc.
e. MIFAB, Inc.
f. Mission Rubber Company; a division of MCP Industries, Inc.
g. Stant.
h. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Clamp-All Corp.
c. Dallas Specialty & Mfg. Co.
d. MIFAB, Inc.

e. Mission Rubber Company; a division of MCP Industries, Inc.
f. Stant.
g. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Solvent Cement: ASTM D 2564.

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Dallas Specialty & Mfg. Co.
2) Fernco Inc.
3) Mission Rubber Company; a division of MCP Industries, Inc.
4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

b. Standard: ASTM C 1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company; a division of MCP Industries, Inc.

b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

I. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

J. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

K. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

L. Install aboveground PVC piping according to ASTM D 2665.

M. Install underground PVC piping according to ASTM D 2321.

N. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.
2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
3. Install drains in storm drainage gravity-flow piping.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

E. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 VALVE INSTALLATION

A. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.

2. Install backwater valves in accessible locations.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

J. Install supports for vertical PVC piping every 48 inches.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor.
3. Comply with requirements for backwater valves cleanouts and drains specified in Division 22 Section "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Not allowed in ceiling spaces used as return air plenums.
4. Dissimilar Pipe-Material Couplings. Shielded, nonpressure transition couplings.

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Not allowed in ceiling spaces used as return air plenums.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings. Shielded, nonpressure transition couplings.

E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Extra Heavy service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 15795

SECTION 15815

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittals and substitutions
2. Identification for HVAC Piping and Equipment.
3. Sleeves.
4. Mechanical sleeve seals.
5. Formed steel channel.
6. Motor Starters and Wiring/Coordination

1.2 SUBMITTALS

A. Shop Drawings: Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

B. Product Data for Pipe and Equipment Identification: Submit for mechanical identification manufacturers catalog literature for each product required.

C. Product Data: Submit for mechanical approval the manufacturers catalog literature for each product required. Submit information showing capacities, dimensions and installation and operating procedures. Submittal information shall be bound in clearly identified 3-ring binders that are indexed and tabbed for the project. Number of submittals shall be as required in the General Conditions or a minimum of five (5) copies.

D. Maintenance Data and Operating Instructions: Submit for approval three (3) copies of operation and maintenance manuals for the owners use. Manuals shall include manufacturer’s installation and operation procedures for each piece of equipment. Manuals shall also include a copy of the Testing and Balancing report. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets. Contractor shall provide scheduled training to the owner for all equipment provided and installed.

E. Building Service Life Plan (Green Globes Submittal): Submit a document/spreadsheet for mechanical, electrical and plumbing systems equipment

showing inspection requirements, frequency of inspections, suggested replacement times, and a preventative maintenance schedule.

1.3 SUBSTITUTIONS

A. Substitutions: Substitution of specified equipment will be allowed through a prior approval process initiated by the contractor. Contractor shall submit intended substitution at least five days prior to bid for approval from Engineer. Submittal shall include capacities, dimensions and operating instructions for each piece of equipment. Substitution shall occur at no cost to the owner. Contractor is responsible for coordination of approved substitution and shall incur all costs associated with the substitution including structural modifications, space layout and redesign costs.

1.4 EXAMINATION OF SITE, DRAWINGS, SPECIFICATIONS

A. Examine carefully the site and conditions of the site. Provide all necessary equipment and labor to install a complete working system within the site conditions.

B. Examine the drawings and specifications and 5 days prior to bidding report any errors, omissions, inconsistencies, and conflicts to the engineer to be remedied in an addendum to the project prior to bid time.

C. Drawings are diagrammatic and catalog numbers given are for reference only. The contractor shall be responsible for verifying the capacity of the equipment meets the drawing requirements and shall not dimension from the mechanical, plumbing, or piping drawings.

D. The latest adopted versions of the International Building codes shall be used as required. This will also include the latest adopted versions of the Mechanical, Plumbing and Energy Conservation Codes. All methods and materials required by these codes shall be required by these specifications unless indicated otherwise. Other applicable local codes and ordinances shall be as required and it shall be the contractor’s responsibility to be knowledgeable of these requirements.

E. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

PART 2 PRODUCTS

2.1 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

A. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.

E. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.2 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

E. Sealant: Acrylic

2.3 MECHANICAL SLEEVE SEALS

A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.4 FORMED STEEL CHANNEL

A. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.5 MOTORS, STARTERS, WIRING

A. Furnish and set in place motors, controls and wiring necessary to operate mechanical equipment in accordance with the following schedule. Starters shall have Hand-Off-Auto, two N.O. contacts and two N.C. contacts. 480 volt starters shall have a 120 volt control transformer sized for the auxiliary equipment provided. Enclosures shall be NEMA 1 unless otherwise indicated. Fuses for the disconnect switches shall be provided under the electrical division.

RESPONSIBLE DIVISION

ITEM	FURNISHED		SET WIRED	POWER-WIRED	CONTROL
Equipment	23	23	26	–	
Mag Motor Starters	23	26	26	23	
Disconnect Switches	26(1)	26(1)	26	–	
Switches, Manual and Multi-speed	23	26	26	–	
Controls, Relays, Transformers	23	23	26	23	
T'Stats and Time Switches	23	23	26	23	
Line Voltage T'Stats	23	23	26	26	
T.C. Control Panels	23	23	26	23	
Motor and Solenoid Valves Damper Motors	23	23(2)	–	23(2)	
Push Buttons and Pilot Lights	23	23(2)	–	23(2)	
HVAC Controls	23	23	26	23	
Exhaust Fan Switches	23	26	26	23(2)	
Fire Protection Controls	26	26	26	26	
Fire and Smoke Detectors	26(3)	26(3)	26	26(3)	

(1) Under Division 23 if furnished factory-wired as part of equipment or if furnished with combination starters.

(2) If item is for line voltage, set in place and connect under Division 26. Where factory mounted on equipment or attached to piping or ducts and using line voltage furnish and set under Division 23, connect under Division 26.

(3) For units factory mounted in or on mechanical equipment or ducts, fan stop connections shall be under Division 23, all other connections under Division 26.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

A. Install plastic nameplates with adhesive.

B. Install plastic tags with corrosion resistant metal chain.

3.3 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel escutcheons at finished surfaces.

END OF SECTION 15815

SECTION 15833

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 4850 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 15833

SECTION 15856

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, 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
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, 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.
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 8-1/2-by-11-inch 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.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, 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.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover 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 1-1/2 inches high.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations 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 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping:

   a. Background Color: Green.
   b. Letter Color: White

2. Condenser-Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

3. Heating Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

4. Refrigerant Piping:

   a. Background Color: Green
   b. Letter Color: White.

END OF SECTION 15856

SECTION 15872

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.
b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.
b. Variable-flow hydronic systems.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

A. LEED Submittal:

1. Air-Balance Report for LEED Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Certified TAB reports.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB.
2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB as a TAB technician.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-

handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.

7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

   a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Division 23 Section "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

   a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove

proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.12 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser-water flow rate recirculating through the cooling tower.
6. Measure cooling-tower spray pump discharge pressure.
7. Adjust water level and feed rate of makeup water system.
8. Measure flow through bypass.

3.13 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.14 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

3.15 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.16 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.17 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.18 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.19 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.

7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 15872

SECTION 15888

HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Flexible elastomeric.
   b. Mineral fiber.
   c. Polyolefin.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied jackets.
10. Tapes.
11. Securements.
12. Corner angles.

B. Related Sections:
1. Division 22 Section "Plumbing Insulation."
2. Division 23 Section "Metal Ducts" for duct liners.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.

3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type.

D. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I or II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; All-Service Duct Wrap.

H. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Johns Manville; HTB 23 Spin-Glas.
    b. Owens Corning; High Temperature Flexible Batt Insulations.

I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; Commercial Board.
    b. Fibrex Insulations Inc.; FBX.
    c. Johns Manville; 800 Series Spin-Glas.
    d. Knauf Insulation; Insulation Board.
    e. Manson Insulation Inc.; AK Board.
    f. Owens Corning; Fiberglas 700 Series.

J. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; FBX.
b. Johns Manville; 1000 Series Spin-Glas.
c. Owens Corning; High Temperature Industrial Board Insulations.
d. Rock Wool Manufacturing Company; Delta Board.
e. Roxul Inc.; Roxul RW.
f. Thermafiber; Thermafiber Industrial Felt.

K. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Knauf Insulation; Permawick Pipe Insulation.
b. Owens Corning; VaporWick Pipe Insulation.

M. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.

b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

N. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Armacell LLC; Tubolit.
b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
c. RBX Corporation; Therma-cell.

O. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); Styrofoam.
b. Knauf Insulation; Knauf Polystyrene.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
d. Thermal Ceramics; FireMaster Duct Wrap.
e. 3M; Fire Barrier Wrap Products.
f. Unifrax Corporation; FyreWrap.
g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2.3 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Insulco, Division of MFS, Inc.; SmoothKote.
    b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
    c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-96.
    b. Foster Products Corporation, H. B. Fuller Company; 81-33.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA Inc.; Aeroseal.
    b. Armacell LCC; 520 Adhesive.
    c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    d. Marathon Industries, Inc.; 225.
    e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 97-13.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.

d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
d. Marathon Industries, Inc.; 550.
e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following**:**

a. Childers Products, Division of ITW; CP-76.
b. Foster Products Corporation, H. B. Fuller Company; 30-45.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.
f. Vimasco Corporation; 750.

2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-70.
b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.

c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements,provide one of the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
    b. Vimasco Corporation; Elastafab 894.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Johns Manville; Zeston.
    b. P.I.C. Plastics, Inc.; FG Series.
    c. Proto PVC Corporation; LoSmoke.
    d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; Metal Jacketing Systems.
    b. PABCO Metals Corporation; Surefit.
    c. RPR Products, Inc.; Insul-Mate.

2. Sheet and roll stock ready for shop or field sizing.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.

5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Tee covers.
    d. Flange and union covers.
    e. End caps.
    f. Beveled collars.
    g. Valve covers.
    h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with stucco-embossed aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Polyguard; Alumaguard 60.

F. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

G. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.

H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.

d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.11 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
      2) GEMCO; Press and Peel.
      3) Midwest Fasteners, Inc.; Self Stick.

   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.

   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) GEMCO.
      2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.

2.12 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor

insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.

e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and

over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.9 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.12 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.13 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.14 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.15 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.

2. Indoor, exposed supply air ducts.
3. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
4. Factory-insulated flexible ducts.
5. Factory-insulated plenums and casings.
6. Flexible connectors.
7. Vibration-control devices.
8. Factory-insulated access panels and doors.

3.16 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 0.75-lb/cu. ft. nominal density.

D. Concealed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

E. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

F. Exposed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

G. Exposed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber blanket, 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

H. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

3.17 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 3 inches thick and 0.75-lb/cu. ft. nominal density.

C. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber board, 3 inches thick and 0.75-lb/cu. ft. nominal density.

D. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 3 inches thick and 0.75-lb/cu. ft. nominal density.

E. Exposed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 3 inches thick and 0.75-lb/cu. ft. nominal density.

F. Exposed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 3 inches thick and 0.75-lb/cu. ft. nominal density.

3.18 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Heat-Exchanger (Water-to-Water for Heating Service) Insulation: Mineral-fiber pipe and tank, 2 inches thick.

D. Dual-service heating and cooling pump insulation shall be one of the following:
   1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

E. Heating-Hot-Water Pump Insulation: Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

F. Chilled-water expansion/compression tank insulation shall be[**one of**] the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Pipe and Tank: 1 inch thick.
   3. Polyolefin: 1 inch thick.

G. Dual-service heating and cooling expansion/compression tank insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Pipe and Tank: 1 inch thick.
   3. Polyolefin: 1 inch thick.

H. Heating-Hot-Water Expansion/Compression Tank Insulation: Mineral-Fiber Pipe and Tank: 1 inch thick.

I. Chilled-water air-separator insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Pipe and Tank: 1 inch thick.
   3. Polyolefin: 1 inch thick.

J. Dual-service heating and cooling air-separator insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Mineral-Fiber Pipe and Tank: 1 inch thick.
   3. Polyolefin: 1 inch thick.

K. Heating-Hot-Water Air-Separator Insulation: Mineral-Fiber Pipe and Tank: 2 inches thick.

3.19 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.20 INDOOR PIPING INSULATION SCHEDULE

A. Chilled Water and Ground Source Heat Pump, above 40 Deg F: Insulation shall be one of the following:
   1. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick for pipe sizes less than or equal to 1.5”.
   2. Mineral-Fiber, Preformed Pipe, Type I: 1.5 inch thick for pipe sizes greater than 1.5”.

B. Heating-Hot-Water Supply and Return, 200 Deg F and below: Insulation shall be one of the following:
   1. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick for pipe sizes less than or equal to 1.5”.
   2. Mineral-Fiber, Preformed Pipe, Type I: 2 inch thick for pipe sizes greater than 1.5”.
   3.

C. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric or Polyolefin, 1 inch thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric or Polyolefin, thick.

3.21 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine: Insulation shall be one of the following:
   1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and below: Insulation shall be one of the following:
   1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Piping: Insulation shall be one of the following:
   1. Flexible Elastomeric: 2 inches thick.
   2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be one of the following:

   1. Flexible Elastomeric: 2 inches thick.
   2. Polyolefin: 2 inches thick.

E. Dual-Service Heating and Cooling: Insulation shall be one of the following:

   1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.22 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.

3.23 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.

D. Ducts and Plenums, Exposed:

1. None.

E. Equipment, Concealed:

1. None.

F. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. None.

G. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. None.

H. Piping, Concealed:

1. None.

I. Piping, Exposed:

1. None.

3.24 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
   1. Aluminum, Stucco Embossed: 0.016 inch thick.

D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

   1. Aluminum, Stucco Embossed: 0.016 inch thick.

E. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

   1. Aluminum, Stucco Embossed with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

F. Piping, Concealed:
   1. PVC: 20 mils thick.
   2. Aluminum, Stucco Embossed: 0.016 inch thick.

G. Piping, Exposed:

   1. PVC: 20 mils thick.

3.25 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230700

SECTION 15913

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings. More than 0.5 psig but not more than 2 psig.

C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

D. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Delegated-Design Submittal: For natural-gas piping and equipment 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 seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

D. Welding certificates.

E. Field quality-control reports.

F. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. OmegaFlex, Inc.
b. Parker Hannifin Corporation; Parflex Division.
c. Titeflex.
d. Tru-Flex Metal Hose Corp.

2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.

a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1) Flame-Spread Index: 25 or less.
2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig.

C. Annealed-Temper Copper Tube: Comply with ASTM B 88, Type K.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
2. Flare Fittings: Comply with ASME B16.26 and SAE J513.

a. Copper fittings with long nuts.
b. Metal-to-metal compression seal without gasket.
c. Dryseal threads complying with ASME B1.20.3.

3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

D. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.

b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.[Vent casing aboveground.]
c. Aboveground Portion: PE transition fitting.
d. Outlet shall be threaded or suitable for welded connection.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
b. Outlet shall be threaded or suitable for welded connection.
c. Bridging sleeve over mechanical coupling.
d. Factory-connected anode.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: [40] [60]-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BrassCraft Manufacturing Company; a Masco company.

b. Conbraco Industries, Inc.; Apollo Div.
c. Lyall, R. W. & Company, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BrassCraft Manufacturing Company; a Masco company.
b. Conbraco Industries, Inc.; Apollo Div.
c. Lyall, R. W. & Company, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Lee Brass Company.

b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. PE Ball Valves: Comply with ASME B16.40.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kerotest Manufacturing Corp.
b. Lyall, R. W. & Company, Inc.
c. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

G. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Electrically Operated Valves: Comply with UL 429.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. ASCO Power Technologies, LP; Division of Emerson.
b. Dungs, Karl, Inc.
c. Eclipse Combustion, Inc.
d. Goyen Valve Corp.; Tyco Environmental Systems.
e. Magnatrol Valve Corporation.
f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

2.6 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide [product indicated on Drawings] <Insert manufacturer's name; product name or designation> or comparable product by one of the following:

a. Vanguard Valves, Inc.
b. <Insert manufacturer's name>.

3. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
4. Maximum Operating Pressure: 5 psig.
5. Cast-aluminum body with nickel-plated chrome steel internal parts.
6. Nitrile-rubber valve washer.
7. Sight windows for visual indication of valve position.
8. Threaded end connections complying with ASME B1.20.1.
9. Wall mounting bracket with bubble level indicator.

2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.

2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Actaris.
   b. American Meter Company.
   c. Eclipse Combustion, Inc.
   d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   e. Invensys.
   f. Maxitrol Company.
   g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 10 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. Canadian Meter Company Inc.
   b. Eaton Corporation; Controls Div.
   c. Harper Wyman Co.
   d. Maxitrol Company.
   e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig.

2.8 DIELECTRIC UNIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Capitol Manufacturing Company.
2. Central Plastics Company.
3. Hart Industries International, Inc.
4. McDonald, A. Y. Mfg. Co.
5. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
6. Wilkins; Zurn Plumbing Products Group.

B. Minimum Operating-Pressure Rating: 150 psig.

C. Combination fitting of copper alloy and ferrous materials.

D. Insulating materials suitable for natural gas.

E. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.9 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

F. Install fittings for changes in direction and branch connections.

G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.2 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

S. Do not use natural-gas piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

U. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be one of the following:

1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
2. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.

C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.10 INDOOR PIPING SCHEDULE

A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
   1. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
   2. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be[one of] the following:

   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.11 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground: Bronze plug valves.

3.12 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be[one of] the following:

   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.
   3. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be[one of] the following:

   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.

3. Bronze plug valve.

C. Valves in branch piping for single appliance shall be[one of] the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 231123

SECTION 15935

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Duct-Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1-2004, Section 7.2.4 - "Ventilation System Start-Up."
4. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface

finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F> at 75 deg F mean temperature.
b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.7 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.

5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; 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: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing;

install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect 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. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Supply and Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Constant-Volume Air-Handling Units:

   a. Pressure Class: Positive 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:

   a. Pressure Class: Positive 4-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

4. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

   a. Pressure Class: Negative 1-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 3-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

   a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
   b. Concealed: Carbon-steel sheet.
   c. Welded seams and joints.
   d. Pressure Class: Positive or negative 4-inch wg.
   e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
   f. SMACNA Leakage Class: 3.

4. Ducts Connected to Dishwasher Hoods:

    a. Type 304, stainless-steel sheet.
    b. Exposed to View: No. 4 finish.
    c. Concealed: No. 2D finish.
    d. Welded seams and flanged joints with watertight EPDM gaskets.
    e. Pressure Class: Positive or negative 2-inch wg.
    f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
    g. SMACNA Leakage Class: 3.

5. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:

    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum.

E. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, 1-1/2 inches thick.
2. Return Air Ducts: Fibrous glass, Type I, 1-1/2 inches thick.
3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch thick.
4. Supply Fan Plenums: Fibrous glass, Type II, 1-1/2 inches thick.
5. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II, 2 inches thick.
6. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 15956

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.
11. Duct accessory hardware.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittal:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.
d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
e. Wiring Diagrams: For power, signal, and control wiring.

D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.

2. American Warming and Ventilating; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.
6. SEMCO Incorporated.
7. Vent Products Company, Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 1-inch wg.

E. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Felt.

I. Blade Axles:

1. Material: Nonferrous metal.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.

   a. Sleeve Thickness: 20-gage minimum.
   b. Sleeve Length: 6 inches minimum.

6. Screen Mounting: Rear mounted.
7. Screen Material: Galvanized steel.
8. Screen Type: Bird.
9. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. McGill AirFlow LLC.
    d. METALAIRE, Inc.
    e. Nailor Industries Inc.
    f. Ruskin Company.
    g. Trox USA Inc.
    h. Vent Products Company, Inc.

2. Standard leakage rating**,** with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Hat-shaped, galvanized -steel channels, 0.064-inch minimum thickness.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

    a. Oil-impregnated bronze.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. McGill AirFlow LLC.

d. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Ruskin Company.
g. Trox USA Inc.
h. Vent Products Company, Inc.

2. Standard leakage rating**,** with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

6. Blade Axles: Galvanized steel.
7. Bearings:

a. Oil-impregnated bronze.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Aluminum.

C. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. McGill AirFlow LLC.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Ruskin Company.
7. Vent Products Company, Inc.

B. Frames:

1. Hat shaped.
2. Galvanized-steel channels, 0.064 inch thick.
3. Mitered and welded corners.

C. Blades:

1. Multiple blade with maximum blade width of 8 inches.
2. Parallel- and opposed-blade design.
3. Galvanized steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

D. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:

1. Oil-impregnated bronze.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.5 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. McGill AirFlow LLC.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Prefco; Perfect Air Control, Inc.
7. Ruskin Company.

8. Vent Products Company, Inc.

B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

K. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F rated.

2.6 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

F. Leakage: Class I .

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

K. Accessories:

1. Auxiliary switches for position indication.
2. Test and reset switches, mounted.

2.7 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.8 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Ductmate Industries, Inc.

3. Greenheck Fan Corporation.
4. McGill AirFlow LLC.
5. Nailor Industries Inc.
6. Pottorff; a division of PCI Industries, Inc.
7. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor 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. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

C. Noninsulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.

D. Noninsulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

E. Noninsulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

F. Noninsulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 100 to plus 435 deg F.

G. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

H. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1-2004.

I. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

J. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

K. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.

L. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.13 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream from turning vanes.
9. Control devices requiring inspection.
10. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

K. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts with flexible connectors. Do not use flexible ducts to change directions.

O. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with draw bands.

Q. Install duct test holes where required for testing and balancing purposes.

R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

SECTION 15976

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rectangular and square ceiling diffusers.
   2. Louver face diffusers.
   3. Adjustable bar registers and grilles.
   4. Fixed face registers and grilles.

B. Related Sections:
   1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Krueger.
      b. METALAIRE, Inc.
      c. Price Industries.
      d. Titus.

   2. Devices shall be specifically designed for variable-air-volume flows.

3. Material: Steel.
4. Finish: Baked enamel, white.
5. Face Style: Plaque.
6. Pattern: Adjustable.
7. Dampers: Radial opposed blade.
8. Accessories:

    a. Equalizing grid.
    b. Plaster ring.
    c. Safety chain.
    d. Wire guard.
    e. Sectorizing baffles.
    f. Operating rod extension.

B. Louver Face Diffuser :
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    a. METALAIRE, Inc.
    b. Price Industries.
    c. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel.
4. Finish: Baked enamel, white.
5. Pattern: Four-way Adjustable core style.
6. Dampers: Radial opposed blade.
7. Accessories:

    a. Square to round neck adaptor.
    b. Adjustable pattern vanes.
    c. Throw reducing vanes.
    d. Equalizing grid.
    e. Plaster ring.
    f. Safety chain.
    g. Wire guard.
    h. Sectorizing baffles.
    i. Operating rod extension.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register :
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    a. Krueger.
    b. METALAIRE, Inc.
    c. Price Industries.

d. Titus.

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
5. Core Construction: Integral.
6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
7. Damper Type: Adjustable opposed blade.

B. Adjustable Bar Grille
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Krueger.
b. METALAIRE, Inc.
c. Price Industries.
d. Titus.

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
5. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.

C. Fixed Face Register :
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
a. Krueger.
b. Metalaire
c. Price Industries.
d. Titus.

2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Removable.
6. Frame: 1 inch wide.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes basic electrical requirements for materials and methods applicable to electrical equipment specified under this section and other related sections.
   1. Conduit
   2. Boxes
   3. Duct Bank
   4. Wire and Cable
   5. Wiring Devices and Device Plates
   6. Maintenance Materials
   7. Grounding Materials
   8. Luminaries
   9. Power Panels

B. Related Sections:
   1. Shop Drawings – Section 01340
   2. Temporary Facilities – Section 01500
   3. Materials and Equipment – Section 01600
   4. Operation & Maintenance Data – Section 01730
   5. Earthwork – Section 02300
   6. Concrete – Section 03000
   7. Painting – Section 09900

1.2 REFERENCES

A. UL – All applicable standards

B. IEEE – All applicable standards

C. IPCEA – All applicable standards

D. NEMA – All applicable standards

E. ANSI/NFPA 70 – National Electrical Code

F. ANSI C2 – National Electrical Safety Code

G. ANSI/NEMA FB 1 – Fittings and Supports for Conduit and Cable Assemblies

H. ANSI/NEMA OS 1 – Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports

I. ANSI/NEMA OS 2 – Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

J. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

1.3 SUBMITTALS

A. Information covering all material that is to be used on this project shall be submitted.

B. Each sheet of descriptive literature shall be clearly marked to identify the material or equipment for which it pertains.

C. Equipment on submitted sheets that is not for this project shall be crossed out.

D. As a minimum the following information shall be submitted:
   1. Lamp fixture descriptive sheets identified by the fixture schedule letter
   2. Equipment sheets shall identify what the equipment refers to by calling out the name of the equipment on the sheet.
   3. Schematics and connection diagrams for all electrical equipment shall be submitted.
   4. Submit all types of conduit and cables with manufacturer and sizes as well as all appurtenances.

1.4 QUALITY ASSURANCE

A. Supplier's qualifications
   1. The entire system shall be designed, coordinated, and supplied by a qualified Electrical Contractor who is regularly engaged in the business of building electrical systems for water and wastewater projects. The Electrical Contractor shall provide a "Statement of Qualifications" indicating that they have successfully provided similar work for at least 5 years.

B. Coordination
   1. The electrical equipment shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufacturer and the manufacturer of related equipment.
   2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
   3. The Contractor shall provide coordination with other contractors and supervision of installation as required during construction.
   4. All service entrance work shall be in accordance with the local utility standards.
   5. The electrical contractor shall coordinate all service entrance work with the local utility. The local utility is Delta-Montrose Electric Association.
   6. The electrical contractor shall NOT pay for the utility's work. That shall be billed directly to the owner.

7. Accurately record actual locations of conduit, duct banks, panels, and accessories.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable Building Code.

B. Electrical: Conform to latest version of NFPA 70.

C. Coordinate, obtain and pay for all permits, inspections and approvals of authority having jurisdiction.

D. Comply with local electrical codes in force or in the absence of local electrical code, the latest edition of the National Electrical Code, ANSI C1.

1.6 WARRANTY

A. The electrical contractor shall warrant the supplied equipment and labor for a period of one year from the date of system acceptance.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The work for this project is at a functioning wastewater treatment plant. All new work shall be done in a way that allows the existing plant to maintain its operation.

B. All equipment furnished under this Section shall be selected by the Contractor for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged, and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
   1. Conduit
      a. Minimum Size: ¾ inch unless otherwise specified, or ½ inch for luminaries pendants.
      b. Underground Installations:
         i) Over 100V: More than five feet from foundation wall: Use thick wall nonmetallic conduit.
         ii) Within five feet from foundation wall: Use rigid steel conduit
         iii) Under 100V: Use rigid steel conduit
         iv) Minimum size: 1 inch.
      c. Outdoor Locations, Above Grade: Use rigid steel conduit.
      d. In Slab Above Grade:
         i) Use rigid steel conduit for circuits that are 24V or less.
         ii) Use rigid thick wall non-metallic conduit for 120V to 480V circuits.
         iii) Maximum Size Conduit in Slab: 2 inch, 1 inch for conduits that cross over each other, or with structural engineer’s approval.

iv) Conduits shall not be spaced closer than 3 conduit widths on center.
v) Aluminum conduit shall not be embedded in concrete.
vi) Conduits shall not pass through a structural concrete beam without the structural engineer's approval.

e. In or under slab on grade:
i) Use rigid steel conduit for circuits that are 24V or less.
ii) Use rigid thick wall non-metallic conduit.

f. Wet and damp locations: Use rigid steel conduit or aluminum conduit.

g. Dry locations:
i) Concealed: In walls or above ceilings, use rigid steel or aluminum conduit.
ii) Exposed: Use rigid steel conduit or aluminum conduit.

h. Rigid Steel Conduit.
i) Rigid steel conduit shall be heavy wall, hot-dipped galvanized, and shall conform to Fed Spec WW-C-581 and ANSI C80.1, and shall be manufactured in accordance with UL 6.

i. Rigid Nonmetallic Conduit (PVC).
i) PVC conduit shall be heavy wall, schedule 40, shall be UL labeled for aboveground and underground uses.

j. PVC-Coated Rigid Steel Conduit.
i) The conduit shall be rigid steel and before the PVC coating is applied, the hot-dipped galvanized surfaces shall be coated with a primer to ensure a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit at a thickness of at least 40 mils. A two part urethane chemically cured coating shall be applied at a nominal 2 mil thickness to the interior of all conduit and fittings.
ii) Manufacturers: Ocal, PermaCote, or Robroy Industries.

k. Rigid Aluminum Conduit.
i) Rigid aluminum conduit shall be heavy wall and shall conform to Fed Spec WW-C-581 and ANSI C80.1, and shall be manufactured in accordance with UL 6.

l. Flexible connections
i) Conduit: Moisture proof vinyl jacketed, liquid-tight, hot-dipped galvanized flexible steel and shall be UL labeled.
ii) Connectors: Watertight, Appleton Type ST or STB, Crouse-Hinds Type LT or LTC, or equal.

2. Outlet Boxes
a. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, Galvanized.
i) Luminaries and equipment supporting boxes: rated for weight of equipment supported.
ii) Concealed installations.

b. Nonmetallic outlet boxes: ANSI/NEMA OS 2.

c. Cast Boxes: NEMA FB 1, Type FD, Cast Ferroalloy.
i) Provide gasketed cover by box manufacturer.
ii) Provide threaded hubs.
iii) Models VXF, GRFX as manufactured by Crouse-Hinds.
iv) Models SEH, JBDX, with mounting lugs as manufactured by Appleton.

3. Pull and Junction

a. Sheet Metal Boxes: NEMA OS 1, Galvanized Steel.
b. Surface-Mounted Cast Metal Box: NEMA 250, Type 4 flat-flanged, surface-mounted junction box.
   i) Material: Galvanized cast iron Cast aluminum in corrosive areas.
   ii) Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
   iii) Model: WCB as manufactured by Crouse-Hinds.
c. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting.
   i) Material: Galvanized cast iron.
   ii) Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
   iii) Cover Legend: ELECTRIC.
   iv) Model: WPD as manufactured by Crouse-Hinds.

4. Large Junction Boxes and Wiring Gutters
   a. Indoor Locations:
      i) Steel, NEMA 12.
   b. Outdoors:
      i) Stainless steel.
      ii) Weather-tight NEMA 4.
   c. Construction.
      i) Provide rigid handles for box covers larger than 9 sq. ft. or heavier than 25 lbs.
      ii) Provide split covers for covers larger than 12 sq. ft.
      iii) Aluminum boxes in concrete not allowed.
5. Seal Fittings
   a. Model ESU with Apelco sealing cement and fiber, as manufactured by Appleton.
   b. Model EZS with Chico X Fiber and Chico A compound as manufactured by Crouse-Hinds.
6. Deflection Fittings
   a. Locations:
      i) Underground conduit runs.
      ii) Runs between concrete sections subject to relative movement.
   b. Material:
      i) Ferroalloy hubs.
      ii) Neoprene outer jacket.
      iii) Stainless steel jacket clamps.
      iv) Molded plastic inner sleeve.
      v) Tinned copper braid grounding strap.
   c. Model XD as Manufactured by Crouse-Hinds.
7. Expansion Fittings
   a. Locations:
      i) In long conduit runs, to permit linear movement caused by thermal expansion and contraction.
      ii) In long conduit runs to prevent conduit from buckling.
      iii) Indoors and outdoors, where conduit expansion occurs or where there is a wide temperature range.
      iv) At structural expansion joints.

b. Material:
   i) End fittings: Ferroalloy.
   ii) Body: Steel conduit.
c. Provide Bonding Strap When Used Outdoors.
d. Model XJ, as Manufactured by Appleton and Crouse-Hinds.

8. Flexible Sealing Compound
   a. “Duxseal” as Manufactured by Johns-Manville.
   b. “Permagum” as Manufactured by In mount.
9. Coal Tar Epoxy Paint
10. Wire and Cable
   a. 600 Volt Power Cable
      i) General Use:
         a) Conductors: Single, copper, 12 AWG minimum.
         b) All conductors shall be stranded.
         c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
         d) Suitability: Wet or dry locations at 75° C and 90° C copper temperature.
         e) Or as specified for service entrances.
      ii) Service entrance and 4 AWG and above:
         a) Conductors: Single, stranded, copper.
         b) Insulation: 600V cross-linked polyethylene, UL Type XHHW/USE or THHN.
         c) Suitability: Wet or dry locations at 75°C and 90° C copper temperature.
      iii) Terminations
         a) Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap standard cable around screw type terminals
   b. Lighting Circuits
      i) General Use:
         a) Conductors: Single, copper, 12 AWG minimum.
         b) Conductors may be solid or stranded.
         c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
         d) Suitability: Wet or dry locations at 75° C and 90° C copper temperature.
      ii) Terminations:
         a) Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap stranded cable around screw type terminals.
   c. Control circuits
      i) General Use:
         a) Conductors: Single, tinned copper, 14 AWG
         b) All conductors shall be stranded
         c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
      ii) Millivolt or Milliampere Instrumentation and Control.
         a) Conductors: 18 AWG stranded copper, 2 or 3 as required.
         b) Insulation: 15 mils, minimum, 90°C PVC.
         c) Shield: Mylar aluminum tape with 20 AWG copper drain wire, fully covering conductors.
         d) Jacket: 20 mils, minimum, 80°C PVC.
         e) Suitability: Wet or dry steel conduit.

iii) Manufacturers: Belden “UL Instrumentation Cable – 1032A”, Samuel Moore “Dekoron ICMX” No. 1852-686 and 1862-686, or equal.

d. Telephone and Networking

i) Cable.

a) The cables shall be rated for use in communications circuits.

b) The cables shall be rated for riser applications.

c) The cables shall be rated for 75 degrees Celsius applications.

d) The cables shall be free of defects and splices.

e) The cables shall be rated for outdoor applications.

f) The cables shall be rated for P-MSHA applications.

g) The cables shall pass a -40 degree Celsius cold bend test per UL 1581.

h) The cables must be UL third party verified to ANSI/TIA/EIA-586-B.2 Category 5e.

i) The cable shall be ROHS compliant.

j) The cable shall be CE compliant.

k) Conductors

1) The conductors shall be solid, bare copper per ASTM B-3.

2) The conductors shall be #24 AWG (.20 sq mm).

l) Insulation

1) The insulation shall be polyolefin.

2) The insulation shall be free of defects and splices.

m) Pairs

1) The cable shall contain four pairs.

2) The insulated conductors shall be bonded together down the entire length of the pair.

3) The pairs shall be marked with a permanent, extruded stripe identification of tip and ring insulated conductors.

4) Each pair shall have a unique twist length to minimize pair to pair coupling.

n) Shielding

1) Shielding shall be an aluminized foil with the foil facing inward, where required.

2) Unshielded cables shall be acceptable except where shielding is required for the system.

o) Jacket.

1) All cables shall have a continuous jacket of Polyvinyl Chloride (PVC).

2) Jacket thickness: The jackets shall be .030" (.75 mm) nominal thickness.

3) The jackets shall be ultraviolet (UV) radiation and sunlight resistant per UL 1581.

4) The jackets shall be oil resistant per UL 1581 Class 43.

p) Manufacturer: Belden “Industrial Data Solutions – 7923A” or equal.

ii) Arc-Proofing Tape: Irvingon “77 Arc-Proofing Tape”, Slipknot No. 50 or Slipknot No. 3, or approved equal.

11. Wiring Devices

a. General:

i) Industrial Specification grade.
ii) White.

b. Receptacles:
i) 120 V duplex outlets: NEMA 5-20R, 3 wire, grounding, 20A, 125 V, Leviton 5362, or approved equal.
ii) 120 V duplex GFCI outlets: NEMA 5-20R, 3 wire, grounding, 20A, 125 V, Leviton 7899, or approved equal.
iii) 240 V duplex outlets: NEMA 6-20R, 3 wire, grounding, 20A, 250 V, Leviton 5462, or approved equal.
iv) Welding outlets: 50A, 125/250V, 3 pole, 4 wire, grounding, NEMA 14-50R, Leviton 55050, or approved equal.

c. Light Switches:
i) 277 V lighting circuits: 20 amp, 120/277 V, Leviton 1221-2W to 1224-2W, or approved equal.

12. Device Plates
a. General:
i) Mounting hardware countersunk and finished to match plate.
ii) Provide over-sized plates where standard plates do not cover wall opening.
iii) Provide engraving as indicated on drawings.

b. Indoors:
i) Surface mounted devices: Galvanized or cadmium-plated steel.
ii) Flush mounted devices in other finished areas: Phenolic plastic, white.
iii) All other flush mounted devices: Type 302 stainless steel.

c. Outdoors and Indoors when identified on Drawings as Weatherproof:
i) Weatherproof with spring doors for receptacles and with provisions for padlocking switches on and off.
ii) Provide an adaptor plate for flush mounted device plates, Crouse-Hinds FS031, or equal.

13. Grounding and Bonding
a. Provide rod electrodes, exothermic connections and mechanical connections.
b. Building perimeter ground cable shall be minimum of 4/0 AWG bare copper.
c. Duct bank ground cable shall be minimum of 4/0 AWG bare copper.
d. Other ground cable shall be as noted on the drawings.

14. Luminaries
a. Furnish products as specified on drawings.
b. Install ballasts, lamps, and specified accessories at factory.
c. Accessories:
i) Provide swivel-type box covers.
ii) Provide threaded conduit pendants.

d. Provide all lamps and required mounting hardware.

15. Power Panels
a. General:
i) Circuit breaker panel board.
ii) With neutral.
iii) Dead front.

b. Enclosure:

i) NEMA 12, surface in unfinished areas, NEMA 1 flush in finished areas or as indicated on the drawings.
ii) Door with latch and lock.
iii) Typewritten circuit directory.
iv) Ground stud bolt through cabinet with removable 1/0 AWG bond to the panel ground bus and an external clamp connector for a station ground conductor.

c. Circuit Breakers:
i) Molded case thermal magnetic.
ii) Multiple pole breakers shall be common trip.
iii) Bolt-in.
iv) Individually front replaceable.
v) Indicating “On”, “Off”, and “Tripped”.
vi) RMS symmetrical interrupting capacity shall be as indicated on the drawings.
vii) Breakers, trip ratings, and number of poles as indicated on the drawings.

d. Buses:
i) Three phase and neutral bus insulated from cabinet.
ii) Ground bus.
a) Connected to cabinet.
b) Clamp type lug for supply circuit and each load circuit.
c) Removable bond to neutral bus.
iii) Copper bussing.
iv) Ampere and voltage ratings as indicated on the drawings.
v) Bracing coordinated with circuit breakers interrupting capacity.

16. Lighting Panels

a. General:
i) Circuit breaker panel board.
ii) With neutral.
iii) Dead front.

b. Enclosure:
i) NEMA 1 or as indicated on the drawings.
ii) Door with latch and lock.
iii) Typewritten circuit directory.
iv) Ground stud bolt through cabinet with removable 1/0 AWG bond to the panel ground bus and an external clamp connector for a station ground conductor.

c. Circuit Breakers:
i) Molded case thermal magnetic.
ii) Multiple pole breakers shall be common trip.
iii) Bolt-in or plug-in.
iv) Individually front replaceable.
v) Indicating “On”, “Off”, and “Tripped”.
vi) 10,000 amp RMS symmetrical interrupting capacity at 240 V.
vii) Handle clips to prevent casual operation for circuit breakers indicated on drawings.
viii) Ground fault interrupting breakers with a sensitivity of 5mA for receptacle branch circuit and where indicated on drawings.
ix) Breakers, trip ratings, and number of poles as indicated on the drawings.

d. Buses:

i) Two phase and neutral bus insulated from cabinet.
ii) Ground bus.
a) Connected to cabinet.
b) Clamp type lug for supply circuit and each load circuit.
c) Removable bond to neutral bus.
iii) Copper.
iv) Ampere and voltage ratings as indicated on the drawings.
v) Bracing coordinated with circuit breakers interrupting capacity.

17. Dry-Type Specialty Transformers.
a. Phase, voltage current ratings as indicated on drawings.
b. Two 2½% full capacity taps below normal voltage.
c. Dry type, wall floor or MCC mounted as indicated on the drawings, enclosed for wiring in conduit.
d. Self air-cooled.
e. Suitable for indoor NEMA 4.
f. Insulation system and average winding temperature rise for rated KVA as follows:
i) 1-15 KVA: Class 185 with 115°C rise.
ii) 16-500 KVA: Class 220 with 115°C rise.
g. Sound Levels: NEMA ST20.
h. Ground core and coil assembly to enclose by means of a visible flexible copper grounding strap.
i. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise

18. Control Stations.
a. Enclosures:
i) Indoors: NEMA 4X.
ii) Outdoors: NEMA 4X
b. Pilot Devices:
i) Refer to specification section 16900.
c. Nameplates:
i) Pilot devices: Laminated plastic nameplates, white surface with a black core, engraved to identify controlled motor or equipment.
ii) Control station: Laminated plastic nameplates, white surface with a black core, engraved to identify controlled motor or equipment.

19. Equipment Disconnects
a. General:
i) Heavy-duty safety switches.
ii) Square D or Cutler-Hammer.
b. Enclosure:
i) Indoor dry areas: NEMA 12.
ii) Outdoor: NEMA 4X.
iii) Corrosive Areas: NEMA 4X.
iv) Use above guidelines unless otherwise noted on drawings.
v) Padlocked external operating handle.
c. Switch:
i) 25,000 amp symmetrical withstand.

ii) Poles to match equipment served.
iii) 600 VAC.
iv) Continuous current rating not less than the serving branch circuit over current protection.
v) Non-fusible except where fusing is required by the served equipment or as noted on the drawings.

20. Separately Enclosed Motor Starters.
    a. General:
        i) Starters shall have a disconnecting means.
        ii) 3 phase: NEMA size 1 minimum size or as indicated on the drawings.
        iii) Dry type control power transformer for 120VAC control power sized to handle all loads simultaneously, both primary leads fused and one secondary lead fused and one secondary lead grounded.
        iv) Two spare NO and NC auxiliary contacts.
        v) Pilot devices.
        vi) Nameplates to identify the starter and all the items in the starter.
        vii) Square D or Cutler-Hammer.
    b. Enclosure:
        i) Indoor dry areas: NEMA 12.
        ii) Outdoors & corrosive areas: NEMA 4X.
        iii) External operating handle to be interlocked with the door to prevent opening door when handle is in the closed position.
        iv) Padlocked external operating handle.
    c. Contactor:
        i) 3 phase: NEMA size 1 minimum size or as indicated on the drawings.
        ii) 1 phase: NEMA size 0 minimum size or as indicated on the drawings.
        iii) Rated for the voltage being provided.
        iv) 120 VAC coils.
        v) Non-reversing NEMA rated magnetic starters.
    d. Overloads:
        i) One solid state overload relay in each phase.
        ii) External manually reset push button for reset of the overload relay.
        iii) Overloads shall provide phase loss tripping capability.
    e. Disconnecting Device:
        i) 3 phase: MCP type disconnect rated at 25KAIC minimum.
        ii) 1 phase: MCP or fused type disconnect rated at 10KAIC minimum.
21. Reduced Voltage Solid State Starters
    a. Starter shall be provided with:
        i) Phase loss, phase unbalance and phase reversal protection.
        ii) Shorted SCR protection.
        iii) Bypass contactor:
            a) Provide a bypass contactor to bypass the SCRs of the starter once the motor is up to speed.
            b) The bypass contactor may be built into the starter, or if it is not, there shall be an external bypass provided.
        iv) Diagnostic module shall be provided which shall include:
            a) Control power

b) Shorted SCR
c) Start inhibit
d) Trip
e) Phase loss
f) Phase unbalance
g) Phase reversal

v) Independently adjustable acceleration and deceleration current limit adjustable from 150 to 400 percent of motor full load current.
vi) Adjustable current ramp to provide breakaway torque to the motor adjustable from 0-150 percent of motor full load current.

b. Starter shall be rated for a minimum of 115 percent of the full load current of the motor that is installed.
c. Each starter shall be provided with a motor run contact and a starter fault contact.

22. Surge Protective Device (SPD).
a. General:
i) SPD units shall be installed as shown on the drawings.
ii) SPD units shall be appropriate for the voltages indicated on the drawings.
iii) Approved manufacturers: Cutler Hammer, Square D, LEA, or equal.
iv) SPD units shall comply with UL 1449 and 1283.
v) SPD units shall comply with IEEE C62.41 and IEEE C62.45.
vi) SPD units shall have a 30 amp disconnect directly before the TVSS unit.
vii) SPD units shall have indication for trouble alarms and surge count.
viii) For assembled equipment the SPD unit shall be of the same manufacturer as the assembled equipment.

b. Ratings:
i) Maximum let through voltage shall be:

Mode	120/208	277/480
L-N or L-G	400V	800V
L-L	800V	1800V

ii) Minimum total surge current capability:

Location	Per Phase	Per Mode
Switchgear	250 KA	125KA
MCC	160KA	80KA
Panelboards	120KA	60KA

2.2 MISCELLANEOUS ITEMS

A. ALARM BEACON
1. The alarm beacon shall be 120vac and be weatherproof.
2. The alarm beacon shall have a red light and be a rotating light that rotates at about 75 RPM.
3. The alarm beacon shall be provided with all accessories for a complete system for installation and to maintain the weatherproof rating of the unit.
4. The alarm beacon shall be Edwards 52 Series or approved equal.

2.3 SPARE PARTS

A. The Supplier shall furnish and deliver the following spare parts.

B. The following spare parts to be furnished as a minimum:
   1. 25% replacement lamps for lighting fixtures.
   2. Two (2) sets of each type of fuse used in the project.

C. All of the above parts shall be provided as spare parts and shall be packaged new in the original manufacturer's packaging. A list of spare parts shall be provided.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General Requirements
   1. The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers' instructions. The services of the system supplier's technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation.

B. Inspection
   1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
      a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

C. Equipment Installation
   1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.
      a. Separate sheet metal junction boxes, equipment enclosures, sheet metal raceways, etc., mounted on water or earth-bearing walls or wall-mounted outdoors ¼" from wall be corrosion resistant spacer.
      b. Seal the base of all outdoor switchgear, motor control center, and similar equipment with grout.
      c. Screen or seal with flexible sealing compound all openings into outdoor equipment to prevent the entrance of rodents, wasps, and mud-daubers.
      d. Electrical work shall conform to the construction schedule and progress of other trades.
      e. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
      f. Perform all work in accordance with manufacturer's instructions.
         i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
         ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.
      g. Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section.

D. Identification:
   1. Conduit. All conduits shall be provided with identification tags. Tags shall be brass nameplates with 3/8" high lettering and attached to the conduits by means of stainless steel wire. Conduits shall be identified at both ends with the same identification number.
   2. Cable. Except for lighting and receptacle circuits, each individual wire in power, control, indication, and instrumentation circuits shall be provided with identification markers at the point of termination. Power wires without individualized identification numbers shall be color coded with electrical tape or colored wire jacket. The wire markers shall be of the heat-shrinkable tube type.
   3. Control Stations. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the drawings. Nameplates shall be laminated plastic, with 1/8 inch engraved letters, and shall be securely fastened to the control stations.
   4. Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated plastic, with 1/8 inch engraved letters, and shall be securely fastened to the circuit breakers.

E. Raceways:
   1. General:
      a. Except as otherwise indicated on drawings, conduit shall be concealed in finished areas and exposed in unfinished areas.
      b. Rigid steel conduit and aluminum conduit connections and terminations shall be reamed, de-burred, threaded and provided with bushings.
      c. Securely fasten conduit connections to sheet metal enclosures with locknuts inside and out. Conduit hubs outdoors and in wet locations.
      d. Provide deflection fittings across structural joints where structural movement is allowed.
      e. Keep conduit clear of structural openings and indicated future openings.
      f. Provide flashing and seal watertight conduits through roofs and metal walls.
      g. Neatly grout conduit into any opening cut into structure.
      h. Cap or plug conduits during construction to prevent the entrance of trash, dirt and water.
      i. Minimum conduit size shall be ¾", except ½" for luminaries pendants or as noted on drawings.
      j. Seal conduits with flexible sealing compound forced to a minimum depth equal to the conduit diameter after cable is installed.
         i) At handholes, manholes, and vaults.
         ii) Building entrance junction boxes.
         iii) One inch or larger connections to equipment.
      k. Provide flexible conduit where flexible connections are necessary, including each motor without flexible cord.
         i) Keep length to a minimum, not to exceed 6' maximum.
         ii) No sharp bends.
      l. Provide suitable pull string in each empty or spare conduit.
   2. Conduit exposed in structures:

a. Install parallel to structural members and surface.
b. Install conduits of the same general routing parallel with symmetrical bends.
c. Arrange supports to prevent misalignment during wiring installation.
d. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
e. Group related conduits; support using conduit rack. Construct rack using steel channel provide space on each for 25 percent additional conduits.
f. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch size.
g. Provide suitable pull string in each empty conduit except sleeves and nipples.
h. Maintain 6” clearance to ducts, piping and flues.
i. Support rigidly with galvanized or cadmium-plated hardware and framing materials, including nuts and bolts.
j. Provide expansion fittings at 100’ centers outdoors, 200’ centers indoors; in each conduit run longer than 100’ outdoors, 200’ indoors.
k. Provide galvanized pipe caps on conduit stubs for future use.
l. Allow 7’ headroom for horizontal conduit runs, except along structures, piping equipment or where not possible.
m. Except as otherwise indicated, do not install exposed conduit in water chambers.
n. Where allowed, coat conduit exposed in water chambers with 2 coats of coal tar paint with paint injuries repaired or use PVC coated conduit.

3. Conduit concealed in structure:
   a. Install between reinforcing steel in slabs with reinforcing in both faces.
   b. Install under reinforcing steel in slabs where only a single layer is provided.
   c. Terminate conduit for future use in equipment or by galvanized couplings and conduit plugs flush with structural surfaces. Seal plugs with self-leveling caulk.
   d. Maximum of two conduits crossing each other in slab.
4. Underground:
   a. One inch minimum.
   b. Duct banks shall NOT be concrete encased. They shall be sand filled around the conduits as noted:
      i) Two inches between conduits.
      ii) Three inches over conduit.
      iii) Paint all metal with 2 coats of coal tar paint.
   c. Two foot minimum bend radius at vertical risers, 3 foot elsewhere.
   d. Install underground conduit so that it does not drain to cable pulling access in buildings; where necessary, provide a handhole or manhole near or adjacent to building.
   e. Provide 3 foot minimum earth cover.
   f. Install underground conduits through buildings, manhole, handhole and vault walls in box outs as indicated on the drawings.
   g. All steel inside manholes, handholes and vaults shall be galvanized with bared spots treated with zinc rich paint.
   h. Provide ¾” galvanized steel pulling eyes on opposite walls below the centerline of each duct bank.

i. Provide end bells at wall terminations and adapters for steel conduit continuations for non-metallic duct systems.
j. Isolate intercommunication and milliampere level instrumentation circuits from all power wiring raceways, conduits, boxes, vaults, manhole and handhole.
k. Provide a full-size extension for each underground conduit entering a building.
l. Rigid nonmetallic conduit (PVC) shall be fastened no less than every 4 feet.

5. Junction boxes and wiring gutters:
   a. Install electrical boxes as shown on drawings and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
   b. Install pull boxes and junction boxes to maintain headroom and to present neat mechanical appearance.
   c. Install level and plumb.
   d. Where indicated, provide a removable side opposite underground duct banks.
   e. At least code size including space for full size continuation of any conduit not originally continued.
   f. Arrange conduit for maximum space for future conduits.
   g. Support boxes independently of conduit except cast box that is connected to rigid metal conduits both supported within 12 inches of box.

F. Wire and Cable
1. General:
   a. Protect the cable and avoid kinking conductors, cutting or puncturing jackets, contaminating by oil or grease or damaging in any manner.
   b. Terminate stranded cable with lugs, cup washers, or pressure type connectors; do not wrap stranded cable around screw type terminals.
   c. Splice stranded cable with pressure type connectors; do not use wire nut type connectors on stranded cable.
   d. Splice cables only at readily accessible locations.
   e. Do not pull cable tight against bushings or press heavily against enclosures.
   f. Use cable pulling lubricants as recommended by the cable manufacturer.
   g. Use swab to clean conduits and ducts before pulling cables.
   h. Install cable and accessories in accordance with manufacturer’s instructions.
   i. Where necessary to prevent heavy loading of cable connectors due to cable weight, support cables in vertical risers with woven cable grips.
   j. Coil and tape spare cable ends.
   k. Support each 250 MCM or larger cable, and each conduit group of smaller cables from manholes, handholes or vault walls.
   l. Use Stranded conductor for feeders and branch circuits.
   m. Use stranded conductors for control circuits.
   n. Use conductor not smaller than 12 AWG for power and lighting circuits.
   o. Use conductor not smaller than 16 AWG for control circuits.
   p. Use 10 AWG conductors for 20 ampere, 120 Volt branch circuits longer than 100 feet.
   q. Pull all conductors into raceway at same time.
   r. Use suitable wire pulling lubricant for building wire 8 AWG and larger.
   s. Protect exposed cable from damage.

t. Neatly train and lace wiring inside boxes, equipment, and panel boards.
u. Clean conductor surfaces before installing lugs and connectors.
v. Make splices, taps, and terminations to carry full ampacity of conductors.

2. Special cables:
   a. Isolate networking and milliampere level instrumentation cables from all power circuits.
   b. Isolate telephone cables from all other circuits.
3. Conductor identification:
   a. Color code all service, feeder, and branch circuit conductors, 277/480 VAC and above as follow:
      i) Phase A: Brown
      ii) Phase B: Orange
      iii) Phase C: Yellow
      iv) Neutral: White
      v) Ground: Bare or Green
   b. Color code all feeder, and branch circuit conductors, 120/208 VAC as follows:
      i) Phase A: Red.
      ii) Phase B: Black.
      iii) Phase C: Blue.
      iv) Neutral: White.
      v) Ground: Bare or Green.
   c. Identify single control conductors by color coding orange and by labeling each end of conductors by color coding orange and by labeling each end of conductor with heat shrink-tube type wire markers.
   d. Identify multi-conductor instrumentation and control cables with heat shrink-tube type wire markers.
   e. Contractor shall establish a control and instrumentation conductor and cable identification system acceptable to Engineer.

G. Wiring Devices:
1. Flush mount wiring devices in concealed conduit system.
2. Surface mount wiring devices in exposed conduit systems.
3. Provide extension rings to bring outlet boxes flush with finished surface.
4. Clean debris from outlet boxes.
5. Install products in accordance with manufacturer’s instructions.
6. Install devices plumb and level.
7. Install switches with OFF position down.
8. Install receptacles with grounding pole on bottom.
9. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
10. Connect wiring devices by wrapping conductor around screw terminal.
11. Use jumbo size plates for outlets installed in masonry walls.
12. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
13. Install wall switch 48 inches above finished floor.
14. Install convenience receptacle 24 inches above finished floor.
15. Inspect each wiring device for defects.

16. Operate each wall switch with circuit energized and verify proper operation.
17. Verify that each receptacle device is energized.
18. Test each receptacle device for proper polarity.
19. Test each GFCI receptacle device for proper operation.
20. Adjust devices and wall plates to be flush and level.

H. Grounding Materials:
1. Coordinate installation with other disciplines.
2. Verify that final backfill and compaction has been completed before driving rod electrodes.
3. Install Products in accordance with manufacturer's instructions.
4. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
5. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.
6. Provide bonding to meet Regulatory Requirements.
7. Install ground cable through building walls within 3' below finish grade and prepare a water stop.
8. Install ground rods and cables as deep in earth as possible and as far from structure as possible, not closer than 6".
9. All branch circuit and feeder circuits to include a copper ground conductor in addition to the conduit ground connection.
10. Connect ground conductors to equipment by ground lugs or clamps.
    a. If no ground bus or terminal is provided and enclosure is not explosion-proof or submersible provide a clamp type lug under a permanent assembly bolt or by grounding locknuts or bushings.
    b. If an explosion-proof or submersible enclosure is not provided with grounding means, provide an adjacent junction box with a ground lug.
    c. Bond grounding system to station piping by connection to the first flange inside the building on either a suction or discharge pipe which will form a good ground connection:
        i) Drill and tap the flange.
        ii) Provide a bolted connection.
        iii) Bond with a copper bar or strap.
    d. Form ground conductors on equipment to the contours of the equipment.
    e. Install main ground cables with encased underground conduit banks in earth at least 3" below 1 corner of the duct bank.
    f. Bond ground cables in underground circuits to main ground cables at each manhole, handhole, and vault.

I. Luminaries
1. Install in the general locations and arrangement indicated on drawings.
2. Align luminaries in rows vertically and horizontally except as otherwise required.
3. Install clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.
4. Adjust luminaries location as required by field conditions.
5. Examine each luminaries to determine suitability for lamps specified.

6. Install in accordance with manufacturer's instructions.
7. Install suspended luminaries using pendants supported from swivel hangers. Provide pendant length required to suspend luminaries at indicated height.
8. Support luminaries larger than 2x4 foot size independent of ceiling framing.
9. Locate recessed ceiling luminaries as indicated on reflected ceiling plan.
10. Install surface mounted luminaries and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
11. Install recessed luminaries to permit removal from below.
12. Install accessories furnished with each luminaire.
13. Bond products and metal accessories to branch circuit equipment grounding conductor.
14. Install specified lamps in each luminaire emergency lighting unit and exit sign.
15. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
16. Aim and adjust luminaries as directed.
17. Relamp luminaries that have failed lamps at Substantial Completion.
18. Clean electrical parts to remove conductive and deleterious materials.
19. Remove dirt and debris from enclosure.
20. Clean photometric control surfaces as recommended by manufacturer.
21. Clean finishes and touch-up damage.

J. Lighting Panel
1. Wall mount in unfinished areas, flush mount in finished areas.
2. Install lighting panel in accordance with NEMA PB 1.1.
3. Install lighting panel plumb. Provide supports. Height: 6 ft. to top of lighting panel; install lighting panel taller than 6 ft. (2M) with bottom no more than 4 in. above floor.
4. Provide filler plates for unused spaces in lighting panels.
5. Provide typed circuit directory for each branch circuit in lighting panel. Revise directory to reflect circuiting changes required to balance phase loads.
6. Measure steady state load currents at each lighting panel feeder; rearrange circuits in the lighting panel to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
7. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

K. Networking – EtherNet/IP cabling
1. Install sufficient networking cable, as shown in the contract drawings, to provide a complete networked system.
2. Terminate all wiring with RJ-45 connectors rated for Cat 5e cable transmissions.
3. Test every communication cable, and provide a testing certificate with the results.

3.2 FIELD QUALITY CONTROL

A. Low Voltage Cable Testing
1. Test 600 V power cables for continuity and freedom from short circuits and ground, except where grounding is intentional immediately after installation.
2. Test all circuits with a 500 V megger or its equivalent.

3. Replace conductors which read less than 1.5 Megohms between conductors and ground.

3.3 PROTECTION AND STORAGE

A. Protection of equipment during storage:
   1. During construction, all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously. Any means necessary shall be used to protect the equipment at the Contractor's expense.

END OF SECTION

SECTION 16900

INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the furnishing and installation of metering and control equipment which shall include the following principal items:
   1. Metering and Control Systems. Principal components of the metering and control systems shall be as listed on the "Instrument List" at the end of this section and shall include the PLC system as is shown on the Drawings.
   2. Miscellaneous. One lot of test equipment, spare parts, and miscellaneous devices as set forth herein. Supplementing this section, the drawings indicate locations and arrangement of panels and instruments, and provide functional diagrams and schematics regarding connection and interaction with other equipment.

B. Related Sections
   1. Materials and Equipment – Section 01600
   2. Electrical – Section 16050

1.2 REFERENCES

A. Codes & Permits
   1. All work and materials shall comply with the National Electrical Code, the National Electrical Safety Code, and applicable local regulations and ordinances. All panels shall be listed by Underwriters Laboratories or other testing organizations acceptable to the governing authority. The Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections, and approval by the proper authorities in local jurisdiction of such work.

1.3 SUBMITTALS

A. Complete fabrication, assembly, and installation drawings: wiring and schematic diagrams: and details, specifications, and data covering the materials used and the parts, devices, and accessories forming a part of the equipment furnished shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in two separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Instrument tag numbers indicated on the contract drawings shall be referenced where applicable. Submittal data for multifunctional instruments shall include complete descriptions of the intended functions and configurations of the instruments.
   1. First-stage Submittal. The first-stage submittal shall include the following items.
      a. Product catalog cut sheets clearly marked to show the applicable model number, operational features, and intended service of the device.
      b. A detailed list of any exceptions, functional differences, or discrepancies between the Supplier's proposed system and the contract requirements.

c. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall include overall dimensions, metal thickness, door swing, mounting details, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.
d. System wiring and installation drawings for all interconnecting wiring between components of the systems furnished and for all interconnecting wiring between the related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections.
e. If panel terminal designations, interdevice connections, device features and options, or other features are modified as a result of the fabrication process or factory testing, revised drawings shall be resubmitted.
f. A total of five (5) copies for the submittal shall be provided.

2. Second-stage Submittal. Complete system documentation, in the form of operation and maintenance manuals, shall be provided. Manuals shall include complete product instruction books for each item of equipment furnished.
   a. Where instruction booklets cover more than one specific model or range of instrument, product data sheets shall be included which indicate the instrument model number, calibrated range, and all other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings, calibration and startup sheets shall be included with the manuals.
   b. A copy of all final O&M manuals shall be provided in PDF format in a CD-ROM or DVD. All AutoCAD drawings shall be provided in PDF and DWG formats.
   c. A total of three (3) printed copies, and five (5) softcopies of final O&M manuals shall be provided.

1.4 QUALITY ASSURANCE

A. Supplier's qualifications
   1. The entire system shall be designed, coordinated, and supplied by a qualified system integrator (Integrator) who is regularly engaged in the business of designing and building instrument and control systems for water and wastewater projects. The Contractor's intended Integrator shall meet the following qualifications.
      a. The Integrator shall have and shall maintain a qualified technical staff and design office. The qualifications and experience of key project personnel shall be acceptable to the Engineer.
      b. The Integrator shall have the physical plant and fabricating personnel to complete the work specified. The Integrator's fabrication capabilities and arrangements shall be acceptable to the Engineer.
      c. The Integrator shall employ competent service personnel to service the equipment furnished. The geographic location of service personnel for this project shall be acceptable to the Engineer.
      d. The Integrator shall provide a "Statement of Qualifications" indicating that they have successfully provided similar work for at least 5 years.

B. Coordination.
   1. Instrument and control systems shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under

other sections of these specifications. All instruments and control devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufactured and the manufacturer of related equipment.

2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
3. The Integrator shall provide coordination with other contractors and supervision of installation as required during construction.
4. Coordination shall be provided between the Integrator and the process system supplier.
5. Instrument and control systems shall be designed and coordinated for proper operation with other sections of these specifications. These shall include but not be limited to Materials and Equipment – Section 01600, Electrical – Section 16050, Variable Frequency Drives – Section 16150, and Programmable Logic Controllers – Section 16950.

1.5 WARRANTY

A. All suppliers shall warrant their hardware for a period of one year from the date of system acceptance.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment furnished under this section shall be selected by the system supplier for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.

1. Power and Instrument Signals. Unless specified otherwise, electrical power supply to the instrumentation equipment will be unregulated 120 VAC at the locations noted on the one-line and functional diagrams. All transmitted electronic analog instrument signals shall be 4-20 mA DC and shall be linear with the measured variable.
2. Metering Accuracy. System metering accuracy, as compared to the actual process value, shall be determined from the value read at the principal readout device such as the recorder or totalizer. System requirements shall not preclude any requirements specified herein for individual devices.
   a. For systems where the primary measuring device, transmitter, and receiver are furnished under this section, the accuracies shall be within the following limits:
      i) Level: 1.0% percent of measured span.
      ii) Flow Rate: magnetic or transit time ultrasonic metering: 1.5 percent of full scale between 1.0 and 100 percent of scale.

3. Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation requirements shall be furnished and installed as required for proper performance of the equipment.
4. Interchangeability and Appearance. Instruments used for the same types of functions and services shall be of the same brand and model line insofar as possible. Similar components of different instruments shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished. Recorders, process indicators, control stations, and similar panel-mounted instruments shall be of the same style and shall be products of the same major instrument manufacturer.
5. Programming Devices. A programming or system configuring device shall be provided for systems that contain any equipment which required such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete and in like-new condition and shall be turned over to the Owner at completion of the startup.
6. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the instrument device schedules and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanels, and rack-mounted devices shall have laminated plastic identification tags securely fastened to the device. Hand lettered labels or tape labels will not be acceptable.
7. Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.2 PANEL FABRICATION

A. General Fabrication Requirements. All panels furnished hereunder shall conform to the requirements of NEMA ICS-6-1988. The following paragraphs describe general fabrication requirements for the instrument panels, consoles, enclosures, and subpanels:
   1. Wiring.
      a. All internal instrument and component device wiring shall be as normally furnished by the manufacturer. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded tinned copper, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90°C.
      b. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 VAC. Surge protectors shall be of a non-faulting and non-interrupting design, with a response time of not more than 5 nanoseconds. Surge protectors shall be Cutler Hammer AEGISPowerline Filters, or equal.
      c. Panels that are over 15 cubic feet in total volume shall have panel lighting above each door of the panel.
      d. Power distribution wiring on the line side of the panel's protective devices shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 16 AWG. Wiring for control circuits shall be minimum 16 AWG. Electronic analog circuits shall be 18 AWG twisted and shielded pairs rated not less than 300 volts.

Analog circuits shall be separated from ac power circuits. Wiring for ac power distribution, dc power distribution, and control circuits shall have different colors and shall agree with the color coding legend on the system supplier's panel wiring diagrams.

e. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with a marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 20% percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fused or circuit breakers shall be clearly labeled and located for easy maintenance. Terminal block shall be Phoenix Contact UT 4-MTD series.

f. All wiring shall be grouped and firmly supported inside the panel. Wiring shall be routed in nonmetallic slotted wire duct or similar. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40 percent of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables. Wire duct shall be Thomas & Betts Ty Duct or approved equal.

g. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams.

h. All analog input signals coming from external from the building where the panel is located shall have surge protection.

i. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic drawings.

j. All wires in the panel shall be identified at both ends of the wire. These labels shall agree with the labels shown on the wiring diagrams. The wire labels shall be of the heat-shrink tube type of wire marker as manufactured by Brady thermal labels.

k. All instruments that require 120vac power that have the signal from the instrument going to a panel, shall be provided 120vac from that panel. The 120vac circuit to these instruments shall be individually fused.

2. Nameplates. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions and legends, as indicated on the drawings, letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified herein under the Device Tag Numbering System paragraph.

3. Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust-inhibitive primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils.

4. Factory test. Panels shall be factory tested electrically by the panel fabricator before shipment.

2.3 METERING & CONTROL SYSTEMS

A. Principal components for the metering and control systems are indicted on the "Instrument List" at the end of this specification.

2.4 MATERIALS & EQUIPMENT

A. Panel Front-Mounted Devices
   1. SELECTOR SWITCHES. Selector switches shall be a minimum 30 mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the drawings or as required for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Cutler-Hammer "Series 10250T", Square D "Class 9001", or approved equal.
   2. INDICATING LIGHTS. Indicating lights shall be a minimum 30 mm, heavy-duty, oil-tight type, Push-to-Test, which uses a low voltage lamp. A built-in transformer shall be used for AC service. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the indicating light. Indicating lights shall be Cutler-Hammer "Series 10250T", Square D "Class 9001", or approved equal.
   3. PUSH BUTTONS. Push buttons shall be a minimum 30 mm, heavy-duty, oil-tight type. Legends shall be engraved on push button faceplate. Contacts shall be rated 10 amperes continuous at 120 VAC. Push buttons shall be Cutler-Hammer "Series 10250T", Square D "Class 9001", or approved equal.
   4. TOTALIZERS. Totalizers shall have miniature, rectangular, semi-flush counters, designed for use in conjunction with miniature indicators and recorders, and shall be of such a design that only the counter is flush-mounted and the associated integrating mechanism is located in the rear of the panel. The counter shall contain not less than seven digits; with a multiplier of a power of 10 plainly engrave on the face of the counter, or on a nameplate below the counter, so that a full range of 9,999,999 is reached before repeating. Totalizers actuated by DC powered coils shall be equipped with a reverse voltage protection device. Totalizers shall not reset upon power failure. Totalizers shall be as manufactured by Red Lion CUB7T series or Action Instruments.
   5. RUN TIME METERS. Run time meters shall have miniature, rectangular, semi-flush counters. The counter shall contain not less than seven digits, with a nameplate plainly engraved on the face of the counter, or below the counter identifying it as a run time meter. Run time meters shall not reset upon power failure. Run time meters shall be as manufactured by Red Lion "CUB7" series or Action Instruments.
   6. DIGITAL PANEL DISPLAYS. Digital panel displays shall be designed for semi-flush mounting in a panel. The display shall be a 3-1/2 digit LED or gas-discharged type, with digit height of not less than 0.5 inch. The display shall be easily read at a distance of 10 feet in varying control room lighting environments. Operating

temperature range shall be 0 to 40 C. Accuracy shall be plus or minus 0.1 percent. The display shall be scaled in engineering units, with the units engraved on the display face or on the associated nameplate. The display shall have selectable decimal point and shall provide red indication. Digital displays shall be as manufactured by Red Lion "PAXP" series or Action Instruments.

B. Panel Interior-Mounted Devices
   1. POWER SUPPLIES. Regulated DC power supplies for instrument loops shall be provided as needed. Power suppliesshall be suitable for input voltage variation of plus or minus 10 percent. The DC power supplies shall be Idec "PS5R Slim line", or Phoenix Contact "Quint".
   2. RELAYS. Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL listed. Relays shall have a minimum rating of 10 amperes at 120 VAC. Time-delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of +/- 2.0 percent of setting. Latching and special purpose relays shall be as required for the specific application. Relays shall have a light to indicate when coil is energized. Relays shall be Idec "RH or RTE Series" or approved equal.

C. Flow Instrumentation
   1. Magnetic Flow Meters
      a. The Magnetic Flow Meter shall be a completely obstructionless, in-line flow meter with no constrictions in the flow of fluid through the meter. The meter shall consist of a metallic tube with flanged ends and with grounding rings. Flange diameter and bolt drilling pattern shall comply with ANSI/ASME B16.5, Class 150. Meters shall be suitable for the maximum range of working pressures of the adjacent piping. Electrode materials shall be fully compatible with the process fluid and shall comply with the requirements specified in the instrument device schedules. Each meter shall be factory calibrated, and a copy of the calibration report shall be submitted as part of the operation and maintenance manual submittal.
      b. The meter shall be capable of standing empty for extended periods of time without damage to any components. The meter housing shall be of a splash-proof and drip-proof design
      c. Power supply to the meter shall be 120 VAC, 60 Hz, single phase.
      d. Meters shall be Rosemount Type 1250 or approved equal.
   2. Magnetic Flow Meter Signal Converters
      a. Magnetic Flow Meter Signal Converters shall be separately mounted, microprocessor-based signal converters. They shall be provided for the magnetic flow meters. The signal converters shall include output dampening, self-testing, integral digital indicator, built-in calibration capability, and an "empty pipe zero" contact input. The overall accuracy of the magnetic flow meter transmitter and signal converter shall be +/-1.0 percent of actual flow rate for full-scale settings of 0.3 to 30 fps. The signal cable between the converter and the magnetic flow meter shall be furnished by the meter manufacturer. The signal converter shall be housed in NEMA Type 12 housing and shall be suitable for operation over an

ambient temperature range of -30° to +140°F, and relative humidity of 10 to 100 percent. The converter shall have an analog output of 4-20 mA DC.

b. The signal converter shall have a seven-digit, non-reset totalizer on the face of the enclosure. Local electronic indicators shall be provided. Indicators shall be mounted on or near the flow meter signal converters in weatherproof NEMA Type 4 housings. Indicators shall be four-digit LCD type and shall read in engineering units.

3. Thermal Air Flow Meter
   a. Each flow meter shall utilize a thermal dispersion type stainless steel sensing element installed in the process piping. The element insertion length shall be approximately one-half the pipe diameter with all mounting accessories provided. The element shall be installed through a full port ball valve with an isolation valve to permit removal while the air line is in service.
   b. The electronic transmitter shall be integral to the sensing element. The electronics assembly shall convert the temperature resistance difference to an air flow value with a maximum error of two percent of calibrated range. The electronics assembly shall include an alphanumeric display with a backlit LCD flow indicator calibrated in the process engineering units.
   c. The electronics shall be housed in a NEMA 4X enclosure.
   d. The electronics shall provide a 4-20mA signal output that shall be linear to the scaled air flow.
   e. The flow meter shall be Fluid Components Model “ST50.”
4. Chlorine Residual Analzyer.
   a. The analyzer shall be micro-processor based unit to provide a 4-20mA signal. The micro-processor shall provide self-diagnostic functions accessible through an alphanumeric, menu-driven keyboard. The analyzer shall be powered by 120 vac power source. The unit shall be based on the DPD colorimetric method of measurement using DPD indicator and a buffer solution. Analyzer shall operate with a continuous sample flow through the analyzer sample cell to drain. The analyzer shall measure free or total chlorine up to 5mg/L with an accuracy of +/- 5%. Analyzer shall be provided with all parts and accessories for a complete and operational system. This shall include at a minimum, pressure reducing valve, shutoff valve, and all tubing and fittings. Analyzer shall be a Hach Model CL17.
5. Pressure and Level Instrumentation
   a. Pressure and Pressure Sensing Level Transmitters.
      i) Transmitters used to measure process pressure, or inferred level from process pressure such as a bubbler system or other source, shall have all solid-state electronic circuitry and shall be of the two-wire type which requires no direct power connection to the transmitter. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0 to 180 F. All transmitter parts shall be of a corrosion-resistant material. Vents shall be provided on the sides of the diaphragm housing body. Transmitter shall have over-range protection to maximum process line pressure. Accuracy shall be plus or minus 0.5 percent of calibrated span, with repeatability of 0.1 percent. Transmitter output shall be 4-20mA dc without the need for external load adjustments and shall have an

elevated or suppressed zero as required by the application. Transmitters shall be furnished with integral indicators with 0-100 percent linear scales.

ii) Differential type transmitters shall be used if required to meet the input range, elevation, or suppression requirements.

iii) Each transmitter shall be provided with a process shutoff valve and a bracket for mounting as required. Transmitters shall be factory calibrated to the required range. Transmitters shall be Rosemount "Model 2088" or approved equal.

b. Hydrostatic Level Transducers

i) Each transducer shall be a hydrostatic pressure sensor for level measurement of fresh water and wastewater applications. The sensor shall be a permanently sealed submersible probe and cable combination. The transducer shall be a of the two-wire type which requires no direct power connection to the transducer. Transducer output shall be 4-20mA DC. The transducer shall be capable of the ranges and pressures for which the application will require. The sensor shall be mounted as shown on drawings or as required for application. The transducer shall be an Endress-Hauser "WaterpilotFMX167", GE Sensing (Druck) "PDCR/PTX- 1730", or approved equal.

c. Ultrasonic Level Transmitters

i) Each ultrasonic level transmitter shall be a microprocessor-based electronic unit consisting of a sensor assembly, a signal converter/transmitter, and an interconnecting cable. The sensor shall be encapsulated in a chemical- and corrosion-resistant material such as keener or CPVC, and shall be suitable for operation over a temperature range of -20 to +150^{0}F and a relative humidity of 10 to 100 percent. The sensor shall be compatible with the process media being measured. The sensor shall be an explosion-proof design suitable for use in all hazardous areas. Sensors mounted in areas subject to freezing shall be provide with special transducers or protected against icing by heaters. Sensors mounted in direct sunlight shall be provided with sunshades.

ii) The supplier shall furnish drawings complete with dimensions and elevations for the sensor mounting.

iii) The ultrasonic level transmitter shall have automatic compensation for changes in air temperature at the sensor location. If separate temperature sensing probes are provided, they shall be mounted with or adjacent to the ultrasonic sensor, as recommended by the manufacturer. The transmitter shall have a four-digit LCD display scaled to read in engineering units. Digit height shall be approximately 0.5 inch. The transmitter shall be designed to ignore momentary level spikes or momentary loss-of-echo. A loss-of-echo condition shall be indicated on the transmitter unit and shall be available as an alarm contact output. The transmitter output shall be an isolated 4-20 mA dc signal linearly proportional to the measured level range. Where specified, the output shall be characterized to be proportional to the tank volume instead of to the tank level. Calibration parameters shall be entered through a keypad on the unit and shall be stored in nonvolatile EEPROM memory. Accuracy of the transmitted signal shall be +/-0.5 percent of the level range.

iv) The transmitter shall contain four independently adjustable level alarm contact outputs. Contacts shall be single-pole, double-throw, rated not less than 5 amperes at 120 volts ac.

v) A sufficient length of sensor-to-transmitter signal cable shall be furnished with the instrument to locate the sensor 25 to 200 feet from the signal converter. The signal converter electronics shall be housed in a NEMA Type 12 enclosure suitable for wall mounting and for operating temperatures of -15 to +125^{0}F and a relative humidity of 10 to 100 percent. The signal converter shall be powered from 120 volts ac, 60 Hz. The ultrasonic level transmitter shall be Siemens "Multiranger", Endress Hauser, or approved equal.

d. Weighted Float Level Switches

i) Each level switch shall consist of a single-pole, double-throw switch, rated not less than 3 amperes AC, sealed and housed in a chemical-resistant polypropylene casing. The switch assembly shall be weighted and suspended on its own cable. The flexible support cable shall be waterproof, three-conductor, synthetic covered cable with 18AWG conductors, and shall be of sufficient length so that no splice or junction box is required in the wetwell. Switches shall be suitable for operation up to 150 volts within an ambient temperature range of 0° to 60° C. Switches shall be suitable for use in a sanitary or wastewater wetwell environment. Installation hardware shall be provided as shown on the drawings or as necessary for application. Switches shall be Flygt "Type EMN-10", Siemens Water Technologies "Model 9G-EF", or approved equal.

e. Pressure Switches

i) Pressure switches shall be field adjustable and shall have a trip point repeatability of better than 1 percent of actual pressure. Contact rating shall be 10 amperes at 120 volts ac.

ii) Switches shall have over-range protection to maximum process line pressure. Switches shall have NEMA type 4X housings.

iii) Switches shall be as manufactured by Ashcroft, Mercoid, United Electric, or equal.

f. Conductance Relay Level Switch

i) Each level switch shall consist of a single-pole, double-throw relay with contacts rated not less than 5 amperes ac at 120 VAC. The relay primary power shall be 120 VAC. The electrodes shall be flexible wire suspension type with shielded stainless steel electrode tips. The electrode holder shall be the manufacturer's standard holder appropriate for the application. Electrodes and conductance relay shall be as manufactured by Gems Sensors (B/W Controls) or Ametek (Warrick Controls), or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General Requirements

1. The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers' instructions. The services of the

system Supplier’s technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation.

B. Inspection.
   1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
      a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

C. Equipment Installation.
   1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.
      a. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
      b. Perform all work in accordance with manufacturer's instructions.
         i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
         ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.
      c. Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section.
      d. Field Piping. Field piping materials and installation shall conform to the requirements of the miscellaneous piping section.
      e. Field-Mounted Instruments. Instruments shall be mounted so they may be easily read and serviced and all appurtenant devices are easily operated. Installation details for some instruments are indicated on the drawings. Unless otherwise indicated on the drawings, instruments which include local indicators shall be mounted approximately 5 feet above the floor and shall be oriented for ease of viewing. Transmitters shall be mounted on corrosion-resistant pipe supports suitable for floor, wall, or bracket mounting.

D. Field Calibration. A technical representative of the system supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final tuning adjustment settings. The adjustment of each calibrated instrument shall be sealed or marked, insofar as possible, to discourage tampering. Instruments shall be calibrated before checkout of the operation of the system.

E. Systems Check. A technical representative of the system supplier shall participate in the checkout of metering and control systems. If interrelated devices furnished by other suppliers, such as valve actuators, motor controls, chemical feeders, or primary measuring devices, do not perform properly when placed in service, the technical representative shall use suitable test equipment to introduce simulated signals to verify or measure signals from such devices as required to locate the source of trouble or malfunction. A written report stating the results of such tests shall be furnished, if requested by the Engineer, to assign responsibility for corrective measures.

1. Installation Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by the Contractor for the duration of the testing work. Unless specified otherwise, test equipment will remain the property of the Contractor or the system Supplier.

F. Adjustment and Cleaning
   1. Perform all required adjustments, tests, operational checks, cleaning and other start-up activities required.
   2. Take precautions, as necessary, to properly protect all equipment from damage. Installed equipment to be protected from further construction operations.

3.2 CUSTOMER TRAINING

A. The coordinating supplier shall provide a qualified representative at the job site to train the Owner's personnel in operating and maintenance of the equipment. The training session shall include a technical explanation of the equipment and an actual hands-on demonstration. The training session shall consist of one 4-hour session, and the schedule shall be arranged and coordinated with the Engineer.

3.3 INSTRUMENT LIST

Instrument List

Tag #	Description	Service	Scale	Provided Under Specification
	Gas Detector	GAS DETECTOR		15500

END OF SECTION