GNHWPCA
Protecting the Environment


GREATER NEW HAVEN Water Pollution Control Authority

# Specifications for Improving Fats Oil and Grease Receivings

November 2023

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**Greater New Haven Water Pollution Control Authority**

# SPECIFICATIONS FOR IMPROVING FATS OIL AND GREASE RECEIVINGS



**November 2023**

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# PROCUREMENT REQUIREMENTS

**BIDDING DOCUMENTS**

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Statement of Qualifications
Proposal
Performance and Payment Bond
Agreement

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# Greater New Haven
# Water Pollution Control Authority

## INVITATION

for Constructing

**PROJECT:** **IMPROVING FATS OIL AND GREASE RECEIVINGS**
**PROJECT NO:** **SSF 2020-03**



Sealed bids will be received at the Office of the Director of Finance and Administration of the Greater New Haven Water Pollution Control Authority located at 260 East Street, New Haven, CT 06511 for **PROJECT: Improving Fats Oil and Grease Receivings** until **Tuesday, January 30th, 2024 at 10:00 AM** at which time and place said bids will be opened publicly and read aloud.

**The purpose of the proposed project is to demolish an existing below grade fuel storage tank, replace it with a new above ground fuel storage tank, and construct FOG Receiving Improvements. The project duration is 540 days from the notice to proceed date.**

The information for Bidders, Proposal, Form of Contract, Plans and Specifications may be examined at the Office of the Director of Finance and Administration at the above address. Anyone submitting a bid for this project must have in their possession a copy of the Plans and a "bid package" containing the Invitation; Labor Rates; Proposal; Special Specifications and Notes can be obtained upon payment of One Hundred Dollars ($100.00).

There will be a non-mandatory pre-bid meeting on **Thursday, January 4th, 2024, at 10:00 AM** at the Greater New Haven Water Pollution Control Authority Water Pollution Abatement Facility (345 East Shore Parkway, New Haven, Connecticut 06511). All questions from Bidders must be received by the Authority via email by Wednesday, January 17th, 2023 at noon, in order to receive consideration. (emails to: engineering@gnhwpca.com).

A certified check or bid bond in the amount of ten percent (10 %) of the total bid amount must accompany the bid. Said checks or bid bonds will be returned to the unsuccessful bidders upon Award of the Contract to the selected firm and execution of the Agreement. If any bid is not accompanied by a bid bond or check at the specified time

for the bid opening, the incomplete bid will not be read and this action will constitute automatic rejection of the bid.

The successful bidder will be required to furnish a performance bond and a labor and materials payment bond in the form as attached to the Bid Documents for the amount of the total bid. A certified check cannot be substituted for either bond. The Greater New Haven Water Pollution Control Authority reserves the right to alter quantities and to accept or reject any or all bids or any portion of any bids, for any or no reason, including unavailability of appropriated funds as it may deem to be in its best interests.

All bidders are to note that the award of this Contract is subject to the following conditions and contingencies:

1. The approval of such governmental agencies as may be required by law.

2. The appropriation of adequate funds by the proper agencies.



Gabriel Varca
**Director of Finance and Administration**

**STATEMENT OF QUALIFICATIONS**

_____
Bidder

_____
Address

**Similar Projects Completed by Bidder:**

1. **NAME OF PROJECT:** _____

   **OWNER:** _____ **ADDRESS:** _____

   **DATE STARTED:** _____ **DATE COMPLETED:** _____

   **APPROX. QUANTITIES OF MAJOR ITEMS:** _____

   _____

   **VALUE OF CONTRACT:** _____

2. **NAME OF PROJECT:** _____

   **OWNER:** _____ **ADDRESS:** _____

   **DATE STARTED:** _____ **DATE COMPLETED:** _____

   **APPROX. QUANTITIES OF MAJOR ITEMS:** _____

   _____

   **VALUE OF CONTRACT:** _____

3. **NAME OF PROJECT:** _____

   **OWNER:** _____ **ADDRESS:** _____

   **DATE STARTED:** _____ **DATE COMPLETED:** _____

   **APPROX. QUANTITIES OF MAJOR ITEMS:** _____

   _____

   **VALUE OF CONTRACT:** _____

4. **OTHER PROJECT REFERENCES:** _____

   _____

   _____

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# ITEMIZED PROPOSAL

For Constructing

**PROJECT:** **IMPROVING FATS OIL AND GREASE RECEIVINGS**
**PROJECT NO:** **SSF 2020-03**

**The Work proposed herein must be completed by (MONTH) (DATE) (YEAR).**

Greater New Haven
Water Pollution Control Authority
260 East Street
New Haven, Connecticut 06511

To Whom It May Concern,

In submitting this bid the duly authorized undersigned declares that the entity on behalf of which this bid is made is, or they are, the only person or persons interested in the said bid; that the bid is made without any connection with any person making another bid for the same contract; that the bid is in all respects fair and without collusion, fraud or mental reservation; and that no official of the Greater New Haven Water Pollution Control Authority, or any person in the employ of the Authority is directly or indirectly interested in said bid or in the supplies or work to which it relates, or in any portion of the profits thereof.



The undersigned also hereby declares that they have, either for themselves or on behalf of the entity they represent, carefully examined the Plans, specifications, and form of Contract for this Project, have personally inspected the actual location of the Work and have considered potential local sources of supply, and are satisfied as to all the quantities and conditions, and understands that in signing this Proposal they or the entity that they represent waives all rights to plead any misunderstanding regarding the same.

The undersigned further understands and agrees that they are to furnish and provide for the respective item price bid all the necessary material, machinery, implements, tools, labor, services, and other items of whatever nature, and to do and perform all the Work necessary under the aforesaid conditions, to complete the improvements of the Project, which Plans and specifications it is agreed are a part of this Proposal, and to accept in full compensation therefore the amount of the summation of the products of the approximate quantities multiplied by the unit prices bid. This summation will hereinafter be referred to as the gross sum bid.

The undersigned further agrees to accept the aforesaid unit bid prices in compensation for any additions or deductions caused by any variation in quantities due to more

accurate measurement, or by any changes or alterations in the Plans or specifications of the Work and for use in the computation of the value of the Work performed for monthly estimates.

Every Proposal must be accompanied by a certified check or bank cashier's check or bid bond payable to the Greater New Haven Water Pollution Control Authority in the amount of ten percent (10%) of the bid.

Accompanying this Proposal is a certified check or bank cashier's check or bid bond payable to the Greater New Haven Water Pollution Control Authority in the amount of $100.00. In case this Proposal shall be accepted by the Authority, and the undersigned shall fail to execute the Contract, the monies represented by such certified check or bank cashier's check or bid bond shall be regarded as liquidated damages and shall be forfeited and become the property of the Authority. The undersigned understands and accepts:

A. When Work is required in which no specific payment item is listed on the Proposal Form, the cost of such Work shall be included in the unit prices bid.

B. All unit prices, lump sums, etc. listed in the bid Proposal are firm and not subject to change for ninety (90) days from the day bids are opened.

C. Within ten (10) days from the date of a notice of acceptance of this Proposal, the undersigned agrees to execute the Contract and to furnish to the Authority a satisfactory "Faithful Performance Bond" and "Labor and Material Payment Bond" in the amount of one hundred percent (100%) of the Contract price.

D. Time is of the Essence. All Work to be performed under the Contract shall be completed within the time stated in the Agreement for the Project or within such extended time for completion as may be granted by the Authority.

E. As a condition of the Contract Award, the successful Bidder shall provide proof, from the Connecticut Secretary of State’s office, of its current authorization to do business in Connecticut. All Connecticut corporations must provide a Certificate of Good Standing from the Secretary of State’s Office. All foreign (out of State) corporations shall provide a valid license to do business in Connecticut, in the form of a current Certificate of Authority from the Secretary of State’s office and evidence of compliance with the bond

requirements of the Connecticut Department of Revenue Services. These documents must be presented within thirty (30) days from the date of the bid opening.

Bidder acknowledges receipt of the Addenda listed below and further acknowledges that the provisions of each Addendum have been included in the preparation of this bid.

| **Addendum No.** | **Date Received** | **Addendum No.** | **Date Received** |
|---|---|---|---|
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |

| BID ITEM NO. | DESCRIPTION | UNITS | QTY. | UNIT PRICE | TOTAL PRICE |
|---|---|---|---|---|---|
| 1 | General Construction | LS | 1 | _____ Figures (_____ _____ _____) Words | _____ Figures (_____ _____ _____) Words |
| 2 | Handling and disposal of regulated materials from excavation activities in accordance with Section 02 61 50, Handling, Transportation, and Disposal of Regulated Materials | CY | 700 | _____ Figures (_____ _____ _____) Words | _____ Figures (_____ _____ _____) Words |
| 3 | Handling and disposal of regulated materials from dewatering activities in accordance with Section 02 61 50, Handling, Transportation, and Disposal of Regulated Materials | Allowance | 1 | $50,000.00 Figures (Fifty Thousand Dollars and No Cents) Words | $50,000.00 Figures (Fifty Thousand Dollars and No Cents) Words |
| 4 | Miscellaneous Fuel Oil repairs in accordance with Section 01 20 00 | Allowance | 1 | $20,000.00 Figures (Twenty Thousand Dollars and No Cents) Words | $20,000.00 Figures (Twenty Thousand Dollars and No Cents) Words |



**Bid Summary**

**Lump Sum Bid Price Bid Item 1 $_____**
**Total Unit Bid Prices Bid Items 2, 3, 4 $_____**
**Total Bid (Bid Items 1, 2, 3, 4) $_____**

**Total Bid (words)_____**
**_____dollars**
**and_____cents**

**COMPANY NAME (BIDDER):** _____

**Address of Bidder:** _____

_____

**Phone Number:** Area Code (_____) _____

**E-mail Address:** _____

I hereby sign this document acting within my authority as a duly authorized representative of the named Bidder. By signing below, I certify, acknowledge and affirm that the information set forth in this document is true, accurate and complete to the best of my knowledge and belief.

**Signature of Bidder:**_____ **Dated:** _____

**Name and Addresses of Members of the Firm:**

_____

_____



**Attachments to this Bid**

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

1. Itemized Proposal
2. Payment Bond
3. Performance Bond
4. Statement of Qualifications

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BOND NO. _____

**PERFORMANCE BOND**

KNOW ALL MEN BY THESE PRESENTS: That _____ as Principal, and _____, as Surety, located at _____ (Business Address), a surety insurer chartered and existing under the laws of the State of _____ and authorized to do business in the State of Connecticut, are held and firmly bound unto the Greater New Haven Water Pollution Control Authority, as Obligee, in the sum of _____ ($_____) for the payment whereof we bind ourselves, our heirs, executors, personal representatives, successors and assigns, jointly and severally.

WHEREAS, Principal has entered into a contract dated as of the __ day of _____, 20__ with Obligee for

_____

_____

_____

in accordance with drawings and specifications, which contract is incorporated by reference and made a part hereof, and is referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS BOND is that of Principal:

1. Performs the Contract at the times and in the manner prescribed in the Contract; and

2. Pays Obligee any and all losses, damages, expenses, costs, direct or indirect, and attorney's fees, including costs of any mediation, arbitration, litigation or appellate proceedings, that Obligee sustains because of any default by Principal under the Contract, including, but not limited to, all delay damages, whether liquidated or actual, incurred by Obligee;



then this Bond is void; otherwise it remains in full force and effect and Surety shall be fully liable for performance of the Principal's obligations provided thereunder.

In the event of a declaration of default of Principal by Obligee under the Contract, the Surety shall, within twenty (20) days of receipt of notice of such default, either: (1) tender the Obligee the full amount of the penal sum of this Bond; or (2) undertake to perform or complete the remaining Contract obligations itself through its agents or through independent contractors.

If Surety denies liability, in whole or in part, it shall notify the Obligee, in writing, citing the detailed reasons therefor, within fifteen (15) days of receipt of the aforesaid declaration of default of Principal.

The Surety, for value received, hereby stipulates and agrees that no changes, extensions of time, or additions to the terms of the Contract, or other work to be performed hereunder, or the specifications referred to therein shall in anyway affect its obligations under this Bond, and it does hereby waive notice of any such changes, extensions of time, alterations, or additions to the terms of the Contract, to the work thereunder or to the specifications.

In no event will the Surety be liable in the aggregate to Obligee for more than the penal sum of this Performance Bond, regardless of the number of suits that may be filed by Obligee.

Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the State of Connecticut and shall be instituted within the applicable statute of limitations for contract actions after Principal defaults.

IN WITNESS WHEREOF, the above parties have executed this instrument this ____ day of _____, 20__, the name of each party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Signed, sealed and delivered
in the presence of:

PRINCIPAL

Witnesses as to Principal:

By:_____

_____

Name:_____

_____

Its:_____

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me this _____ day of _____, 20____ by _____, as _____ of _____, a _____ [corporation/limited liability company/partnership], on behalf of the [corporation/limited liability company/partnership]. [He/She[ is personally known to me or what has produced _____ as identification and who [did] [did not] take an oath.

My Commission Expires:

_____
Notary Public (Signature)

(AFFIX NOTARY SEAL)

_____

_____
(Printed Name)

_____
(Title or Rank)

_____
(Serial Number, if any)

ATTEST:

SURETY:

Witnesses as to Surety:

_____
(Printed Name)

_____ _____
(Business Address)

_____ _____
(Authorized Signature)

_____
(Printed Name)

OR

Witnesses as to Attorney-in-Fact:

_____
As Attorney-in-Fact
(Attach Power of Attorney)

_____

_____
(Business Address)

_____
(Printed Name)

_____
(Telephone Number)

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me this _____ day of _____, 20____ by _____, as _____ of _____, a _____ [corporation/limited liability company/partnership], on behalf of the [corporation/limited liability company/partnership]. [He/She[ is personally known to me or what has produced _____ as identification and who [did] [did not] take an oath.

My Commission Expires:

_____
Notary Public (Signature)

(AFFIX NOTARY SEAL)

_____

_____
(Printed Name)

_____
(Title or Rank)

_____
(Serial Number, if any)

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BOND NO. _____

**PAYMENT BOND (incorporating C.G.S. § 49-41)**

KNOW ALL MEN BY THESE PRESENTS: That by this Bond, we, _____ (hereinafter called the "Principal") and _____ (hereinafter called the "Surety"), located at _____, a surety insurer chartered and existing under the laws of the State of _____ and authorized to do business in the State of Connecticut, are held and firmly bound unto the Greater New Haven Water Pollution Control Authority (hereinafter called "Owner") in the sum of _____ ($_____) for the payment whereof we bind ourselves, our heirs, personal representatives, executors, successors and assigns, jointly and severally.

WHEREAS, Principal and the Owner have reached a mutual agreement (hereinafter referred to as the "Contract") for the purpose of _____, said Contract being made a part of this Bond by this reference.

NOW, THEREFORE, THE CONDITION OF THIS BOND is that if the Principal:

1. Promptly makes payments to all claimants supplying the Principal with labor, materials or supplies, as used directly or indirectly by the Principal in the prosecution of the work provided for in the Contract; and

2. Pays the Owner for all losses, damages, expenses, costs, and attorneys' fees, including the costs of any mediation, arbitration, litigation or appellate proceedings, that the Owner sustains because of a default by the Principal under paragraph 1 of this Bond, then this Bond is void, otherwise this Bond remains in full force and effect.

BE IT FURTHER KNOWN:

Any changes in or under the Contract and compliance or noncompliance with formalities connected with the Contract or alterations which may be made in the terms of the said Contract, or in the work to be done under it, or the giving by the Owner of any extension of time for the performance of the said Contract, or any other forbearance on the part of the Owner or Principal to the other, shall not affect the obligation of the Principal and the Surety, or either of them, their heirs, personal representatives, successors or assigns under this Bond, notice to the Surety of any such changes, alterations, extensions or forbearance being hereby waived.

This Bond is issued in accordance with and expressly incorporates herein the requirements of Conn. Gen. Stat. § 49-41.

IN WITNESS WHEREOF, the above parties have executed this instrument this ____ day of _____, 20__, the name of each party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

Signed, sealed and delivered in the presence of:

Witnesses as to Principal:

_____

_____

PRINCIPAL:

By:_____

Name:_____

Its:_____

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me this ____ day of _____, 20__ by _____, as _____ of _____, a _____ [corporation/limited liability company /partnership], on behalf of the _____ [corporation/limited liability company/partnership]. [He/She] is personally known to me or who has produced _____ as identification and who [did] [did not] take an oath.

My Commission Expires:

_____

Notary Public (Signature)

(AFFIX NOTARY SEAL)

_____

(Printed Name)

_____

(Title or Rank)

_____

(Serial Number, if any)

ATTEST:

SURETY:

Witnesses as to Surety:

_____
(Printed Name)

_____ _____
(Business Address)

_____ _____
(Authorized Signature)

_____
(Printed Name)

OR

Witnesses as to Attorney-in-Fact:

_____
As Attorney-in-Fact
(Attach Power of Attorney)

_____ _____
(Business Address)

_____
(Printed Name)

_____
(Telephone Number)

STATE OF _____

COUNTY OF _____

The foregoing instrument was acknowledged before me this ____ day of _____, 20__ by _____, as _____ of _____, a Surety, on behalf of the Surety. [He/She] is personally known to me or who has produced _____ as identification and who [did] [did not] take an oath.

My Commission Expires:

_____
Notary Public (Signature)

(AFFIX NOTARY SEAL)

_____
(Printed Name)

_____
(Title or Rank)

_____
(Serial Number, if any)

# AGREEMENT

## GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY
## CONTRACT FOR CONSTRUCTION SERVICES

CONTRACT NO:

This Agreement (“Agreement”) entered into this _____day of _____ 20__, by the Greater New Haven Water Pollution Control Authority, hereinafter referred to as "AUTHORITY", acting by and through _____, its Executive Director, duly authorized and _____, a corporation organized and existing under the laws of the State of Connecticut and having offices at _____, acting herein by _____ _____, its _____, duly authorized, hereinafter called the "CONTRACTOR".



WITNESSETH: That the Authority and Contractor, for the consideration hereinafter named, agree as follows:

**ARTICLE 1 WORK TO BE DONE**

The Contractor shall (a) furnish all the materials, machinery, implements, tools, labor, services, and other items of every kind required to perform and complete in the most substantial and workmanlike manner, the Project generally identified and shown on: Improving Fats Oil and Grease Receivings (hereinafter the Project) in accordance with the general specifications and conditions of contract, materials of construction, and payment items, and all requirements of the Contract Documents as defined herein.

The AUTHORITY will pay to the Contractor for the satisfactory completion of the Project, the total sum of $ _____ (“Contract Sum”) in the manner as set forth in the Standard Specifications and the Contract Documents.

No increase in the Contract Sum shall be allowed on account of any escalation in the price of material, equipment or wages during the performance of the Work.

The Contractor acknowledges that the Contract Plans and specifications may not be fully developed and the Contractor agrees to perform all Work which may not be specifically mentioned in these documents, but which is required to make the Work complete, functional, and operational as determined by the Engineer and the Authority.

The Contractor shall assume sole responsibility for and shall perform, or cause to be performed, all special inspections and testings required by the Connecticut Building

Code, or any other applicable code or regulation, or the relative Contract Documents. To the fullest extent permitted by law, the Contractor shall be liable to Authority for any and all liability, costs, expenses, fines, penalties and attorney's fees resulting from its failure to perform such duties.

## ARTICLE 2 ADMINISTRATION BY AUTHORITY

The Work to be performed under this Contract shall be administered on behalf of the Authority by Brown and Caldwell, or their designated representative, hereinafter referred to as the "Engineer."

## ARTICLE 3 DOCUMENTS FORMING THE CONTRACT

The Contract Documents shall be deemed to include the advertisement for bid or for Proposals including all General Provisions; the Contractor's bid or Proposal response or extracts thereof as selected by the Authority; this written document, including all bonds and insurance certificates; technical and special specifications; the Project Plans; minimum applicable labor wage rates; any Addenda to specifications if the same are issued prior to the date of receipt of bids; and all provisions required by law or required by external source of funding to be inserted in the Contract, whether actually inserted or not.

This Contract will supersede any agreement or contract form that may have been included in the bid specifications.

While the intention is for all Contract Documents to be read together, to the extent there is any conflict and ambiguity between the terms of this Agreement, and any other Contract Document then the terms of the Agreement shall have priority and prevail.

## ARTICLE 4 EXAMINATION OF DOCUMENTS AND SITE

The Contractor confirms that it has carefully examined all the Contract Documents, together with the Site of the Project, as well as its surrounding territory; it is fully informed regarding all existing conditions, both natural and man-made, as well as all such above grade, at grade and subsurface conditions that may in any way affect the Work to be done and labor and materials to be furnished for the proper completion of the Project, including, by way of example, the existence of poles, wires, pipes, ducts, conduits and other facilities and structures of municipal and public service corporations on, over or under the Project Site; that it has secured such information by personal investigation, research, and inquiry into all reasonably available data concerning the actual Site and has not relied upon the estimates or records of the Authority; and that it will make no claim against the Authority by reason of reliance on any such estimates, tests, information, data or representations made by any officer, agent, representative or employee of the Authority, or for costs incurred as a result thereof.

The Authority makes no representations or warranties as to the accuracy of as-built conditions indicated on the drawings or other documents pertaining to existing facilities including, but not limited to, information on piping, sewers, wiring, ducts and structural members. The Contractor shall independently verify the location of all existing physical conditions and improvements before proceeding with the Work and will provide the access line and benchmarks, layout or line and grade work necessary for proper execution of the Work.

## ARTICLE 5 DATE OF COMPLETION

Time is of the Essence. The Contractor further agrees that it will begin the Work herein described within ten (10) days of the effective date hereof, unless written instruction to the Contractor is given to begin at a different date. The Contractor shall prosecute the same so that the Project shall be entirely completed no later than 540 days from NTP.

No extension beyond this date of completion shall be effective unless in writing signed by the Authority. Such extension shall be for such time and upon such terms and conditions as shall be fixed by the Authority, which may include a charge for engineering and inspection expenses actually incurred upon the Work, including engineering and inspection expenses incurred by railroad companies on contracts which affect a railroad right of way. Notice of application for such extension shall be filed with the Engineer at least fifteen (15) days prior to the date of completion fixed by the terms of this Contract.



## ARTICLE 6 ALTERATIONS AND OMISSIONS

The Work shall be performed in accordance with the true intent and meaning of the Contract Documents without any expense of any nature whatsoever to the Authority exceeding the consideration named in Article 1.

The Authority reserves the right, at any time during the progress of the Work hereunder; to alter the Plans therefore or omit any portion of the Work as it deems to be in the interest of the Project. In such event, allowances for additions and/or deductions to the prices listed in the Proposal will be made commensurate with such changes in the scope or extent of the Work. Any such action by the Authority shall not constitute grounds for a claim by the Contractor for damages, loss of anticipated profits, or for costs resulting from any variations between the approximate quantities and quality of work contemplated in the Proposal and as built.

## ARTICLE 7 CONTINGENCIES, EXTRA WORK, AND CHANGES

Whenever the Engineer determines that, from any cause not foreseeable at the time of this Contract, the scope of Work contemplated hereunder should be altered to provide for changes, deletions, contingencies, or additional or Extra Work, they may issue an Order on Contract to the Contractor who shall forthwith commence the Work necessary to comply with the specifications of such Order on Contract. No Extra Work shall be commenced or undertaken nor shall any be deleted until the Engineer has issued and signed a written Order on Contract in the Authority's standard form.

Payment for any unforeseen work and/or changes shall be made as provided for in the Standard Specifications.

Pending resolution of any claim, dispute, change or other controversy, nothing shall excuse the Contractor from proceeding diligently with prosecution of the Work.

## ARTICLE 8 NO COLLUSION OR FRAUD

The Contractor hereby agrees that the only person or persons interested as principal or principals in the bid or Proposal submitted by the Contractor for this Project are named therein; that this Contract has been secured without any connection with any person or persons other than those named; that this Contract was secured without collusion or fraud; and that neither any officer nor employee of the Authority, nor any member of the immediate family of any such person, has or shall have a financial interest in the performance of this Contract, in the supplies, work or business to which it relates, or in any portion of the profits thereof, except as permitted by the Code of Ethics of the Greater New Haven Water Pollution Control Authority.



## ARTICLE 9 PAYMENT OF ESTIMATES

As the Work progresses in accordance with the Contract and in a manner that is satisfactory to the Authority, the Authority hereby agrees to make payments to the Contractor therefore, based upon the Proposal attached hereto and made a part hereof, as follows: The Engineer shall once in each month and on such days as it may fix, estimate the quantity of Work done and Material furnished in accordance with the terms and conditions of this Contract during the preceding month, and, subject to receipt of an acceptable application for payment and all supporting documentation, which shall include, without limitation, a partial release and waiver of liens in the form as shown in **§ 102-22, Sample Form of Conditional Partial Release and Waiver of Liens** and which has been executed by Contractor, shall pay to the Contractor ninety-five (95%) percent of such amount.

Commencing with the second application for payment and continuing thereafter, as a condition to receipt of any progress payments the Contractor shall also submit partial releases and waivers of lien as executed by all subcontractors and material suppliers which have furnished any labor, material or equipment on the Project and which shall be

effective through the immediately preceding application for payment. The five (5%) percent retained shall be held by the Authority until Final Completion and acceptance of all Work covered by this Contract and compliance by the Contractor with all of its responsibilities hereunder including the posting of a twenty-five percent (25 %) maintenance bond in a form acceptable to the Authority by the Contractor ensuring the Project for a period of three (3) years from the date of final acceptance and the making of all payments due all subcontractors and material suppliers in connection with the Project. Nothing herein shall modify or limit detailed payment provisions contained in the Contract Documents and approved by the Engineer.

It is further agreed that so long as the Contractor fails to comply with any lawful or proper direction concerning the Work or Material given by the Engineer, the Contractor shall not be entitled to have any estimate made for the purpose of payment. No such estimate shall be rendered until the Contractor fully and satisfactorily complies with all such directions.

The Contractor shall not apply for payment of any sums on account of Work performed by any subcontractor or vendor unless it intends to immediately pay such sums to them. All monies paid to Contractor on account of Work performed by any subcontractors, vendors or laborers shall be deemed to be trust funds for the benefit of such entities.

The Authority may withhold from any payment, including final payment, such amount as the Authority, in its discretion, deems reasonably necessary to protect itself against any actual or potential liability (including attorney's fees and costs) or damage directly or indirectly relating to the Contract arising from, or alleged to arise from, any act or omission by Contractor.

The Authority shall have the right to set off against amounts otherwise due to the Contractor under this Contract or under any other contract or arrangement that the Contractor has with the Authority, any costs that the Authority has incurred due to the Contractor's non-compliance with this Contract and any other amounts that are due and payable from the Contractor to the Authority. Any sum taken and set off from the Contractor shall be deemed to have been paid to the Contractor for purposes of payment obligations under Article 9.



**ARTICLE 10 UNCOMPLETED WORK**

If, in the judgment of the Engineer, the Work to be performed under this Contract is "substantially", although not entirely, completed, and in its judgment the withholding of the retained percentage would be an injustice to the Contractor, the Engineer may, provided that it receives certification that the essential items in the Contract have been completed in accordance with the terms of the Contract, include in the final account such uncompleted items. The Engineer will pay the Contractor therefore at the item prices in the Contract upon the Contractor's depositing with the Engineer a certified check drawn upon a legally incorporated bank or trust company equal to at least double the value of such uncompleted work. The deposit may be used by the Engineer to

complete the uncompleted portion of the Contract and any unused portion shall be returned to the Contractor upon its satisfactory completion of the uncompleted work within a specified number of working days after it has been notified to proceed.

## ARTICLE 11 FINAL ACCEPTANCE OF WORK

When, in the opinion of the Engineer or, if applicable, the Authority's representative, the Contractor has fully performed the Work under this Contract, the Engineer, or the Authority's representative, shall recommend to the Authority the acceptance of the Work so completed. If the Authority accepts the recommendation, it shall thereupon by letter notify the Contractor of such acceptance, and copies of such acceptance shall be sent to other interested parties.

## ARTICLE 12 FINAL PAYMENT

Final payment shall be made only after acceptance of the Work performed hereunder, approval of the final determination of such Work by the Engineer, the Contractor's execution of a final release and waiver of liens in the form as shown in **§102-23, Sample Form of final Release and Waiver of Liens**, and the Contractor's having posted a satisfactory three (3) year maintenance bond with the Authority. The Engineer, or the Authority's representative, shall prepare the final determination of the Work done from actual field measurements and computations relating to the same, shall compute the value of such Work under and according to the terms of this Contract, certify as to the correctness of such determination, and submit the same to the Authority for final approval. The right is hereby reserved to the Authority to reject the whole or any portion of the final determination, should it be found or known to be inconsistent with the terms of this Contract or otherwise improperly given. All certifications, upon which partial payments may have been made, being merely estimates, are subject to correction in the final determination or upon final payment.



## ARTICLE 13 ACCEPTANCE OF PAYMENT

Acceptance by the Contractor, or anyone claiming by or through it, of any interim or final payment hereunder shall constitute and operate as a release of the Authority from any and all claims of any liability or responsibility to the Contractor for anything done to, furnished for, relating to or in connection with the Work hereunder, and for any act, neglect, default on the part of the Authority or any of its officers, agents, or employees unless the Contractor serves a detailed and verified statement of claim upon the Authority prior to the acceptance of such payment. Such statement shall specify the items and details upon which the claim is based and any claim shall be limited to such items. The Contractor's refusal to accept the final payment as tendered shall constitute a waiver of any right to interest thereon.

## ARTICLE 14 LABOR AND EMPLOYMENT REGULATIONS

Pursuant to Connecticut General Statutes, §31-52, all contracts for the construction, remodeling or repairing of any public building are required by law to contain the following provisions:

> "In the employment of labor to perform the Work specified herein, preference shall be given to citizens of the United States, who are, and continuously for at least three months prior to the date hereof have been, residents of the labor market areas, as established by the Labor Commissioner of the State of Connecticut, in which such work is to be done, and if no such qualified person is available, then to citizens who have continuously resided in the county in which the work is to be performed for at least three months prior to the date hereof, and then to citizens of the state who have continuously resided in the state at least three months prior to the date of this contract."

In no event shall these provisions be deemed to abrogate or supersede, in any manner, any provision regarding residency requirements contained in any collective bargaining agreement to which the Contractor is a party.

Pursuant to Connecticut General Statutes, §31-52a, the following provision shall be incorporated into this Contract and each subcontract hereunder insofar as this Contract or any such subcontract concerns a public works project, including, but not limited to, construction, remodeling or repairing of any public facility or structure except public buildings covered by §31-52, site preparation or site improvement, appurtenances or highways, or the preparation or improvement of any land or waterway on or in which a structure is situated or to be constructed are required by law to contain the following provision:

> "In the employment of mechanics, laborers or workmen to perform the work specified herein, preference shall be given to residents of the State who are, and continuously for at least six (6) months prior to the date hereof have been, residents of this State, and if no such person is available then to residents of other states."

Nothing herein shall abrogate or supersede any provision regarding residence requirements contained in any collective bargaining agreement to which the Contractor is a party.

The Contractor shall include the foregoing provisions in all subcontracts and sub-agreements entered into pursuant to this Contract or related to this Project.

Pursuant to Connecticut General Statutes, §31-53, the following provision shall be incorporated into each contract for work relating to new construction of a public works project where the total cost of all work to be performed in connection with such project is Four Hundred Thousand Dollars ($400,000) or more, and each contract for work

relating to the remodeling, refinishing, refurbishing, rehabilitation, alteration or repair of any public works project where the total cost of all work to be performed in connection with such project is One Hundred Thousand Dollars ($100,000) or more:

> "The wages paid on an hourly basis to any mechanic, laborer or workman employed upon the work herein contracted to be done and the amount of payment contribution paid or payable on behalf of each such employee to any employee welfare fund described in §31-53(h) of the Connecticut General Statutes, shall be at a rate equal to the rate customary or prevailing for the same work in the same trade or occupation in the town in which such public works project is being constructed. Any Contractor who is not obligated by agreement to make a payment or contribution on behalf of such employees to any such employee welfare fund shall pay to each employee as part of their wages the amount of payment or contribution for their classification on each pay day."

**NOTE:** Prevailing wage rates are fixed by the State Labor Commissioner.

The most recent wage rate schedule will be obtained and attached to the Contract.

In the event that the Authority determines that any mechanic, laborer or workman employed by the Contractor or any subcontractor directly on the Site for the work contemplated hereunder has been or is being paid a rate of wages less than that required to be paid, as stated herein, the Authority may, by written notice to the Contractor, terminate the Contractor's right to proceed with the work hereunder or such part of the work for which there has been a failure to pay the required wages. In the event of such termination, the Authority may prosecute the work to completion by contract or otherwise and the Contractor and its Sureties shall be liable to the Authority for all costs incurred thereby in excess of the compensation to be paid under this Contract.



## ARTICLE 15 RIGHT TO SUSPEND WORK OR TERMINATE CONTRACT

If, at any time, the Engineer or the Authority determines that the Work hereunder is not being performed according to the Contract Documents or in the best interests of the Authority, the execution of the Work by the Contractor may be temporarily suspended by the Engineer or the Authority, who may then proceed with the Work under its own direction in accordance with the Contract specifications and in such manner as determined to be in the best interests of the Authority; or the Authority may terminate the Contractor's employment under this Contract while it is in progress, and thereupon proceed with the Work in such manner and by such process as determined to be in the best interest of the Project and the Authority. All costs, expenses, losses and damages, including attorney fees, and all other charges incurred by the Authority for the Project as a result shall be charged to the Contractor and deducted by the Authority from any monies due or payable or to become due or payable hereunder. If the cost of completing the Contract exceeds the amount stated herein, such amount shall be

charged to and promptly paid by the Contractor to the Authority. In computing the amounts chargeable to the Contractor, the Authority shall not be held to a basis of the lowest prices for which the completion of
the Project or any part thereof might have been accomplished, but the Contractor shall be liable for all sums actually paid or expenses actually incurred in affecting prompt completion of the Project Work hereunder. The rights described herein are in addition to any other rights and remedies provided by the law.

Should the Authority reactivate the performance of services covered by this Contract, in whole or in part, within one (1) year from the time of suspension, any fees paid to the Contractor pursuant to this Contract shall be applied as payment on the fees as set forth in the Contract at the time of reactivation. Should reactivation occur after a period of suspension exceeding one (1) year, the Contractor and the Authority may renegotiate the Contract based upon current conditions or may unilaterally elect to terminate the Contract.

Termination under this section shall not give rise to any claim against the Authority for damages or compensation in addition to that provided hereunder.

No person shall have any right or claim by reason of the Authority's failure or refusal to withhold monies. No interest shall be payable by the Authority on any amounts withheld under this provision. This provision is not intended to limit or in any way prejudice any other right of the Authority.

If the Engineer determines to suspend or stop Work, or if the Authority determines to terminate or cancel this Contract, a written notice sent by mail to the Contractor at its address and to the Sureties at their respective addresses shall be sufficient notice of its action. In the event of termination, no further payment to the Contractor shall be made until the Work is completed and the Authority determines the additional costs, expenses, losses and damages due and owing by the Contractor to the Authority.

If it is subsequently determined that Authority has wrongfully terminated Contractor for default under this Article 15, then the termination shall be deemed to be a termination for convenience as provided under **§105-07, Termination for Convenience Clause** of the General Provisions.



## ARTICLE 16 INTERPRETATION OF PLANS

Any ambiguity in, or difference in interpretation of the Plans, specifications or other Contract Documents, or between or among any of them, must be immediately submitted to the Engineer, who shall resolve the same, and its decision in relation thereto shall be final and conclusive upon the parties.

## ARTICLE 17 REJECTED WORK AND MATERIAL

In the event the Engineer finds that the Materials furnished, the finished Project or the Work performed hereunder by the Contractor does not conform with the plans and specifications and has resulted or will result in an inferior or unsatisfactory product, the Materials or Work shall be removed and replaced or otherwise corrected, to the satisfaction of the Engineer, by and at the expense of the Contractor.

The Contractor agrees that it shall at once remove from the Site at its own expense all Work or Material which may be rejected by the Engineer and replace the same with Work or Material satisfactory to the Engineer. All Work shall be in a first class and satisfactory condition at the time of final acceptance.

## ARTICLE 18 PAYMENTS TO SUBCONTRACTORS AND SUPPLIERS

A. The Contractor shall, within thirty (30) days after its receipt of payment from the Authority, pay any amounts due any subcontractor, whether for labor performed or Materials furnished hereunder, when the labor or materials have been included in a requisition submitted by the Contractor and paid by the Authority.

B. The Contractor shall include in each of its subcontracts a provision requiring each subcontractor to pay any amounts due any of its subcontractors, whether for labor performed or materials furnished, within thirty (30) days after such subcontractor receives payment from the general Contractor which encompasses labor or materials furnished by such subcontractor.



## ARTICLE 19 LAWS, PERMITS, AND LICENSES

The Contractor shall observe all federal, state, and local laws and regulations and agrees to procure all necessary licenses and permits, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the Work hereunder.

## ARTICLE 20 EQUAL EMPLOYMENT OPPORTUNITY

The Contractor agrees and warrants that in the performance of this Contract it will not discriminate or permit discrimination against any person or group of persons on the grounds of race, color, religious creed, age, marital status, national origin, ancestry, sex, sexual orientation, mental retardation or physical disability, including, but not limited to, blindness, unless it is shown by the Contractor that such disability prevents performance of the Work involved, in any manner prohibited by the laws of the United States or of the State of Connecticut. The Contractor further agrees to take affirmative action to insure that applicants with job-related qualifications are employed and that employees are treated in a nondiscriminatory manner.

The Contractor agrees to provide the Commission on Human Rights and Opportunities with such information requested by the Commission concerning its employment practices and procedures.

The Contractor will cause the foregoing provisions to be inserted in all subcontracts for any Work covered by this Contract so that such provisions will be binding upon each subcontractor.

## ARTICLE 21 SUCCESSORS AND ASSIGNS

This Contract shall bind the successors, assigns and representatives of the parties hereto. Notwithstanding the foregoing, this Contract may not be assigned by the Contractor nor shall the Contractor's rights, title or interest herein or hereto be assigned, transferred, conveyed, sublet, or disposed of without the previous written consent of the Authority.

## ARTICLE 22 LIQUIDATED DAMAGES

It is understood by the parties that timely completion of the Project is essential. If the Contractor fails to satisfactorily complete the Work hereunder within the time specified or within any extra time that may have been allowed by way of an extension, there shall be deducted from any monies due or that may become due the Contractor, the sum of One Thousand Dollars ($1,000.00 ) for each and every Calendar Day, including Saturdays and Legal Holidays, that the Project remains incomplete. This sum shall not be imposed as a penalty, but as liquidated damages due the Authority from the Contractor by reason of the inconvenience to the public and other problems incurred by the Authority as a result of the delay thereby occasioned, including, but not limited to, the added cost of engineering and supervision, maintenance and other items which involve the unanticipated expenditure of public funds.



## ARTICLE 23 INSURANCE AND INDEMNIFICATION

The Contractor agrees to obtain at its own cost and expense all insurance required by the Contract Documents and to keep the same in continuous effect until the Authority indicates the termination of the Contractor's responsibilities hereunder. Before commencing the Work, the Contractor shall furnish the Authority a certificate of insurance, and shall thereafter provide renewal certificates, as appropriate, evidencing such coverage written by a company or companies acceptable to the Authority. Each insurance certificate shall be endorsed to name the Greater New Haven Water Pollution Control Authority as an additional insured party and shall provide that the insurance company shall notify the Authority by certified mail at least thirty (30) days in advance of termination of or any change in the policy. No change shall be made without the prior written approval of the Authority Counsel.

To the maximum extent permitted by law, the Contractor expressly agrees to at all times indemnify, defend and save harmless the Greater New Haven Water Pollution Control

Authority, the Engineer and their respective officers, agents and employees ("Indemnitees"), on account of any and all demands; claims; damages; losses; litigation; financial costs and expenses, including counsel fees; and compensation arising out of personal injuries (including death), any damage to property, real or personal, any economic loss and any other loss, expense or aggrievement directly or indirectly arising out of, related to or in connection with the Project and the Work to be performed hereunder by the Contractor, its employees, agents, subcontractors, material suppliers, or anyone directly or indirectly employed by any of them, subject only to the exception that this indemnification obligation excludes any liability arising out of bodily injury or property damage caused by the negligence of the Indemnitees, their employees and agents. The Contractor shall and does hereby assume and agree to pay for the defense of all such claims, demands, suits, proceedings and litigation. The provisions of this paragraph shall survive the expiration or early termination of this Contract and shall not be limited by reason of any insurance coverage.

The Contractor hereby assumes the entire responsibility and liability for all Work, supervision, labor and materials provided hereunder, whether or not erected in place, and for all plant, scaffolding, tools, equipment, supplies, and other things provided by Contractor until a final acceptance of the entirety of the Work by the Authority. In the event of any loss, damage or destruction thereof from any cause, the Contractor shall be liable therefor, and shall repair, re-build and make good such loss, damage or destruction at Contractor's cost and expense, subject only to the extent that any net proceeds are payable under any Builder's Risk property insurance that may be maintained by the Authority.



**ARTICLE 24 SUBCONTRACTING**

The Contractor shall not subcontract any portion of the Work to be performed hereunder unless the prior consent of the Authority is given for both the Work to be subcontracted and the subcontractor to perform the same.

The Authority shall be an express third party beneficiary of all subcontracts, purchase orders, and other agreements entered into between the Contractor and third parties with respect to the Project.

**ARTICLE 25 GENERAL PROVISIONS**

A. This Contract shall be deemed binding only to the extent that money is available and appropriated to the Authority for payment in accordance with the terms hereof and no liability on account of this Contract shall be incurred by the Authority beyond such moneys as are properly made available and appropriated for the Project.

B. The relationship of the Contractor to the Authority is that of an independent Contractor. The Contractor covenants and agrees that it will conduct itself consistent with such status; that it will neither hold itself nor any of its employees

or agents out as nor claim to be an officer, agent, or employee of the Authority by reason hereof; and that it will not, neither for itself nor on behalf of any of its employees, agents, or subcontractors, by reason hereof, make any claim, demand or application to or for any right or privilege applicable to an officer or employee of the Authority, including, but not limited to, workers' compensation coverage, unemployment insurance benefits, social security coverage, or retirement membership or credit.

C. The Contractor hereby certifies that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal or state department or agency. Should the Contractor be unable to certify the above statement, it shall attach a certified statement explaining such to this Contract. The Contractor further agrees to include the foregoing certification in any subcontract or purchase order which it may enter into in furtherance of the Work contemplated hereunder.

D. No member of the governing body of the Authority, and no other officer, employee, or agent of the Authority, shall have any personal interest, direct or indirect, in this Contract, except as permitted by the Code of Ethics of the Greater New Haven Water Pollution Control Authority; and the Contractor covenants that no person having such interest shall be employed in the performance of this Contract.

E. This Contract shall be construed in accordance with the laws of the State of Connecticut, and any action at law in connection herewith shall be brought in a Connecticut state court in New Haven, Connecticut.

F. The Contractor shall comply with all applicable laws, ordinances and codes of the State of Connecticut and the Greater New Haven Water Pollution Control Authority and of any municipality wherein the Work is to be performed, and shall commit no trespass on any private property in performing any of the Work embraced herein.

G. This Contract incorporates all the understandings of the parties hereto, supersedes any and all agreements and negotiations reached and all commitments made by the parties prior to the execution of this Contract, whether oral or written, and shall not be released, amended or modified in any way unless by a written instrument signed by the parties hereto.

H. If any provision of this Contract is held invalid, the balance of the provisions of this Contract shall not be affected thereby if the balance of the provisions of this Contract would then continue to conform to the requirements of applicable laws.

I. Each and every provision and clause required by law to be inserted in this Contract shall be deemed to be inserted herein, and the Contract shall be read

and enforced as though such provisions and clauses were included herein. If, through mistake or otherwise, any such provision is not inserted or is not correctly inserted, then upon written consent of the parties, this Contract shall forthwith be physically amended to make such insertion.

J. All notices of any nature referred to in this Contract shall be in writing and sent by registered or certified mail, postage prepaid, to the respective addresses set forth below or to such other addresses as the respective parties hereto may designate in writing:

**To the Authority:** **Executive Director**
**Greater New Haven**
**Water Pollution Control Authority**
**260 East Street**
**New Haven, Connecticut 06511**

**To the Contractor:** **Address**

K. The Contractor expressly waives its right to notice of hearing under Connecticut General Statutes §52-278a through §52-278q, inclusive, relative to prejudgment remedies, and agrees that the Authority may issue a writ for prejudgment remedy (attachment, foreign attachment, garnishment or replevin) by its attorney without securing a court order.

L. The Contractor and its subcontractors shall not employ anyone to perform any portion of the Work whose employment may be objected to by the Engineer or the Authority. It is understood that contracts to be awarded by the Authority and labor will be employed on the Project without discrimination without as to whether employees, agents, suppliers or subcontractors of the Authority or any subcontractor including those that may be employed by the Contractor, are members or non-members of any labor or collective bargaining organization, and the Contractor accepts this Agreement with this understanding. There should be no manifestations on the Project of any dispute between any labor organization and the Contractor. The Contractor agrees to employ workers, agents, suppliers, and subcontractors who will perform the Work under this Agreement whether or not such employees and mechanics on the Project are members or non-members of any labor or collective bargaining organization. Should any workers perform any portion of the Work, engage in a strike or other work stoppage or cease to work due to picketing or a labor dispute of any kind, said circumstances shall be deemed a failure to perform the Work on the part of the Contractor subject to the conditions and terms set forth in Article 15 of the Agreement.

M. The Contractor shall waive all claims against the Authority for consequential or special damages of any kind whether arising under a theory of breach of contract, tort, breach of warranty, or otherwise.

N. In accordance with Section 108.04 of the General Provisions, Contractor shall not be entitled to any payment of costs, expenses or damages on account of delay on the Project.

**[THE NEXT PAGE IS THE SIGNATURE PAGE]**

IN WITNESS HEREOF, this agreement has been executed in four (4) counterparts by the Authority, acting by and through its Executive Director, who has caused the seal of their office to be affixed hereto, and the Contractor has duly executed this agreement on the day and year first above written.

Signed, Sealed and Delivered in the
Presence of:

**Greater New Haven**
**Water Pollution Control Authority**

_____ By _____
(NAME)
Its Executive Director
Duly Authorized

**(CONTRACTOR)**

_____ By _____
(OFFICER) (POSITION)
Duly Authorized

(affix corporate seal of Contractor, if a corporation)



**APPROVED AS TO FORM:**

**By:** _____

**Authority Counsel**

**APPROVED AS TO**
**AVAILABILITY OF FUNDS:**

**By:** _____

**Director of Finance & Administration**

## SECTION 101 DEFINITIONS AND TERMS

Wherever in these specifications or in other Contract Documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

**ABBREVIATIONS** wherever the following abbreviations are used in these specifications or on the Plans, they are to be construed the same as the respective expressions represented. Some of these abbreviations may be acronyms and may appear without periods.

| | |
|---|---|
| A.A.R | American Association of Railroads |
| A.A.S.H.T.O. | American Association of State Highway and Transportation Officials |
| A.C.I. | American Concrete Institute |
| A.D.A. | Americans with Disabilities Act |
| A.G.C. | Associated General Contractors of America |
| A.I.A. | American Institute of Architects |
| A.I.S.C. | American Institute of Steel Construction |
| A.I.S.I. | American Iron and Steel Institute |
| A.N.L.A. | American Nursery and Landscape Association |
| A.N.S.I. | American National Standards Institute |
| A.R.E.A. | American Railway Engineering Association |
| A.R.T.B.A. | American Road and Transportation Builders Association |
| A.S.C.E. | American Society of Civil Engineers |
| A.S.L.E. | American Society of Landscape Architects |
| A.S.M.E. | American Society of Mechanical Engineers |
| A.S.T.M. | American Society for Testing & Materials |
| A.W.W.A. | American Water Works Association |
| A.W.S. | American Welding Society |
| B.O.C.A. | Building Officials and Code Administrators International |
| ConnDOT. | State of Connecticut, Department of Transportation |
| C.F.R. | Code of Federal Regulations |
| C.G.S. | Connecticut General Statutes |
| C.S.I. | Construction Specifications Institute |
| M.U.T.C.D. | Manual Of Uniform Traffic Control Devices |
| N.E.M.A. | National Electrical Manufacturers Association |
| O.S.H.A. | Occupational Safety and Health Administration |
| S.A.E. | Society of Automotive Engineers |



**ADDENDA:** Written instruments issued prior to the opening of bids which clarify, correct or change the Contract Documents.

**AUTHORITY:** When used, means the Greater New Haven Water Pollution Control Authority represented by the Executive Director.

**AUTHORITY COUNSEL:** The Legal Department or Attorney of the Greater New Haven Water Pollution Control Authority or its authorized representative.

**AWARD:** The Greater New Haven Water Pollution Control Authority's acceptance in writing of the Proposal of the lowest responsible Bidder for the Work, subject to the execution and approval of a satisfactory contract therefore; the provisions of proper bonds to secure the performance thereof, and full payment to all suppliers of labor and materials therefore and the fulfillment of such other conditions as may be specified or otherwise required by law.

**BID DEPOSIT:** The security furnished by the Bidder with their Proposal for a Project, as guaranty that they will enter into a contract for the Work at the price bid if their Proposal is accepted. Also referred to as Bid Bond.

**BIDDER:** An individual, firm or corporation formally submitting a Proposal for the Work contemplated, acting directly or through a duly authorized representative.

**BOND:** The approved form of security in favor of the Authority, executed by the Contractor and their Surety or Sureties, guaranteeing complete execution of the Work specified in the Contract and all supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the Project. Includes Performance Bond, Labor and Materials Payment Bond and Maintenance Bond.

**CALENDAR DAY:** Every day shown on the calendar, Sundays and holidays included.

**CFR:** Code of Federal Regulations published by the U.S. Office of the Federal Register, written TT CFR PPP.SS. TT refers to the Title, PPP refers to the Part and SS refers to the section. For example: 29 CFR 126.1 refers to Title 29, Code of Federal Regulations, Part 126, Section 1.

**CONTRACT:** The written agreement specifying the terms and conditions for the performance of the Work and the furnishing of labor and materials in connection with a specific Project. Also referred to as "Agreement".

**CONTRACT DOCUMENTS:** The Contract Documents shall include the advertisement for bid or Proposal; the Contractor's bid or Proposal response; extracts selected by Authority; the written agreement including all bonds and insurance certificates; the Greater New Haven Water Pollution Control Authority Standard Specifications; technical and special specifications; the Project Plans; State Labor Department minimum wage rates (if applicable); any Addenda to specifications if the same are issued prior to the date of receipt of bids; and all provisions required by law to be inserted in the Contract whether actually inserted or not.

**CONTRACT ITEM (Pay Item):** A specifically described unit of Work for which a price is provided in the Contract Documents. Also known as Pay Item.

**CONTRACTOR:** The individual, firm or corporation undertaking the execution of the Work under the terms of the Contract and acting directly or indirectly or through any agents, representatives or employees.

**EMPLOYEE:** Any person working on the Project mentioned in the Contract of which these specifications are a part, and who is under the direction or control, or receives compensation from the Contractor or Subcontractor.

**ENGINEER OR ENGINEER-IN-CHARGE:** The Engineer representing the Greater New Haven Water Pollution Control Authority, having direct supervision of the execution of the Contract under the direction of the Executive Director.

**EQUIPMENT:** All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the Work.

**EROSION CONTROL:** Erosion control is any action taken or item used as part of a project or as a separate action to minimize the destructive effects of wind or water on surface soil. The use and placement of berms and dams, fiber mats, grasses, sod, mulches, slope drains, sediment basins and drainage systems may be temporary and used throughout construction or permanent and installed for the anticipated life of the facility.

**EXTRA WORK:** An item of Work not provided for in the intended scope of the Contract as awarded but found essential to the satisfactory completion of the Project.

**FEDERAL-AID:** Joint cooperative construction or reconstruction with monies contributed to the Greater New Haven Water Pollution Control Authority by the Federal Government.



**FINAL AGREEMENT:** Written agreement between the Greater New Haven Water Pollution Control Authority, and the Contractor, stating the total amount of Work done by the Contractor and the total value of such Work under and according to the terms of the Contract. The Final Agreement includes the Final Estimate as an attachment.

**FINAL COMPLETION:** Final acceptance of all component parts of the completed Work as determined by the Authority and at which stage the Authority may arrange for the release of retention monies.

**FINAL ESTIMATE:** A certified listing of final quantities, amounts of each item and total cost of the completed Work specified in the Final Agreement, the amounts paid to the Contractor under the Contract, any deductions not included in the Final Agreement and the amount of the final payment due the Contractor.

**FORM 817:** State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form 817, 2016, as amended.

**HIGHWAY:** The whole strip of land bounded by the Right-of-Way lines.

**INSPECTOR:** The Authority duly authorized representative detailed to inspect methods and Materials relating to Work both on and off the Site of the contract.

**LAYING LENGTH OF PIPE:** Feet (laying length) of pipe, shall be measured by multiplying the number of whole units, by the nominal length of each unit, and adding thereto, the length of any fractional units incorporated in the Work. The nominal length of a unit or fractional unit shall be the inside measured length from butt end to butt end and exclusive of the bell or groove on the female end.

**MANUFACTURER:** A Manufacturer operates or maintains a factory or establishment that produces, on the premises, materials or supplies of the general character described by the specifications.

**MATERIAL:** Any approved material acceptable to the Greater New Haven Water Pollution Control Authority and conforming to the requirements of the specifications.

**MATERIAL SUPPLIER:** A Material Supplier is a firm that owns, operates, or maintains a store, warehouse, or other establishment in which the Materials or supplies required for the performance of the Contract are bought, kept in stock, and regularly sold to the public in the usual course of business. A Material Supplier is a firm that engages in, as its principal business, and in its own name, the purchase and sale of the products in question. A Material Supplier who deals in bulk items such as steel, cement, gravel, stone and petroleum products need not keep such products in stock, if it owns or operates distribution equipment. Packagers, brokers, manufacturer's representatives or other persons who arrange or expedite transactions are **NOT** Material Suppliers.



**NOTICE OF AWARD:** The written notice by the Authority to the apparent successful Bidder stating that upon compliance with the conditions precedent enumerated therein, within the time specified, the Authority will sign and deliver the Agreement.

**NOTICE TO PROCEED:** A written notice given by the Authority to the Contractor fixing the date on which the Contractor shall start to perform their obligations under the Contract Documents and from which date the Time for Completion is based.

**ORDER ON CONTRACT:** Written order issued by the Authority covering contingencies, Extra Work, deductions, increases or decreases and additions, alterations or omissions to the Plans, specifications, or other provisions of the Agreement. Also, referred to as "Change Order".

**PARTIAL OR MONTHLY ESTIMATES:** Payments to the Contractor for Work satisfactorily performed.

**PAYMENT LIMIT:** A Payment Limit defines the boundary beyond which no quantities will be measured for payment. Whenever Payment Limits are indicated, only the Work which is actually directed and completed within these limits will be measured and computed for payment. Payment Limits may be revised in writing by the Engineer prior to performing the Work.

**PAYMENT LINE:** Defines the exact line from which Work quantity will be computed. Whenever Payment Lines are indicated, quantities representing Work will be computed from these lines only. No other lines or locations will be used to compute quantities. Payment Lines may be revised in writing by the Engineer prior to performing the Work.

**PLANS:** All official drawings, sketches or reproductions of drawings pertaining to the Work or to any structure connected therewith.

**PROJECT:** The Work to be performed under this Contract including all labor, materials equipment, supervision and all incidentals necessary to complete the construction work identified in the Contract Documents, Plans and Specifications.

**PROPOSAL:** The offer of the Bidder for the Work, when executed and submitted on the prescribed form.

**PROPOSAL FORM:** The approved form on which the Authority requires formal bids to be prepared and submitted for the Work.

**PUNCH LIST:** A formal list of deficiencies in the Work prepared by the Contractor at the request of the Engineer pending Final Completion of the Work.

**REASONABLY CLOSE CONFORMITY:** Reasonably Close Conformity means compliance with reasonable and customary manufacturing and construction tolerances where working tolerances are not specified. Where working tolerances are specified, Reasonably Close Conformity means compliance with such working tolerances. Without detracting from the complete and absolute discretion of the Engineer to insist upon such tolerances as establishing Reasonably Close Conformity, the Engineer may accept variation beyond such tolerances as Reasonably Close Conformity where they will not materially affect the quality or utility of the Work and will be in the best interests of the Greater New Haven Water Pollution Control Authority.

**RIGHT-OF-WAY or R.O.W.:** A general term denoting land, property or interest therein, acquired for or devoted to a Utility installation or a highway, street, road, etc. Property upon which or within which the Project is to be constructed.

**ROADBED:** The graded portions of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

**ROADWAY:** The portion of highway included between the outside edges of the shoulders.

**ROAD SECTION:** That portion of a highway included between the top of slope in cut and the bottom of slope in fill.

**SHOP DRAWINGS:** All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for the Contractor to illustrate some portion of the Work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a manufacturer, fabricator, supplier or distributor and submitted by the Contractor to illustrate material or equipment for some portions of the Work.

**SHOULDER:** The portion of the Roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

**SITE:** The specific area adjacent to and including the area upon which construction of the Work is to be performed. Generally such area may be considered as defined by the right of way or property made available to the Contractor for construction operations.

**SPECIAL NOTES:** Special directions, provisions, or requirements peculiar to the Project under construction.

**STANDARD SHEETS:** The standard drawings approved for repetitive use, showing details to be used where appropriate.

**STANDARD SPECIFICATIONS:** The body of directions, requirements, etc. contained in this present volume, together with all documents of any description and agreements made (or to be made) pertaining to the methods or manner of performing the Work or to the quantities and quality as shown by the test records of accepted materials to be furnished under a contract.



**STATE AID:** Joint cooperative construction or reconstruction with monies contributed to the Greater New Haven Water Pollution Control Authority by the State of Connecticut.

**STRUCTURES:** Bridges, culverts, catch basins, drop inlets, retaining walls, manholes, end-walls, buildings, sewers, service pipes, under-drains, foundation drains and other features which may be encountered in the Work and not otherwise classed herein.

**SUBCONTRACTOR:** Any individual, firm or corporation to whom the Contractor, with the written consent of the Authority, sublets any part of the Contract Work.

**SUBSTANTIAL COMPLETION:** That stage of a Project when the construction is substantially complete and/or ready for occupation and/or use at which the Engineer

allows the Contractor to prepare its final Punch List of outstanding and/or incomplete items pending preparation of final Project closure documents.

**SURETY:** The corporate body bound with and for the Contractor, for the full and complete performance of the Contract, and for the payment of all debts, pertaining to the Work.

**UTILITY:** Person, corporation, municipality or public authority engaged in the distribution of electricity, gases, petroleum products, water, steam, the collection wastewater, the operation of traffic control systems, or the provision of telecommunication services. For the purposes of these Standard Specifications, the term Utility will apply to organizations that operate utilities owned by others.

**WORK:** Work shall be understood to mean the furnishing of all labor, materials, equipment and other incidentals necessary or convenient to the successful completion of the Project and the carrying out of all the duties and obligations imposed by the Contract.

**WORK DAY:** A Calendar Day, exclusive of Sundays and Authority-recognized legal holidays, on which weather and other conditions, not under the control of the Contractor, will permit construction operations to proceed for the major part of the day on the principal item or items of Work which would normally be in progress at that time.

## SECTION 102 BIDDING REQUIREMENTS AND CONDITIONS

### § 102-01 LOCATION OF OFFICES

Persons desiring to make a Proposal shall use the Proposal blank provide in Section 102-20. The time for which Proposals will be received will be found in the published notice calling for Proposals. Any Proposal received after the hour specified in the published notice shall not be accepted. Detailed Plans of the Work and Proposals may be examined at the Office of the Director of Finance and Administration, Greater New Haven Water Pollution Control Authority, 260 East Street, New Haven, CT 06511 or where indicated in the published notice calling for Proposals.

### § 102-02 PROPOSALS

Each Proposal must be submitted on the official form which is furnished by the Authority directly to the Bidder in Section 102-20. All blank spaces in the Proposal Form must be filled in as noted, and no change shall be made to the Proposal Form or in the items mentioned therein.

Proposals that are illegible or that contain any omissions, erasures, alterations, additions, or items not called for in the itemized Proposal or that contain irregularities of any kind, may be rejected at the discretion of the Authority as non-responsive.

The Bidder shall sign in the space provided in the Proposal Form, with their usual signature. An officer of a corporation or a member of a partnership signing for the Bidder shall place their signature and title after the word "By" under the name of the Contractor. The same procedure shall apply to the Proposal of a joint venture by two or more bidders; however, if the signature is by an agent or attorney-in-fact for the joint ventures, then the Proposal shall be accompanied by four (4) authenticated copies of the evidence of the signatory's authority to act on behalf of all of the joint venturers.



If the Proposal is made by a firm, the name and place of residence of each member of the firm shall be given. If made by a corporation, the names of the president, secretary and treasurer shall be given. If made by a partnership, the names of the partners shall be given.

The Authority is responsible for providing Addenda only to those persons or firms having purchased Plans and/or Proposals from the Authority, and those that made a specific request of the Authority for Addenda. Persons or firms that obtain Plans and/or Proposals from sources other than the Authority bear the sole responsibility for obtaining any Addenda issued by the Authority for the subject Project.

The envelopes containing the bids must be sealed, addressed to the Office of the Director of Finance and Administration, Greater New Haven Water Pollution Control Authority, 260 East Street, New Haven, CT 06511 and shall be plainly marked on the

outside with the Contractor's name and title of the bid. If forwarded by mail or other service, the sealed envelope containing the Proposal, and marked as directed above, must be enclosed in another sealed envelope addressed in the same manner and shall preferably be sent by Registered Mail. The prospective Bidder is solely responsible for the sealed bid arriving to the appropriate location in advance of the time designated in the published notice.

## § 102-03 PROPOSAL SHALL SPECIFY GROSS SUM

Each Proposal shall specify the correct gross sum, in the manner hereafter described for which the Work will be performed according to the Plans and specifications and any Addenda to the specifications, together with a unit price for each of the separate items as called for. The lowest responsive bid shall be determined by the Engineer on the basis of the gross sum for which the entire Work will be performed, arrived at by a correct computation of all the items specified in the Proposal at the unit prices stated in the Proposal. The Engineer reserves the right to reject any Proposal in which any of the bid prices are significantly unbalanced to the potential detriment of the Authority. An unbalanced bid is considered to be one containing lump sum or unit bid items which do not reflect reasonable actual costs plus a reasonable proportionate share of the Bidder's anticipated profit, overhead costs, and other indirect costs which are anticipated for the performance of the items in question. The Authority reserves the ultimate authority to assess and determine the responsiveness of all Bidders.

Any Proposal may be deemed non-responsive which does not contain prices set opposite each of the several items for which there is a quantity exhibited in the itemized Proposal or which shall in any manner fail to conform to the conditions of the published notice inviting Proposals. The unit prices and gross sum bid shall be indicated in words and figures. In case the amount shown in words and its equivalent in figures do not agree, the written words may, in the discretion of the Authority, be considered binding upon the Contractor.



The Bidder's attention is directed to the fact that it cannot exceed two (2) decimal positions in the cents column under unit bid price.

Some of the items may be designated as Fixed Price Items. When this is the case, the fixed prices are published in the Proposal. They can be identified in the Itemized Proposal by the words, "Fixed Price - § 102-03" appearing beneath the description of the item. In addition, the "Unit Bid Price" and "Amount Bid" columns have preprinted entries in them. The Bidder shall not change these entries. Should the amount shown be altered, the altered figures will be disregarded and the preprinted price and amount will be used to determine the total amount bid for the Contract.

Some Fixed Price Items indicate the price that will be paid for certain work. These have been prepared taking into account the cost of all labor, materials, and equipment necessary to complete the Work including an allowance for overhead and profit. Other Fixed Priced Items indicate an estimate of payments, with actual payments to be based

on actual costs and provision of the controlling specification. In either case, payments made under Fixed Price Items shall be in accord with the provisions for the specification for that item.

Similarly, one or more items may be designed as MINIMUM PRICE ITEMS or MAXIMUM PRICE ITEMS. When this is the case, the minimum (or maximum) prices are published in the Proposal. Those items can also be identified in the Itemized Proposal by the words “Minimum Bid ____” or “Maximum Bid ____” appearing beneath the description of the item. The price bid for Minimum Price Items shall not be less than the minimum price shown in the Itemized Proposal, but it may exceed that price. Conversely, the price bid for Maximum Price Items shall be less than, or equal to, the maximum price shown in the Itemized Proposal. In the event a bid is less than the Minimum Price (or more than the Maximum Price) indicated in the Itemized Proposal, the Authority will substitute the appropriate minimum (or maximum) price and make the necessary adjustments to determine the total amount bid.

## § 102-04 NO MISUNDERSTANDING

The Bidder shall review all information provided by the Authority regarding the Project, all existing site and other related conditions. The Bidder is advised that, while such information is given in good faith by the Authority, the Authority cannot ensure its sufficiency and accuracy and that such information is intended solely for reference purposes. The Bidder is responsible to verify the status of all existing structures, equipment, systems and site conditions to obtain all information needed to properly perform the Work under the Project. The Bidder shall examine the Contract Documents and the Site of the Work and shall fully inform himself from their personal examination of the same regarding the quantities, character, location and other conditions affecting the Work to be performed, including the existence of poles, wires, pipes, ducts, conduits, and other facilities and structures of municipal and other public service corporations on, over, or under the Site. The Bidder will make no claim against the Authority by reason of reliance upon any such estimates, tests or other representations made by any officer or agent of the Authority with respect to the Work to be performed under the Contract. Particular attention is called to special notes and special specifications in the Proposal which may contain contract requirements at variance with standard plans and specifications and may include information concerning the existence of poles, wires, pipes, ducts, conduits and other facilities and structures of municipal and other public service corporations on, over or under the Site.



The Bidder shall notify the Authority in writing, upon discovery, of any and all omissions, errors or discrepancies that the Bidder discovers within or among the Plans, specifications and other Contract Documents.

## § 102-05 STATEMENT OF NON COLLUSION

By submission of the bid each Bidder and each person signing on behalf of any Bidder certifies, and in the case of a joint Bidder each party certifies as to its own organization, under penalty of perjury, that to the best of knowledge and belief:

A. The prices in this bid have been arrived at independently without collusion, consultation, communication or agreement, for the purpose of restricting competition, as to any matter relating to such prices with any other Bidder or with any competitor.

B. Unless otherwise required by law, the prices which have been quoted in this bid have not been knowingly disclosed by the Bidder and will not knowingly be disclosed by the Bidder prior to opening, directly or indirectly, to any other Bidder or to any competitor, and

C. No attempt has been made or will be made by the Bidder to induce any other person, partnership or corporation to submit or not to submit a bid for the purpose of restricting competition.

## § 102-06 SUBSURFACE INFORMATION

Boring logs and other subsurface information made available for the inspection of Bidders were obtained with reasonable care and recorded in good faith by the Authority.

The following geotechnical document is provided as supplemental information to the Contract Documents and a copy of the report is included in the appendix to the Contract Documents:

FOG Receiving Station &Fuel Storage Tank Relocation, East Shore Water Pollution Control Facility, 365 East Shore Parkway, new Haven, Connecticut. Haley & Aldrich, Inc, July 2023

The soil and rock descriptions shown are as determined by a visual inspection of the samples from the various explorations unless otherwise noted. The observed water levels and/or water conditions indicated are as recorded at the time of the exploration. These levels and/or conditions may vary considerably, with time, according to the prevailing climate, rainfall and other factors.

The locations of utilities or other underground man-made features were ascertained with reasonable care and recorded in good faith from various sources, including the records of municipal and other public service corporations, and therefore the location of known utilities may only be approximate.

The subsurface information shown was obtained by the Authority for design and estimating purposes. It is made available to the Bidders so that they may have access to the same information available to the Authority. It is presented in good faith, but as with all subsurface information it represents only a fraction of the total volume of

material at the Site. Interpolation between data points may not be indicative of the actual material to be encountered. Such information is not intended as a substitute for personal investigations, interpretations and judgment of the Bidder. Rather, each Bidder is responsible for verifying such information and obtaining all additional information necessary to properly perform the Work under the Contract Agreement. The Contractor shall be responsible for determining the existence and location of all subsurface utilities, lines, cables and pipes that may affect performance of the Work. The Contractor shall undertake such further investigations, analyses, tests and studies as may be necessary and useful to determine all surface, subsurface or concealed conditions. If conditions are encountered at the Project Site which are subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Contract Documents, then notice by the observing party shall be given to the other party no later than five (5) days after first observance of the conditions. If the Authority and the Engineer verify such differing site condition, then the Contract Sum and the Project Schedule will be reasonably adjusted. However, in no event will any adjustment be permitted in connection with a concealed or unknown condition which does not differ materially from those conditions disclosed or which reasonably should have been disclosed by the Contractor's prior inspections, tests, and reviews performed by the Contractor, or which the Contractor had the opportunity to perform, in connection with the Project.



## § 102-07 INTERPRETATIONS AND ADDENDA

All questions about the meaning or intent of the Contract Documents shall be submitted to the Authority in writing. In order to receive consideration, questions must be received by the Authority at least ten (10) days prior to the date fixed for the receipt of bids. Any interpretations of questions so raised which in the opinion of the Authority require interpretations, will be issued by Addenda mailed or delivered to all parties recorded by the Authority as having received the Proposal blank prepared by the Authority for the individual contract no later than three (3) days prior to the date fixed for opening of Bids. The Authority will not be responsible for oral interpretations or clarifications which anyone presumes to make on its behalf.

In addition, the Authority may issue such Addenda as may be necessary to clarify, correct or change the Contract Documents.

The Bidder shall acknowledge receipt of the Addenda in the space provided in the Proposal Form and further acknowledge that the provisions of each Addendum have been included in the preparation of the bid.

## § 102-08 MODIFICATION OR WITHDRAWAL OF PROPOSAL

No modification to or explanation of any Proposal or bid in any form, shall be accepted after the Proposal or bid has been deposited with the Authority. No Proposal shall be withdrawn or cancelled before the time designated for publicly opening, except upon

such conditions as the Authority may deem to be necessary. No Proposal shall be withdrawn or cancelled after the time designated for opening such Proposals publicly.

## § 102-09 BID DEPOSIT

Every Proposal must be accompanied by a certified check or bank cashier's check or bid bond payable to the Greater New Haven Water Pollution Control Authority in the amount of ten (10%) percent of the total bid amount. Said checks or bid bonds will be returned to the unsuccessful Bidders upon execution of the Contract Agreement.

## § 102-10 CONTRACT CLAUSES REQUIRED FOR PUBLIC PROJECTS

The execution of the Contract by the Contractor binds him to the following specific agreements required by law:

A. This Contract may not be assigned, in whole or in part, by the Contractor or its rights, title or interest assigned, transferred, conveyed, sublet or disposed of without the previous consent in writing of the Authority.

B. It is understood that the Authority is dependent upon receiving authorized appropriations or budgeted funds for this Project. The Contract for Work on the Project therefore, shall be deemed binding only to the extent of money being made available to the Authority for the performance of the Work there under. No liability on account of such Work shall be incurred by the Authority beyond monies available for the purpose thereof.

C. It is hereby agreed that all applicable provisions of the Labor Laws of the State of Connecticut shall be carried out in the performance of Work under the Contract.

D. The relationship of the Contractor to the Authority is that of an independent Contractor. Accordingly, said Contractor covenants and agrees that it will conduct itself consistent with such status, that it will neither hold itself out as nor claim to be an officer or employee of the Authority by reason hereof, and that it will not make any claim, demand or application to or for any right or privilege applicable to an officer or employee of the Authority, including, but not limited to worker's compensation coverage, unemployment insurance benefits, social security coverage, or retirement membership or credit.

E. The Contractor and anyone employing services for work in connection with this Project shall not discriminate in any employment or work related practices.

## § 102-11 OTHER CONTRACTS

The Authority reserves the right to let other contracts in connection with the Work to be performed on the Project. Therefore, the Contractor may not have exclusive occupancy of the territory within or adjacent to limits of the Site.

The Contractor will be required to cooperate with all other contractors and the owners of the various utilities in and around the Site and to coordinate and arrange the sequence of their work to conform with the progressive operations of such other work. Cooperation and adjustments with the Contractors already engaged and to be engaged upon the Site is essential to properly coordinate the construction efforts of all Contractors, Utility Owners, and Subcontractors engaged in the Work within and adjacent to the construction area of this Project.

In case of interference with the operations of any private Utility Owners or other Contractor, the Authority will be the sole judge of the rights of the Contractor and each Contractor and the sequence of work necessary to expedite the completion of the entire Project. The Authority does not warrant the performance of other contractors to the Contractor. In all cases, the Authority's decision shall be accepted as final.



## § 102-12 FORMS

The form of contract and bond, if given, shall be that provided by the Greater New Haven Water Pollution Control Authority.

## § 102-13 ENGINEERING CHARGES

When the Work embraced in the Contract is not completed on or before the date specified, engineering and inspection expenses incurred by the Authority upon the Work, from the completion date originally fixed in the Contract to the actual date of completion of the Work may be charged to the Contractor and may be deducted by the Authority from the final monies due the Contractor. Consideration of any Extra Work or Order on Contract added to the original Contract amount, as well as extenuating circumstances beyond the control of the Contractor, will be given due consideration by the Authority before assessing engineering and inspection charges against the Contractor. Such charges will be assessed, however, in cases where the Work has been unduly delayed by the Contractor without acceptable reasons, or due to inefficient operations, or any other reason for which the Authority determines the Contractor liable.

## § 102-14 EXEMPTION FROM TAX

Purchases made by the Greater New Haven Water Pollution Control Authority are exempt from payment of Federal Taxes, and State of Connecticut Sales and Use Taxes. Such taxes must not be included in the bid price of any item or materials permanently incorporated into the Work or furnished to the Authority under the Contract.

## § 102-15 CHANGES IN AMOUNT OF BID

All unit prices, lump sums, etc. listed in the bid Proposal, are firm and not subject to change for ninety (90) days from the day bids are opened, unless noted otherwise. Extensions may be agreed to by the Authority and the Bidder.

## § 102-16 SPECIAL SPECIFICATIONS AND NOTES

The schedule of liquidated damages, scope of work, the list designated by the Authority as "Specialty Items" and specific Contract Special Notes and Requirements, will be listed in this location of the Specifications.

## § 102-17 PREQUALIFICATION

To the extent applicable, all bidders must hold a current State of Connecticut DAS prequalification certificate as required by the DAS Contractor prequalification program (See Connecticut General Statutes §4a-100) and shall submit a current certificate and DAS Contractor prequalification update statement at the time of bid. However, DAS prequalification does not preclude the right of the Authority to independently evaluate and make determinations regarding the responsibility of the bidders.

**§ 102-19 PREVAILING WAGE RATES**

**Project specific prevailing wage rates will be obtained from the Connecticut Department of Labor, Wage and Workplace Standards Division.**

**These rates are to be the minimum paid to workers employed in these occupations on this Project and shall remain in effect until completion, unless adjusted prior thereto. The Contractor remains fully liable for the increase in any prevailing wages rates which may be made during the course of the Project.**

**Please direct any questions pertaining to this matter to the Wage and Workplace Standards Division, Telephone No. 860-263-6790**

## SECTION 103 AWARD AND EXECUTION OF CONTRACT

### § 103-01 AWARD OF CONTRACT

Award of contract will be made only to the lowest responsible responsive Bidder as will best promote the public interest. The Greater New Haven Water Pollution Control Authority reserves the right to reject any or all proposals or any portion thereof, or, to award to other than the low Bidder, to waive minor informalities, to advertise for new proposals, or to proceed to do the Work otherwise, if, in its opinion, the best interests of the Authority will thereby be promoted. The Authority reserves the right to assess and determine the responsibility of each Bidder.

If requested by the Authority, the Bidder must present evidence of ownership; corporate structure; experience; ability; compliance with environmental, health and safety regulations; and financial standing; as well as a statement as to equipment.



### § 103-02 EXECUTION OF CONTRACT

The person or persons whose Proposal is accepted will be required to execute the written Contract provided by the Authority and to comply in all respects with the insurance coverage and bonding requirements relating to the Contract within ten (10) days of the date of the delivery of the Contract form by the Authority. In case of failure or refusal on the part of the Bidder to deliver the duly executed Contract to the Authority within the ten (10) day period herein mentioned, the amount of the Bid Deposit made will be forfeited to the Authority.

The Contractor agrees that they will conduct their operations in compliance with all the laws, and regulations of the United States, and the State of Connecticut. All costs due to compliance with the above described laws, regulations, and ordinances shall be included in the prices bid for Contract Items unless otherwise provided for in the Contract.

### § 103-03 RIGHT TO SUSPEND WORK AND CANCEL CONTRACT

If at any time during the prosecution of the Work the Engineer determines that the Work under the Contract is not being performed according to the Contract Documents or in the best interest of the Authority, the execution of the Work by the Contractor may be temporarily suspended by the Engineer, who may then proceed with the Work under its own direction in such manner as will accord with the Contract specifications and be for the best interests of the Authority; or they may terminate the Contractor's employment under the Contract while it is in progress, and thereupon proceed with the Work, in affirmance of the Contract, by a new contract negotiated or publicly let, by the use of its own forces, by calling upon the Surety to complete the Work in accordance with the Plans and specifications or by a combination of any such methods. If the cost of completing the Contract exceeds the price for which it was originally awarded, such costs shall be charged to and paid by the Contractor or their Surety. Whenever the Engineer determines

to suspend or stop work under the Contract, a written notice sent by mail to the Contractor at their address and to the Sureties at their respective addresses, shall be sufficient notice of its action.

## § 103-04 BONDS

The Contractor shall procure and maintain without any expense to the Authority and until final acceptance of the Work the following:

A. FAITHFUL PERFORMANCE BOND. A bond in the form acceptable to the Authority with sufficient sureties, to ensure that the Contractor will perform the Work in accordance with the terms of the Contract and with the Plans and specifications, and that it will commence and complete the Work within the time prescribed in the Contract, and that it will provide against direct or indirect damages that shall be suffered or claimed on account of such construction or improvement, during the time thereof, and until the Contract is accepted.

B. LABOR AND MATERIAL PAYMENT BOND. A bond in a form acceptable to the Authority guaranteeing prompt payment of all monies due all persons supplying the Contractor or a Subcontractor with labor or materials employed or used in carrying out the Contract. The bond shall inure to the benefit of the persons supplying such labor or materials.

C. AMOUNT OF BONDS. The amounts of the Faithful Performance Bond and Labor and Material Payment Bond shall each be one hundred percent (100%) of the amount of the Contract price.

D. All bonds shall be submitted to the office of the Authority Counsel for review at least five (5) days prior to the scheduled signing of a Contract. No Work on the Contract shall commence until such bonds have been properly completed and submitted.



## § 103-05 LIQUIDATED DAMAGES

Time is of the essence for the Project. The Contractor is expected to perform the Work within the time limitations set out in the Contract Documents, with due allowance being made for any extensions of time made in accordance with the provisions herein set out. In the event that the Contractor shall not so perform, it shall be liable to the Authority for liquidated damages in accordance with that specified in the Contract, for each Calendar Day that the Contractor is in default of completion. The Authority will deduct the liquidated damages from any amount due or that may become due to the Contractor, or to collect the liquidated damages from the Contractor or its Surety immediately upon demand.

## SECTION 104 SCOPE OF WORK

### § 104-01 WORK REQUIRED

The Contractor shall be required to perform all Work enumerated under the different items of the Contract and to protect all adjoining property, all utilities and existing Roadway facilities within the Right-of-Way/Site and to repair or replace any such properties, utilities and facilities damaged or destroyed by them or their employees in performing the Work, both within and adjacent to the Right-of-Way/Site.

The Contractor's attention is directed to the fact that during the life of this Contract the owners and operators of Utilities may make changes in their facilities within the limits of or adjacent to this Contract which may be both temporary and permanent.

The Contractor shall be responsible for the coordination of the Work of their various Subcontractors. The Contractor shall be responsible for the acts and omissions of its Subcontractors. Their respective operations shall be arranged and conducted so that delays will be avoided. Where the Work of the Contractor, or Subcontractors, overlaps, or dovetails with that of other Contractors, materials shall be delivered and operations conducted so as to carry on the Work continuously in an efficient and workmanlike manner.

Delays or oversights on the part of the Contractor or Subcontractors or Utility owners in getting any or all of their Work properly done, thereby requiring the cutting, removing and replacing of Work already in place, shall not be the basis of a claim or request for extra compensation. Such Work will be performed at the cost and expense of the offending Contractor, Subcontractor or Utility owners.



### § 104-02 ALTERATIONS AND OMISSIONS

The Work shall be performed in accordance with the true intent and meaning of the Contract Documents without any further expense of any nature whatsoever to the Authority other than the consideration named therein.

The Authority reserves the right, at any time during the progress of the Work, to alter the Plans or omit any portion of the Work as it may deem reasonably necessary for the public interest. In such event, allowances will be made for additions and deductions in compensation at the prices named in the Proposal for this Work and shall not constitute grounds for any claim by the Contractor for damages, loss of anticipated profits, or for any variations between the approximate quantities and the quantities of the Work as done.

### § 104-03 CONTINGENCIES, EXTRA WORK, DEDUCTIONS

Whenever the Engineer determines that from any unforeseen cause the terms of any contract should be altered to provide for changes, contingencies or Extra Work, they may

issue an Order on Contract to the Contractor who shall forthwith proceed with the performance of the Work and the furnishing of the Materials and equipment necessary for its accomplishment in accordance with the pertinent specifications. No such Extra Work shall be commenced or undertaken until the Engineer has issued a signed, written Order on Contract.

No instruction or Extra Work, either written or verbal, shall be construed as an order for changes unless it is in the form of a written Order on Contract bearing the signed approval of the Engineer.

Payment for unforeseen Work shall be made as provided for in **§ 109-04 "EXTRA AND FORCE ACCOUNT WORK".**

Pending resolution of any claim, dispute, change or other controversy, nothing shall excuse the Contractor from proceeding diligently with prosecution of the Work.



**§ 104-04 CLOSING OF HIGHWAY**

NOT USED

**§ 104-05 RESTRICTED USE OF HIGHWAY**

NOT USED

**§ 104-06 CLEANING UP**

The Site shall be cleaned on a continuous, daily basis during performance of the Work and shall be neatly cleaned up upon completion according to the Engineer's directions, so that the Project Site shall be left in a neat and orderly condition.

Any salvaged material not specified to be disposed of otherwise, shall become the property of the Contractor and removed from the Site.

**§ 104-07 METHODS AND EQUIPMENT**

Where particular methods or equipment are specifically required in these specifications, the Contractor may apply in writing to the Engineer to use alternate methods and equipment to provide the same results. Such alternates may be used only after favorable recommendation by the Engineer and the written approval of the Authority. When, in the opinion of the Engineer, satisfactory results are not being obtained using the Contractor's alternate methods and equipment, the methods and/or equipment shall be immediately modified to produce satisfactory results in accordance with the requirements of the Authority.

## SECTION 105 CONTROL OF THE WORK

### § 105-01 STOPPING WORK

The Engineer may stop by written order any Work or any part of the Work under the Contract if the methods or conditions are such that unsatisfactory Work might result, or if improper material or workmanship is being used.

### § 105-02 ORDERS TO FOREMEN

Whenever the Contractor or their superintendent is not present on any part of the Work where it may be desired to give directions, orders will be given by the Engineer or their representative and shall be received and obeyed by the person in charge of the particular Work for which the orders are given.

### § 105-03 ACCURACY OF PLANS AND SPECIFICATIONS

The detail Plans and specifications for the Contract have been prepared with care and are intended to show as clearly as is practicable the Work required to be done. The Contractor must realize, however, that construction details cannot always be accurately anticipated and that in executing the Work, field conditions may require reasonable modifications in the details of Plans and quantities of Work involved. Work under all items in the Contract must be carried out to meet these field conditions to the satisfaction of the Engineer and in accordance with their instructions and the Contract specifications.

The Contractor shall take no advantage of any apparent error or omission in the Plans or specifications. In the event the Contractor discovers an error or omission in the Plans or specifications, they shall immediately notify the Engineer in writing. The Engineer will then make corrections and interpretations as may be deemed necessary for fulfilling the intent of the Plans and specifications.



### § 105-04 CONFORMITY WITH PLANS AND SPECIFICATIONS

All Work performed and all Materials furnished shall be in Reasonably Close Conformity with the lines, grades, cross sections, dimensions and Material requirements, including tolerances, shown on the Plans or indicated in the specifications.

Plan dimensions and Contract specification values are to be considered as the target value to be strived for and complied with as the design value from which any deviations are allowed. It is the intent of the specifications that the Materials and workmanship shall be uniform in character and shall conform as nearly as realistically possible to the prescribed target value or to the middle portion of the tolerance range. The purpose of the tolerance range is to accommodate occasional minor variations from the median zone that are unavoidable for practical reasons. When a maximum or minimum value is specified, the production and processing of the Material and the performance of the Work shall be so

controlled that Material or Work will not be preponderantly of borderline quality or dimension.

In the event the Engineer finds the Materials or the finished product in which the Materials are used not within Reasonably Close Conformity with the Plans and specifications but that reasonably acceptable Work has been produced, they shall then make a determination if the Work is reasonably satisfactory and, on that basis shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the Contract price for such Work or Materials as they deem necessary to conform to their determination based on engineering judgment.

In the event the Engineer finds that the Materials, the finished product in which the Materials are used, or the Work performed is not in Reasonably Close Conformity with the Plans and specifications and has resulted in an inferior or unsatisfactory product, the Work or Materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.



## § 105-05 PROJECT RECORDS

The Contractor is required to keep their Project records in accordance with the standard procedures in force at the time the Project is started.

## § 105-06 INTERPRETATION OF PLANS

In case of any difference in the interpretation of the plans, specifications or maps, or between them, the matter must be immediately submitted to the Engineer, who shall adjust the same, and their decision shall be final and conclusive.

## § 105-07 TERMINATION FOR CONVENIENCE CLAUSE

The Authority may, by written notice, terminate the Contract or a portion thereof when the Contractor is prevented from proceeding with the Work as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense or by Executive Order of the Governor with respect to a major catastrophe.

In addition, the Authority may at any time and for any reason, with or without cause, terminate the Contract, or any portion thereof, by written notice specifying the termination date.

When contracts, or any portion thereof, are terminated before completion of all items of Work in the Contract, payment will be made for the actual number of units or items of Work completed at the Contract unit price, or as mutually agreed for items of Work partially completed. No claim for loss of anticipated profits shall be considered.

Reimbursement for organization of the Work (when not otherwise included in the Contract) and moving equipment to and from the job will be considered where the volume of Work completed is too small to compensate the Contractor for these expenses under the Contract unit prices, the intent being that an equitable settlement will be made with the Contractor.

Acceptable Materials, obtained by the Contractor for the Work, that have been inspected, tested, and accepted by the Engineer, and that are not incorporated in the Work may, at the option of the Engineer, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the Engineer.

Termination of a contract or a portion thereof shall not relieve the Contractor of their responsibilities for the completed Work, nor shall it relieve their Surety of its obligation for and concerning any just claims arising out of the Work performed.

## § 105-08 COOPERATION BY THE CONTRACTOR

The Contractor shall give their constant personal attention to the Work while it is in progress or they shall place it in charge of a competent and reliable English speaking superintendent, who shall have authority to act for the Contractor and who shall be acceptable to the Engineer. The Contractor shall, at all times, employ labor and equipment which shall be sufficient to prosecute the several classes of Work to full completion in the manner and time specified. All workmen must have sufficient skill and experience to properly perform the Work assigned them. All workmen engaged on special or skilled Work shall have had sufficient experience in such Work to properly and satisfactorily perform it and operate the equipment involved. Any person employed by the Contractor whom the Engineer may deem incompetent or unfit to perform the Work shall be at once discharged, and shall not be again employed on a Authority Project. In case the Contractor disagrees with the Engineer regarding the discharge of such employees, the matter may be reviewed by the Authority, and its decision shall be accepted as final.



## § 105-09 WORK AFFECTING RAILROADS

NOT USED

## § 105-10 STAKEOUT

The Contractor shall perform all layout work necessary for the satisfactory execution of the construction as shown on the Contract Drawings. The Contractor shall employ competent personnel and all Work shall be subject to the approval of the Engineer.

The Contractor shall be held responsible for the protection and safe guarding of all control points and bench marks set by the Engineer. Any replacement or re-establishment of control points or bench marks by the Engineer shall be at the expense of the Contractor.

When no price for **Item 985, "Project Survey and Stakeout"** is asked for on the Proposal Form, the cost of the Work as shown on the Contract Drawings shall be included in the cost of other Items and no direct payment for "Project Survey and Stakeout" will be made.

## § 105-11 REMOVAL OF UNSATISFACTORY WORK

Wherever or whenever the Engineer shall consider it necessary to remove any portion of the Work executed under this Contract for inspection or for any other purpose, no payment shall be made for such removal or for replacement of the Work to satisfactory condition in case such inspection shows that the Work was not constructed in accordance with the terms of the Contract; nor shall payment be made for the removal or replacement of any Work which may itself be satisfactory, but the removal of which is necessary for the replacement of unsatisfactory Work.

But if such inspection shows that the Work was constructed in accordance with the terms of the Contract, payment shall be made for the removal and replacement at fair and reasonable prices for the Work performed under an Order or Contract.

All Work shall be in a first-class and satisfactory condition at the time of the acceptance of the Contract and all materials shall be new.

## § 105-12 CONSTRUCTION EQUIPMENT

It is the intent of these specifications to permit the use of the most efficient equipment that is consistent with conditions at the time of use. It is, however, anticipated that seasonal or weather conditions combined with the nature of the terrain or character of the Site will often require the use of lighter and smaller equipment that might be used under optimum conditions.

Construction equipment exceeding the maximum axle loading allowable by Law shall not be operated on or across any segment of pavement or structure which is to be retained as part of the ultimate section without specific authorization in writing by the Engineer. This authorization shall indicate specifically the limits within which such equipment with over legal axle loads shall operate, frequency of such over loads and any other limiting factors consistent with conditions.

If the Engineer determines that the use of heavy equipment on portions of the Road Section other than pavement, on any part of or all of a Contract, is having or will result in detrimental effects on the finished Roadway they will so notify the Contractor in writing and shall indicate the maximum weight and/or axle load for any equipment that may be used for any specific operation or location.

## § 105-13 CONSTRUCTION EQUIPMENT IDENTIFICATION

All construction equipment used for compaction purposes shall be marked by means of an identification plate or other approved means indicating:

A. Name.
B. Model.
C. Weight (Net and Ballast)
D. Year of Manufacture.

This means of identification shall be permanently attached to the equipment, shall not be altered in any manner and shall be legible at all times.

## § 105-14 DISPUTED WORK

If the Contractor is of the opinion that any Work ordered to be done as Contract Work by the Engineer is Extra Work, and not Contract Work, or that any order of the Engineer violates the provisions of the Contract, the Contractor shall promptly notify the Authority and the Engineer in writing of their contentions with respect thereto, and the Authority shall make a finding thereon which shall be accepted by all parties as final. The Work shall, in the meantime, be progressed by the Contractor as required and ordered. During the progress of such disputed Work the Contractor and Engineer shall keep daily records and make reports of all labor, material and equipment used in connection with such Work and the cost thereof as specified in §109-04 "EXTRA AND FORCE ACCOUNT WORK".

If the Engineer determines that the Work in question is Contract Work, and not Extra Work, and that the order complained of is proper, they shall direct the Contractor to continue the disputed Work and the Contractor must promptly comply. The Contractor's right to file a claim for extra compensation or damages will not be affected in any way by their complying with the directions of the Engineer, provided the Contractor continues to keep and furnish the Engineer with Force Account Reports as specified in §109-04.

If the Engineer determines that such Work is Extra Work, and not Contract Work, or that the order complained of is not proper, then the Engineer shall have prepared, if necessary, an Order on Contract covering such Work. This will be done as soon after the determination as is practical. Adjustments in Contract Items or the addition of new items to the Contract necessitated by any such determination may be made up until the time the Final Agreement is submitted for payment provided that all the requirements of this subsection, "Disputed Work" and the section entitled **§ 104-03 "CONTINGENCIES, EXTRA WORK, DEDUCTIONS,"** are complied with.

In the event the Contractor fails to furnish force account reports, such failure shall constitute a waiver of any claim of payment for disputed Work other than for payment at Contract unit prices for the Work performed.

## § 105-15 CONTRACTOR'S RESPONSIBILITY FOR WORK

The Contractor is responsible for carrying out the provisions of the Contract at all times, regardless of whether an authorized Inspector is present or not. Any Work or item that is, at any time, found to be out of specifications or not in compliance with the Plans shall be subject to such corrective measures as are directed in writing by the Engineer.

## SECTION 106 CONTROL OF MATERIALS

### § 106-01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS

All Materials used in the Work shall meet the quality requirements described in the latest version of the State of Connecticut Department of Transportation, Standard Specifications for Roads, Bridges and Incidental Construction, Division III, Materials Section as amended unless the same are altered by specific notes shown upon the Plans, or in the Proposal. A copy of **The Greater New Haven Water Pollution Control Authority Standard Specifications** dated September 2017 can be obtained upon payment of One Hundred Dollars ($100.00). However, it shall be the responsibility of the Contractor to verify that all materials used in the Work meet the current quality requirements as amended.

It shall be the responsibility of the Contractor to advise the Engineer of the sources of proposed Materials sufficiently in advance of their use.

Immediately upon Award of the Contract, the Contractor shall furnish in writing to the Engineer the sources of supply, types of all items and kinds of Materials which they propose to use in the Work. No change shall be made in the sources of supply or kinds of Materials or in the type of any item except upon written approval by the Engineer.



### § 106-02 STORAGE OF MATERIALS

Materials shall be so stored as to insure the preservation of their quality and fitness for the Work. Stored Materials, even though accepted before storage, shall be inspected prior to their use in the Work and shall meet the requirements of the Contract at the time of their use.

### § 106-03 CERTIFICATIONS

The Contractor shall furnish at its own expense and upon request of the Engineer a certified test report, materials certificate and certificate of compliance for all items and Materials incorporated into the Work.

These documents shall be forwarded to the Engineer; and in addition, a copy of the certified test report and materials certification shall be forwarded to the job Site.

Materials requiring such documentation may be conditionally incorporated in the Work prior to receipt of a certified test report and a materials certificate; however, payment for such incorporated Materials will not be made prior to receipt of the required documentation which shows that the Material meet the requirements of the specifications.

If the reports and certificates show the Material conditionally incorporated in the Work does not meet the requirements of the specifications, such Material shall be removed and replaced with Material which does meet the requirements, at no cost or expense to the Authority.

A certified test report is a document containing a list of the dimensional, chemical, metallurgical, electrical and physical results obtained from an actual test of the Materials involved, and shall certify that the Materials meet the requirements of the Plans and specifications, and shall also include the following information:

1. Item number and description of Material.
2. Date of Manufacture.
3. Date of Testing.
4. Name of organization to whom the Material is consigned.
5. Quantity of Material represented, such as batch, lot, group, etc.
6. Means of identifying the consignment, such as label, marking, lot number, etc.
7. Date and method of shipment.
8. Name of organization performing tests.

The certified test report shall be signed by an authorized and responsible agent for the organization manufacturing the Material, and it shall be notarized.

A material certificate is a document certifying that the materials, components and equipment furnished, conform to all requirements of the Plans and specifications. The document shall also include the following information:

1. Project to which the material is consigned.
2. Name of Contractor to whom material is supplied.
3. Item number and description of material.
4. Quantity of material represented by the certification.
5. Means of identifying the consignment, such as label, marking, lot number, etc.
6. Date and method of shipment.

The material certificate shall be signed by an authorized and responsible agent for the organization supplying the Material, and shall be notarized.

A certificate of compliance is a document certifying that the materials, components and equipment covered by the previously submitted certified test report and materials certificate, have been installed in the Work and that they conform to all the requirements of the Plans and specifications. The following information shall also be required on the document:

1. Project number.
2. Item number and description of material.

3. Quantity represented by the certificate.
4. Name of manufacturer.

The certificate of compliance shall be signed by an authorized and responsible agent for the Contractor, and shall be notarized.

## § 106-04 WARRANTIES, GUARANTEES AND INSTRUCTION SHEETS

Manufacturers' warranties and guarantees furnished for Materials used in the Work and instruction sheets and parts lists supplied with Materials shall be delivered to the Engineer prior to acceptance of the Work, and shall be written so as to provide to the Authority the benefit of their protections.

## § 106-05 EQUIVALENTS

The requirements for apparatus, articles, or materials shall be specified, if feasible, in generic terms which afford competition for equivalent products or items. When no generic specification can be found or devised, known acceptable trade names and approved equals shall be provided for the Contractor's benefit and to afford the desired competition. The Engineer shall be the judge of the qualifications of the products and will determine all questions regarding the conformance of any item with the specifications.

## § 106-06 DOMESTIC MATERIALS

Preference will be given to articles or materials manufactured or produced within the United States, conditions of quality and price with duty being equal. Unless otherwise stated in the Proposal or on the Plans, it will be understood that only domestic articles or materials will be used on the job.

## § 106-07 SHOP DRAWINGS

After checking and verifying all field measurements, the Contractor shall submit to the Engineer for review and approval, copies of all Shop Drawings, which shall have been identified, checked by and stamped with the approval of the Contractor as the Engineer may require. The data shown on the Shop Drawings shall be complete with respect to dimensions, design criteria, materials of construction and all other necessary data to enable the Engineer to review the information as required.

The Contractor shall also submit to the Engineer for review and approval with such promptness as to cause no delay in the Work, all samples required by the Specifications. All samples shall have been checked by and stamped with the approval of the Contractor, identified clearly as to material, manufacturer, any pertinent catalogue numbers and the use for which intended.

At the time of each submission, the Contractor shall be responsible for notifying the Engineer in writing calling the Engineer's attention to all deviations that the Shop Drawings or samples may have from the requirements of the Specifications.

The Engineer will review and approve with reasonable promptness Shop Drawings and samples, but the Engineer's review and approval shall be only for conformance with the design concept of the Project and for compliance with the information given in the Specifications and shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto. The review and approval of a separate item as such shall not indicate approval of the assembly in which the item functions. The Contractor shall make all corrections required by the Engineer and shall return the required number of corrected copies of Shop Drawings and resubmit new samples for review and approval. The Contractor shall direct specific attention in writing to revisions other than the corrections called for by the Engineer on previous submittals. The Contractor's stamp of approval on any Shop Drawing or sample shall constitute a representation to the Engineer that the Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalogue numbers, and similar data or assumes full responsibility for doing so, and that the Contractor has reviewed or coordinated each Shop Drawing or sample with the requirements of the Work and the Specifications.

Where a Shop Drawing or sample is required by the Specifications, no related Work shall be commenced until the submittal has been reviewed and approved by the Engineer.

The Engineer's review and approval of Shop Drawings or samples shall not relieve the Contractor from responsibility for any deviations from the Specifications unless the Contractor has in writing called the Engineer's attention to such deviation at the time of submission and the Engineer has given written concurrence and approval to the specific deviation, nor shall any concurrence and approval by the Engineer relieve the Contractor from responsibility for errors or omissions in the Shop Drawings or samples.

## SECTION 107 LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

### § 107-01 LAWS, PERMITS AND LICENSES

The Contractor shall observe all federal, state and local laws, ordinances, policies, practices and regulations. In addition, the Contractor agrees to promptly procure all necessary approvals, licenses and permits, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the Work.

### § 107-02 PATENTED DEVICES, MATERIALS AND PROCESSES

It is mutually understood and agreed that the Contract prices are to include all royalties and costs arising from patents, trademarks, and copyrights in any way involved in the Work. Whenever the Contractor is required or desires to use any design, device, material or process covered by letters, patent or copyright, the Contractor shall indemnify, defend and save harmless the Authority, its officers and employees from any and all claims for infringement by reason of the use of any such patented design, device, material or process, and shall indemnify the Authority for any costs, expenses and damages which it may be obliged to pay, by reason of any such infringement, at any time.



### § 107-03 CLEAN WATER FUND FINANCIAL PARTICIPATION

In all contracts in which the State of Connecticut, Department of Energy and Environmental Protection's participates financially, or which are designated as Clean Water Fund contracts, the Contractor shall conform in all respects in accordance with the true intent and meaning of each and all of the requirements contained in the "Required Construction Contract Provisions Under the Connecticut Department of Energy and Environmental Protection's Clean Water Fund," a copy of which will be incorporated in each Proposal for contracts so classified. When any of such Clean Water Fund Provisions are in conflict with any other provisions of the Contract Documents, the Clean Water Fund Provisions shall prevail and take precedence.

### § 107-04 SANITARY CODE

The Contractor shall provide and maintain in a neat and sanitary condition such accommodations for the use of their employees as may be necessary to comply with the requirements and regulations of the State and local Authority of Health and any other entity having jurisdiction over such matters.

### § 107-05 SAFETY AND HEALTH REQUIREMENTS

The Contractor shall conduct the Work at all times in such a manner as to insure the least possible obstruction to traffic. The convenience of the general public and of the residents along and adjacent to the roadway shall be provided for in an adequate and satisfactory manner as the Engineer may direct.

All equipment and Materials shall be placed or stored in such locations so as not to be or to create the danger of becoming a hazard to the traveling public. No section of road shall be closed to the public except by permission of the Authority.

In addition to the requirements of the Maintenance and Protection of Traffic Item, the Contractor shall take all precautions necessary and reasonable for the protection of all persons, including employees of both the Contractor and the Authority and members of the public, and for protection of property until the Contractor is notified in writing of the satisfactory completion of the construction Work. The Authority makes no representation to the Contractor concerning the physical conditions or safety of the Project site and the Contractor shall be responsible for the safety of all persons and property affected by performance of the Work. Prior to the commencement of Work, the Contractor shall submit a written safety program for review by the Authority and Engineer. Review by the Authority and Engineer of the Contractor's safety program shall not be construed as an approval of the program or as a waiver of any indemnity or other obligation that the Contractor has to the Authority hereunder.

The safety provisions of applicable laws, building, construction and fire safety codes and the latest edition of the "Construction Safety Code, State of Connecticut, Labor Department", approved by the State Labor Commissioner, shall be complied with at all times. A copy of the latest edition of the "Construction Safety Code, State of Connecticut, Labor Department" shall be made available by the Contractor for reference at all times in the Contractor's field office.

The Contractor shall furnish to the Engineer on project two copies of all report of each accident on the Project or contingent to the prosecution of the Project which involves personal injury requiring treatment by a doctor or loss of time. The Contractor shall also furnish to the Engineer two copies of all accident reports involving public liability or property damage. These reports shall be on forms acceptable to the Engineer.

The authority vested in the Engineer under **§ 105-01, "STOPPING WORK"**, is hereby extended to the effect that they may suspend the Work of the Contractor when the latter does not comply with the above-mentioned precautions or fails to provide adequate protection to allow for inspection of the Work without jeopardy to the safety of the Engineer or their authorized representatives.

Nothing herein shall be construed to relieve the Contractor from responsibility for the prosecution of the Work, nor the responsibility for damage claims as stated in **§ 107-08, "DAMAGE"**.

When the use of explosives is necessary for the prosecution of the Work, the Contractor shall use the utmost care so as not to endanger life or property, including new Work, and shall comply fully with **§ 107-01," LAWS, PERMITS AND LICENSES"**.

The Contractor shall schedule their Work in such a manner as to avoid the use of explosives in close proximity to new or existing structures. The Contractor shall at all times take adequate protective measures and shall be responsible for any damage which may result from blasting operations.

The Contractor shall notify each public Utility company having structures in proximity to the Site of the Work, and others who may be affected, of their intention to use explosives; and such notice shall be given sufficiently in advance to enable the companies, the Contractor and others to take such steps as they deem necessary to protect utilities and property from possible injury. Such notice shall not relieve the Contractor of responsibility for any damage resulting from their blasting operation.

**§ 107-06 INSURANCE**

Before the Contract is executed and prior to commencement of Work thereunder, the Contractor will be required to take out and maintain at its sole cost and expense insurance of the types and amounts specified herein and to file with the Authority a certificate of insurance satisfactory to the Authority and in an acceptable form. The Contractor shall carry insurance at a minimum in accordance with the following requirements:



1. WORKER'S COMPENSATION AND EMPLOYER'S LIABILITY INSURANCE: With respect to work that the Contractor performs and performed for the Contractor by subcontractors, the Contractor shall carry Worker's Compensation and Employer's Liability Insurance in the minimum amount of Five Hundred Thousand Dollars ($500,000) each accident for bodily injury and Five Hundred Thousand Dollars ($500,000) each employee for bodily injury by disease with a Five Hundred Thousand Dollar ($500,000) policy limit by disease.

2. COMMERCIAL GENERAL LIABILITY INSURANCE: With respect to the Contractor's work and work performed for the Contractor by its subcontractors, the Contractor shall carry Commercial General Liability insurance on an ISO form CG 00 01 providing the following limits:

One Million Dollars (1,000,000) Each Occurrence
Two Million Dollars (2,000,000) General Aggregate – Applicable Per Project
Two Million Dollars (2,000,000) Products/Completed Operations Aggregate
One Million Dollars (1,000,000) Personal/Advertising Injury Per Person or Organization

The policy shall be written on an occurrence basis covering liability arising from premises, operations, independent contractors, product/completed operations, personal and advertising injury liability, and liability assumed under an insured contract. There shall be no modification limiting the scope of coverage for liability arising from explosion, collapse or underground hazards.

3. BUSINESS AUTOMOBILE LIABILITY INSURANCE: The operation of all motor vehicles, including those owned, hired, leased or borrowed and non-owned, used in connection with the Work shall be covered by Automobile Liability insurance in the amount of not less than One Million Dollars ($1,000,000) combined single limit each accident.

4. OWNER'S AND CONTRACTORS PROTECTIVE LIABILITY INSURANCE FOR AND IN THE NAME OF THE GREATER NEW HAVEN WATER POLLUTION CONTROL AUTHORITY: With respect to the Work the Contractor performs, the Contractor shall carry for and in behalf of the Authority:

Protective Liability insurance providing for a total limit of not less than One Million Dollars ($1,000,000) each occurrence, One Million Dollars ($1,000,000) in the aggregate.

Unless requested otherwise by the Authority, the Contractor and its insurer shall waive governmental immunity as defense and shall not use the defense of governmental immunity in the adjustment of claims or in the defense of any suit brought against the Authority, its officers or employees.

The Contractor shall assume and pay all costs and billings for premiums and audit charges earned and payable under the required insurance.

5. Not Used

6. UMBRELLA EXCESS LIABILITY INSURANCE: This policy is on a follow form basis in the minimum amount of Ten Million Dollars ($10,000,000) excess of the Employer's Liability, Commercial General Liability and Business Automobile Liability coverages described herein.

7. EQUIPMENT AND INSTALLATION FLOATER: The Contractor shall provide an equipment and installation floater covering Contractor's tools and also materials not accepted by the Authority.

8. TERMINATION OR CHANGE OF INSURANCE: Each insurance policy shall be endorsed to provide that the insurance company shall notify the Authority by certified mail at least thirty (30) days in advance of termination or policy non-renewal.

The Contractor shall at its own expense, keep all the required insurance coverage in continuous effect until the date the Authority indicates the termination of the Contractor's responsibility. Such coverage shall be written on an "occurrence" basis and shall provide that the Commercial General Liability and Umbrella Liability coverages will be renewed for three (3) years after completion of the Work. This provision survives the termination of this contract.

9. COMPENSATION: The Contractor shall be fully responsible for all expenses to maintain the coverage required herein. There shall be no direct compensation allowed the Contractor on account of any premium or other charge necessary to take out and keep in

effect all insurance or bonds, but the costs thereof shall be considered included in the general cost of the Work.

10. DEDUCTIBLE/SIR CLAUSE: Insurance contracts required under this section shall not contain a deductible or self-insured retention clause. In the event that such a deductible clause is an unavoidable part of any policy, the Contractor shall be responsible for payment of the full amount of such deductible or self-insured retention.

11. ADDITIONAL INSURED: All insurance policies, except for workers' compensation, shall be endorsed to include the Authority and its officers, directors, agents and employees as additional insureds (collectively "Indemnitees") covered for liability arising out of any ongoing and completed operations using additional insured endorsement being on a CG 20 10 and CG 20 37 or their equivalent.

12. WAIVERS OF SUBROGATION: All insurance policies shall contain express waivers by the insurance company of its right of subrogation against all Indemnitees.

13. PRIMARY: The Commercial General Liability policy and the Umbrella Liability policy shall be primary and non-contributory meaning each policy shall be amended to specifically state such insurance will be considered primary and will not seek contribution with respect to any and all other insurance that may be available to Authority and any other person required to be named as additional insured under this Contract.

14. EVIDENCE: This Contractor will furnish the Contractor's certificates of insurance, and copies of insurance policies, forms and endorsements as requested.



**§ 107-07 PRESERVATION OF PROPERTY**

It is the intent of this specification that the Contractor protect and preserve all public and private property including all existing vegetation, existing landscape features and monuments within, along and adjacent to the highway Right-of-Way. The Contractor shall use every precaution necessary and perform the Work as specified, in a manner approved by the Engineer, to prevent damage, injury, pollution or destruction; shall protect all trees and other woody plants which are to remain; shall take special care to protect the natural vegetation and surroundings including all natural drainage ways, ponds, lakes, wetlands, woods and fields; shall store materials in such a manner as to prevent leaching which would be injurious to soils and plants; shall repair all injuries to woody plants which are to remain by approved horticultural methods; and shall scarify and compact solid and re-grade as directed to restore the property to a natural condition.

The Contractor shall also use suitable precaution necessary to prevent damage to pipes, conduits and other underground structures, and protect carefully from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and shall not remove them until directed.

Where the soil over root area of trees to be preserved has been compacted, it shall be restored by proper cultivation as directed by the Engineer to a condition to permit the entrance of water and the proper aeration of roots.

The Contractor shall exercise care in its construction procedures in order to protect all trees and shrubs which are not directly and unavoidably in conflict with its excavations. Prior to the commencement of Work, the Engineer and the Contractor shall inspect the Site to determine the extent of clearing and grubbing and the specific locations in which tree protection is required.

**§ 107-08 DAMAGE**

All damage, direct or indirect, of whatever nature resulting from the performance of the Work or resulting to the Work during its progress from whatever cause, including omissions and supervisory acts of the Authority, shall be borne and sustained by the Contractor, and all Work shall be solely at its risk until it has been finally inspected and accepted by the Authority except that:

A. Payment shall be made to the Contractor for the repair or replacement of the following completed permanent elements of the Roadway, for which the Contractor is responsible, and which may be damaged by public traffic other than that of the Contractor's:

Guide Rail, Guide Posts, Bridge Railing, Median Barrier, Curbs, Permanent Barricades, Fencing, Light Poles and Appurtenances, Delineators, Signs and Sign Structures, and Traffic Signal Equipment.

Work for which there is no bid item will be paid for at an agreed price or by means of force account. Payment will not be made for repair or replacement in any way connected with untimely failure of any portion of the highway under public traffic, and the determination regarding this matter shall be made by the Director, taking into consideration the normal life and the amount of normal wear of the element involved. This provision does not relieve the Contractor of the responsibility for maintenance and protection of traffic for the Project or of the responsibility of having a wholly complete and acceptable job at the time of final inspection and acceptance of the entire Project. Payment for such damage shall be made only after the Contractor has demonstrated to the satisfaction of the Director that the Contractor has made every reasonable effort to collect the costs from the person or persons responsible for the damage.

B. The Contractor shall not be responsible for damages resulting from faulty designs as shown by the Plans and specifications nor the damages resulting from willful acts of Authority officials or employees and nothing in this paragraph or in this Contract shall create or give to third parties any claim or right of action against the Contractor, the Authority beyond such as may legally exist irrespective of this paragraph or Contract.

The Contractor shall indemnify, defend and save harmless the Authority its agents, servants and employees from all suits, actions, damages and financial costs of every name and description resulting from the Work under this Contract and the Authority may retain such monies from the amount due the Contractor as may be necessary to satisfy any claim or potential for damages against the Authority. The Contractor's obligations under this paragraph shall not be deemed waived by the failure of the Authority to retain the whole or any part of such monies due the Contractor, nor shall such obligation be deemed limited or discharged by the enumeration or procurement of any insurance coverage for damages imposed by law upon the Contractor, Subcontractor or the Authority.

## § 107-09 RESTORATION

All areas outside of the right of way and those within the right of way but outside of the Work limits, except as noted in the following text, that is in anyway disturbed, used by, or serving as a source of Material for the Contractor, shall be restored to a pleasing and acceptable condition as specified and as satisfactory to the Engineer.

The Contractor shall obtain the written approval of the Engineer for the use of any specific area before any Work in such area is begun, except as noted in the following text. Where deemed necessary by the Engineer, the Contractor shall submit, as part of the request for approval, a grading plan. Such a plan shall not be given if, in the opinion of the Engineer, the area is not suited to acceptable restoration or if serious or permanent ecological damage is foreseeable. This specification applies to areas such as, but not limited to, borrow pits or areas, spoil or waste areas, haul roads, storage areas, batching areas, equipment storage areas, shop areas and all similar areas. These provisions do not apply to areas that have been or are being used by the Contractor as its established and permanent headquarters and equipment pool sites; or to commercial gravel pits, commercial quarries, public disposal areas; and all similar areas.



In general, the restoration shall include:

A. The removal of all equipment and parts, junk, rubbish, excess materials and debris of all kind;

B. Clean up as required, grading as shown, if a grading plan has been prepared; or grading so as to blend into the surrounding ground forms, to the satisfaction of the Engineer;

C. Scarification of storage yards, batching sites, haul roads, etc., to the depth determined by the Engineer as necessary to support vegetation.

D. The removal and re-grading of temporary roads or areas as required by the Engineer.

E. The repair or removal of damaged trees and the fertilizing, seeding and mulching of the areas as provided for in the Contract or as directed by the Engineer.

All of this restoration shall be accomplished prior to acceptance of the Contract except that Work of restoring Contractor's Work areas may be done after the official acceptance of the Project but must be completed prior to the final release of retained funds.

Since the extent of such area to be restored and the use and treatment during construction is within the discretion of the Contractor, within the limitations and requirements outlined, no payment will be made for any labor, material or equipment necessary for the restoration of these areas. The cost of the Work shall be included in the amount bid for other items of Work. Any Work done shall, in general, be in accordance with the Department's specifications for similar items of Work and/or as specified by the Engineer.

In the event the Contractor carries on any operation on the referenced areas without written approval of the Engineer no payment will be made for any item in the Contract involved in any way with any operation on the unapproved area.



## § 107-10 SOIL EROSION, WATER AND AIR POLLUTION ABATEMENT

The Contractor shall schedule and conduct its operations in such a way as to minimize erosion of soils and to prevent silting and muddying of streams, rivers, irrigation systems, impoundments, lakes, wetlands, reservoirs, etc. and lands adjacent to or affected by the Work. Construction of drainage facilities and performance of other Contract Work which will contribute to the control of erosion and sedimentation shall be carried out in conjunction with earthwork operations or as soon thereafter as practicable. The area of bare soil exposed at any one time by construction operations shall be kept to a minimum.

Whenever the Contractor's operations, carried out in accordance with the approved schedule, result in a situation where temporary erosion control measures not shown on the Plans, must be taken and these measures are approved or ordered by the Engineer, the Contractor shall conduct this Work in accordance with the provisions of **01 35 43 – Environmental Procedures.**
In carrying out erosion control measures, the Contractor will be guided by, controls which shall include but not be limited to the following:

A. Frequent fording of live streams will not be permitted; therefore, temporary bridges or other structures shall be used wherever an appreciable number of stream crossings are necessary. Unless otherwise approved in writing by the Engineer, mechanized equipment shall not be operated in live streams.

B When Work areas are located in or adjacent to live streams, such areas shall be separated from the main stream by a dike or other barrier to keep sediment from entering a flowing stream. Care shall be taken during the construction and removal of such barriers to minimize the muddying of a stream.

C. All waterways shall be cleared as soon as practicable of false work, piling, debris or other obstructions placed during construction operations and not part of the finished Work. Ditches which are filled or partly inoperative before the Contractor stops work for any day, and shall be maintained in a condition satisfactory to the Engineer for the duration of the Project.

D. Water from aggregate washing or other operations containing sediment shall be treated by filtration, settling basin or other means sufficient to reduce the sediment content to not more than that of the stream into which it is discharged.

E. Pollutants such as fuels, lubricants, bitumen, raw sewage and other harmful materials shall not be discharged into or near rivers, streams, wetlands and impoundments or into natural or man-made channels leading thereto. Wash water or waste from concrete mixing operations shall not be allowed to enter live streams.

F. All applicable regulations of fish and wildlife agencies and statutes relating to the prevention and abatement of pollution shall be complied with in the performance of the Contract.

The Contractor shall at all times exercise every reasonable precaution to safeguard the air resources of the State by controlling or abating air pollution as set forth by the Authority of Environmental Protection's and Federal Clean Air Act regulations. These measures shall include the control and abatement of dust, fumes, mist, smoke, vapor, gas, aerosol, other particulate matter, odorous substances, or any combination thereof arising from the construction operations, hauling storage or manufacture of materials.

The Contractor shall take measures to control the noise intensity to comply with the prescribed ratings as set forth by the regulations of the Department of Environmental Protection, the Occupational Safety and Health Administration and any other agencies of the Municipality wherein the Work is to be performed, the Authority, State or Federal Government.

When it becomes necessary, the Engineer will inform the Contractor of unsatisfactory construction procedures and operations insofar as erosion control, water and air pollution are concerned. If the unsatisfactory construction procedures and operations are not corrected promptly, the Engineer may suspend the performance of any or all of other construction until the unsatisfactory condition has been corrected.



## § 107-11 FURNISHING RIGHT OF WAY

Not Used.

## § 107-12 LABOR REQUIREMENTS

Pursuant to Connecticut General Statutes, §31-52, all contracts for the construction, remodeling or repairing of any public building are required by law to contain the following provisions:

> "In the employment of labor to perform the Work specified herein, preference shall be given to citizens of the United States, who are, and continuously for at least three months prior to the date hereof have been, residents of the labor market areas, as established by the Labor Commissioner of the State of Connecticut, in which such work is to be done, and if no such qualified person is available, then to citizens who have continuously resided in the county in which the work is to be performed for at least three months prior to the date hereof, and then to citizens of the state who have continuously resided in the state at least three months prior to the date of this contract."

In no event shall these provisions be deemed to abrogate or supersede, in any manner, any provision regarding residency requirements contained in any collective bargaining agreement to which the Contractor is a party.

Pursuant to Connecticut General Statutes, §31-52a, the following provision shall be incorporated into this Contract and each subcontract hereunder insofar as this Contract or any such subcontract concerns a public works project, including, but not limited to, construction, remodeling or repairing of any public facility or structure except public buildings covered by §31-52, site preparation or site improvement, appurtenances or highways, or the preparation or improvement of any land or waterway on or in which a structure is situated or to be constructed are required by law to contain the following provision:

> "In the employment of mechanics, laborers or workmen to perform the work specified herein, preference shall be given to residents of the State who are, and continuously for at least six (6) months prior to the date hereof have been, residents of this State, and if no such person is available then to residents of other states."

Nothing herein shall abrogate or supersede any provision regarding residence requirements contained in any collective bargaining agreement to which the Contractor is a party.

The Contractor shall include the foregoing provisions in all subcontracts and sub-agreements entered into pursuant to this Contract or related to this Project.
Pursuant to Connecticut General Statutes, §31-53, the following provision shall be incorporated into each contract for work relating to new construction of a public works project where the total cost of all work to be performed in connection with such project is Four Hundred Thousand Dollars ($400,000) or more, and each contract for work relating to the remodeling, refinishing, refurbishing, rehabilitation, alteration or repair of any public

works project where the total cost of all work to be performed in connection with such project is One Hundred Thousand Dollars ($100,000) or more:

> "The wages paid on an hourly basis to any mechanic, laborer or workman employed upon the work herein contracted to be done and the amount of payment contribution paid or payable on behalf of each such employee to any employee welfare fund described in §31-53(h) of the Connecticut General Statutes, shall be at a rate equal to the rate customary or prevailing for the same work in the same trade or occupation in the town in which such public works project is being constructed. Any Contractor who is not obligated by agreement to make a payment or contribution on behalf of such employees to any such employee welfare fund shall pay to each employee as part of their wages the amount of payment or contribution for their classification on each pay day."

**NOTE:** Prevailing wage rates are fixed by the State Labor Commissioner.

The most recent wage rate schedule will be obtained and attached to the Contract.

In the event that the Authority determines that any mechanic, laborer or workman employed by the Contractor or any subcontractor directly on the Site for the work contemplated hereunder has been or is being paid a rate of wages less than that required to be paid, as stated herein, the Authority may, by written notice to the Contractor, terminate the Contractor's right to proceed with the work hereunder or such part of the work for which there has been a failure to pay the required wages. In the event of such termination, the Authority may prosecute the work to completion by contract or otherwise and the Contractor and its Sureties shall be liable to the Authority for all costs incurred thereby in excess of the compensation to be paid under this Contract.



## § 107-13 GUARDING AND PROTECTION

The Contractor shall be responsible for guarding and protecting open and unattended excavations and other potentially hazardous locations in and adjacent to area lawfully frequented by any person. Such guarding and protection shall consist of any one, or a combination of the following:

1. A substantial fence or barricade, not less than four (4) feet in height and mounted on satisfactory supports spaced at intervals of not more than ten (10) feet. Warning signs reading "DANGER-KEEP OUT" shall be mounted on the fence or barricade, as required by the Engineer, at no more than one hundred (100) foot intervals. The signs shall be 16"X24" with five (5) inch black letters on a white background. All fences, barricades and warning signs shall be furnished, erected, relocated, maintained and removed as required.

2. A forty-eight (48) inch extension of the trench sheeting above the ground surface adjacent to the excavation.

3. A substantial covering over the excavation. Where it is possible that vehicles will move over such covering, the covering shall be of sufficient strength to withstand the loading.

There will be no measurement for payment for this work; however, the cost of such guarding and protection shall be included in the other unit prices bid.

## § 107-14 NONDISCRIMINATION

The Contractor agrees and warrants that in the performance of the Contract it will not discriminate or permit discrimination against any person or group of persons on the grounds of sexual orientation, in any manner prohibited by the laws of the United States or of the State of Connecticut, and that employees are treated when employed without regard to their sexual orientation.

The Contractor agrees to provide each labor union or representative of workers with which such Contractor has a collective bargaining agreement or other contract or understanding and each vendor with which such Contractor has a contract or understanding, a notice to be provided by the commission on human rights and opportunities advising the labor union or workers' representative of the Contractor's commitments under this section, and to post copies of the notice in conspicuous places available to employees and applicants for employment.

The Contractor agrees to comply with each provision of this section and §§46a-68e and 46a-68f of the general statutes and with each regulation or relevant order issued by said commission pursuant to §§46a-56, 46a-68e and 46a-68f of the general statutes.

The Contractor agrees to provide the commission on human rights and opportunities with such information requested by the commission, and permit access to pertinent books, records and accounts, concerning the employment practices and procedures of the Contractor as relate to the provisions of this section and §46a-56 of the general statutes.

The Contractor shall include the foregoing provisions in every subcontract or purchase order entered into in order to fulfill any obligation of this Contract and such provisions shall be binding on a subcontractor, vendor or manufacturer unless exempted by regulations or orders of the commission.

## SECTION 108 PROSECUTION AND PROGRESS

### § 108-01 START AND PROGRESS OF WORK

After filing the necessary bonds and certificates of insurance with the Authority Counsel and before starting the Work the Contractor shall submit to the Engineer for review and outline of their proposed methods and manner of executing the Work including sequences of operation and a time schedule of performing the same. This time schedule will be consistent with the Project Schedule attached to the Agreement. If found satisfactory, the Engineer shall accept, and the Work shall be prosecuted in accordance with such schedules or approved amendments.

When requested by the Engineer, the Contractor shall furnish weekly work schedules indicating number of personnel, kind of equipment and location and nature of the Work to be performed.

### § 108-02 DATE OF COMPLETION AND CLOSING

All Work to be performed under the Contract shall be completed within the time stated in the Agreement for the Project or within such extended time for completion as may be granted by the Authority.

Whenever the Engineer shall deem it necessary that any portion or certain portions of the Work shall be progressed in any particular manner or that any such portion or portions of the Work shall be completed pursuant to a certain sequence or schedule and before the date of completion of the entire Contract, the Contractor shall punctually comply with the related instructions, dates and periods of time.

The extent of the Contractor's compliance with the provisions under this heading will be considered as relevant in any future determination of an award to him as the lowest responsible Bidder for any Project under the supervision of the Authority.

If, during the progress of the Work, it should become necessary because of lateness of the season, to stop the Work, then the Contractor shall open proper drainage ditches, erect temporary structures where necessary, prepare the Project so that there will be a minimum interference with traffic, set up and maintain a competent organization, as directed by the Engineer, to keep the Project in first class condition for traffic, and take every precaution to prevent any damage or unreasonable deterioration of the Work during the time it is closed.

### § 108-03 FAILURE TO COMPLETE WORK ON TIME

For each Calendar Day that any Work shall remain uncompleted after the date specified for the completion of the Work provided in the Contract, the amount per Calendar Day specified in **§102-16 "SPECIAL SPECIFICATIONS AND NOTES"** will be deducted from any money due the Contractor, not as a penalty but as liquidated damages; provided

however that due account shall be taken of any adjustment of the contract time for completion of the Work as provided for elsewhere in the specifications.

Permitting the Contractor to continue and finish the Work or any part of it after the time fixed for its completion or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Authority of any of the rights under the Contract.

The Engineer may waive such portions of the liquidated damages as may accrue if they deem the Work is in such condition as to be safe and convenient for use by the public, and that the Authority has suffered no damages or monetary loss due to the Contractor's actions or omissions.

The assessing of liquidated damages shall be in addition to Engineering Charges as provided for in **§ 102-13, "ENGINEERING CHARGES"**, of the specifications.



## § 108-04 EXTENSION OF TIME

Delays which affect the scheduled completion date of the Project and which were unforeseeable and beyond the control of the Contractor and any entity for which it is responsible, and which are attributable to interference between contractors and Utility owners, special requirements or actions by Authority, State and Federal agencies and other public bodies not anticipated in the Contract Documents, and unusually severe storms of extended duration or impact shall be compensated solely by the granting of an extension of time by the Authority complete the Work without engineering charges. Time necessary for reviews of Shop Drawings, for field changes to meet actual conditions, and delays incurred by seasonal and weather limitations should be anticipated and are neither compensatory nor eligible for extensions of time.

In no event will the Contractor be entitled to any increase in the Contract Sum, damages or additional compensation as a consequence of any delay, impact, disruption or acceleration resulting therefrom, regardless of the cause; the Contractor accepting an extension of time as granted in accordance with the preceding paragraph as its sole and exclusive remedy for such delay, impact, disruption or acceleration.

The Contractor agrees to include in its unit price bid for the various items of the Contract the additional cost of doing the Work under this Contract caused by not having a clear Site for the Work, by interference by other contractors and necessary Utility work and by the other non-compensatory delays described above and being required to open certain sections of the Work before the entire Work is completed.

## § 108-05 SUBLETTING OR ASSIGNING THE CONTRACT

The Contractor shall perform with their own organization Contract Work amounting to not less than fifty (50) percent of the original total Contract price, except that any items designated by the Authority as "Specialty Items" so performed may be deducted from the

original total Contract price before computing the amount of work required to be performed by the Contractor with their own organization.

A. "Their own organization" shall be construed to include only workers employed and paid directly by the Contractor and equipment owned or rented by him, with or without operators. The cost of furnishing and supplying materials to a subcontractor for installation by the subcontractor shall not be considered as Work with "their own organization."

B. "Specialty Items" shall be construed to be limited to Work that requires specialized knowledge, craftsmanship or equipment not ordinarily available in contracting organizations qualified to bid on the Contract as a whole and in general are to be limited to minor components of the overall Contract.

## SECTION 109 MEASUREMENT AND PAYMENT

### § 109-01 ESTIMATES AND PAYMENT

As the Work progresses in accordance with the Contract and in a manner that is satisfactory to the Engineer, the Authority shall make payments to the Contractor, based upon the Proposal as follows: The Authority shall once in each month and on such days as it may fix, make an estimate of the quantity of Work done and of Material which has actually been put in place in accordance with the terms and conditions of the Contract, during the preceding month, and compute the value and pay to the Contractor ninety-five (95%) percent of the amount of the Work performed. The five (5%) percent retained percentage may be held by the Authority until Final Completion and acceptance of all Work covered by this Contract.

In computing amounts in estimates or Work done the unit prices will be used.

In making up the Final Estimate, the linear measurement made along the axis of the surface of the finished Work will be considered the length of the Work.

All estimates including the final will be made for actual quantities of Work performed and Materials placed in accordance with the requirements contained in the specifications, Contract Plans and Standard Sheets as determined by the measurements of the Engineer, and resulting quantities involving in any Contract shall be accepted as final, conclusive and binding upon the Contractor. For computations of earthwork to be paid for under the various items of the Contract, it is agreed that the planimeter shall be considered an instrument of precision, and quantities computed from areas obtained by its use shall be accepted by all parties hereto as accurate. Arithmetical computations, utilizing any type of computing device or machines including electronic computers, shall not be precluded by reference to the planimeter.



PAYMENT TO SUBCONTRACTORS: Within thirty (30) days after payment is made to the Contractor by the Authority, the Contractor shall pay any amount due any subcontractor, whether for labor performed or materials furnished, when the labor and materials have been included in a requisition submitted by the Contractor and paid by the Authority. The Contractor shall include in all of its subcontracts a provision requiring each subcontractor to pay any amounts due any of its subcontractors, whether for labor performed or materials furnished within thirty (30) days after such subcontractor receives a payment from the Contractor which encompasses labor or materials furnished by such subcontractor.

### § 109-02 FINAL ADDITIONS OR DEDUCTIONS

Upon the completion of the required Work as shown in the Plans and specifications, should the Final Estimate of quantities show either an increase or decrease form the approximate estimate of quantities, then such variations will be computed at the unit prices

bid and a Final Agreement will be made respectively adding or deducting this amount from the gross sum bid.

## § 109-03 PAYMENTS ON CONTRACT

Payments to the Contractor for Work satisfactorily performed will be made monthly upon the percentage basis. No monthly estimate will be rendered unless the value of the Work done equals five (5%) percent of the Contract Amount or one thousand dollars, whichever is the lesser. Semi-monthly estimates may be rendered provided the value of the Work performed in a two week interval is in excess of fifty thousand dollars or if, in the opinion of the Engineer, it is to the best interests of the Authority to do so.

## § 109-04 EXTRA AND FORCE ACCOUNT WORK

*CONTRACT ITEM CHARGES*

When an Order on Contract provides for similar items of Work or Materials which increase or decrease the itemized quantity or scope of Work provided for in the original Contract Documents, the price to be paid therefore, shall not exceed the unit bid price for such items.

*NEW ITEM CHARGES*

1. Agreed Prices for new items of Work or Materials may be incorporated in the Order on Contract as the Engineer may deem them to be just and fair and beneficial to the Authority. These prices will be used in computing the Final Estimate.

   Agreed prices must be supported by a complete price analysis in the Order on Contract. The analysis will be based on an estimated breakdown of charges listed in the following paragraph 2, "Force Account Charges," unless some other basis is approved by the Authority.

2. Force Account Charges

   A. Contractor Charges - Where there are no applicable unit prices for Extra Work ordered and agreed prices cannot be readily established or substantiated, the Contractor shall be paid the actual and reasonable cost of the following:

      1. Necessary Materials including transportation to the Site. Material used, if acquired by direct purchase, must be covered by bills or acceptable invoices. All prices on used material incorporated in either temporary or permanent Work shall be billed at fair value, less than the original cost when new. A reasonable salvage credit shall be given for all salvageable material recovered. Salvage value of

substantial material recovered must be determined jointly by the Contractor and the Engineer.

2. Necessary direct labor charges. Each class of labor shall be billed separately at actual payroll rates. Average rates based on different class or labor, will not be accepted.

3. Payments required to be made to labor organizations under existing labor agreements.

4. Equipment and Plant rentals, other than small tools:

   a. Contractor owned Equipment and Plant. The base hourly rates for Contractor owned equipment and plant shall be the rates as listed in "Rental Rate Blue Book" as published by Dataquest Incorporated of San Jose, California currently on file in the Department at the time the Work is done.

      The daily rate per hour shall apply when the equipment is specifically assigned to the Work by the Engineer for a period of seven (7) consecutive Calendar Days or less.

      The weekly rate per hour shall apply when the assigned time exceeds seven (7) consecutive Calendar Days.

      The monthly rate per hour shall apply when the assigned time exceeds 21 consecutive Calendar Days.

      The number of hours to be paid for shall be the number of hours that the equipment or plant is actually used on a specified force account Job.

      Equipment used by the Contractor shall be specifically described and be of suitable size and capacity required for the Work to be performed. In the event the Contractor elects to use equipment of a higher rental value than that suitable for the Work, payment will be made at the rate applicable to the suitable equipment. The equipment actually used and the suitable equipment paid for will be recorded as a part of the record for force account work. The Engineer shall determine the suitability of the equipment. If there is a differential in the rate of pay of the operator of oversize or higher rate equipment, the rate paid for the operator will likewise be that for the suitable equipment.

In the event that a rate is not established in the "Rental Rate Blue Book" for a particular piece of equipment or plant, the Engineer shall establish a rate for that piece of equipment or plant that is consistent with its cost and use.

It is mutually understood that the base rates for all Contractor owned equipment shall include all incidental and maintenance costs except labor necessary to operate the equipment. In addition, the base rates shall include all costs, equipment and labor, of moving equipment or plant on to and away from the Work Site.

b. Rented Equipment and Plant. In the event that the Contractor does not own a specific type of equipment and must obtain it by rental at a higher rate than provided for in the formulas noted above, they shall be paid the actual daily rental rate for the equipment for the time that the equipment is actually used to accomplish the Work, plus the cost of moving the equipment on to and away from the job.

5. Profit and Overhead. Profit and overhead costs shall be computed at fifteen percent (15%) of the following:

a. Total Material Cost (Bare Cost - F.O.B.)

b. Total Direct Labor Cost (Actual hours worked multiplied by regular hourly wage rate).

Overhead may be defined to include the following:

a. Premium on Bond;

b. Premium on Insurance required by the Authority other than Workmen's Compensation Insurance, Public liability and property damage insurance, unemployment insurance, Federal retirement benefits, other payroll taxes such reasonable charges that are paid by the Contractor pursuant to written agreement with their employees;

c. All salary and expenses of executive officers, supervising officers or supervising employees;

d. All clerical or stenographic employees;

e. All charges for minor equipment, such as small tools, including shovels, picks, axes, saws, bars, sledges, lanterns, jacks,

cables, pails, wrenches, etc. and other miscellaneous supplies and services;

f. All drafting room accessories such as paper, tracing cloth, blue printing, etc.

B. Subcontractor Charges - When the Work is performed by a subcontractor, the Contractor shall be paid the actual and reasonable cost of such subcontracted Work as outlined above in Items 1 through 5 under subsection A, the subcontractor maximum profit and overhead shall not exceed fifteen percent (15%). The Contractor Charges for profit and overhead on the subcontractor's work shall not exceed five percent (5%) unless some other basis is approved by the Engineer.

C. Force Account Report - Payment for force account work will be made on the basis of the following reports.

1. The Contractor will deliver to the Engineer a daily summary of FORCE ACCOUNT WORK done on the Contract. This summary, in a format provided by the Authority, will be delivered to the Engineer not later than closing time on the day following that for which the Work is reported.

The summary shall contain:

a. A list of materials used indicating the amount, and nature of each material. The cost (if known) should also be included. This must be later documented by proper receipts.

b. A list of equipment used indicating the number of hours used and kind, type and size of equipment.

c. A list of personnel by name, including the hours worked, and labor classification at which they were used on the force account work and the location by station or stations of the Work proposed.

d. A statement of the Work accomplished by force account for that day.

e. This summary will be dated and signed by the Contractor's authorized representative and the Inspector.

f. The Contract number and other identification as well as the name of the Contractor shall appear on the statement.

g. The Inspector will make any notation, remarks or comments on this form that may assist in final payments.

2. Within 5 Calendar Days after the end of each pay period the Contractor shall deliver to the Engineer a FORCE ACCOUNTS SUMMARY OF LABOR used on the Work which shall include the name, hourly rate of pay, hours worked, fringe benefits and/or items as shown on the actual payroll.

3. On completion of the specific force account work the Contractor shall within 10 Calendar Days, deliver to the Engineer, a FORCE ACCOUNT SUMMATION wherein all materials, equipment and labor charges are shown and totaled together with such other expenditures as are concerned with the Force Account Summation. This summation shall be dated and signed by the Contractor's authorized representative and the Inspector.

## § 109-05 PROGRESS PAYMENTS

Unless otherwise specified in the method of payment for a particular item, no payment will be made for an item of Work until its completion in accordance with Specifications.

## § 109-06 PAYMENT OF ESTIMATES

As the Work progresses in accordance with the Contract and in a manner that is satisfactory to the Engineer, the Authority shall once in each month and on such days as it may fix, make an estimate of the quantity of Work done and of Material which has actually been put in place in accordance with the terms and conditions of the Contract Documents, during the preceding month, and compute the value thereof and pay to the Contractor the monies due.



## § 109-07 NO ESTIMATE ON CONTRACTOR'S NON-COMPLIANCE

It is understood that so long as any lawful or proper direction concerning the Work or Material given by the Engineer, or their representative, shall remain uncomplied with, the Contractor shall not be entitled to have any estimate made for the purpose of payment, nor shall any estimate be rendered on account of Work done or Material furnished until such lawful or proper direction has been fully and satisfactorily complied with.

## § 109-08 FINAL ACCEPTANCE OF WORK

When in the opinion of the Engineer, the Contractor has fully performed the Work under the Contract, the Engineer shall recommend to the Authority the acceptance of the Work so completed. If the Authority accepts the recommendation of the Engineer, the Engineer shall thereupon notify the Contractor of such acceptance, and copies of such acceptance shall be sent to other interested parties.

## § 109-09 UNCOMPLETED WORK AGREEMENT

Whenever a Contract shall, in the judgment of the Authority, be substantially completed and the withholding of the retained percentage would be an injustice to the Contractor, the Authority may, provided that the Engineer certifies that the essential items in the Contract Documents have been completed in accordance with the terms of the Contract and the provisions of **§ 109-10, "FINAL AGREEMENT"** direct the Engineer to include in the final account such uncompleted items and pay therefore at the item prices in the Contract upon the Contractor's depositing with the Authority a certified check drawn upon a legally incorporated bank or trust company equal to at least double the value of such uncompleted Work. The deposit may be used by the Authority to complete the uncompleted portion of the Contract and shall be returned to the Contractor if the Contractor completes the uncompleted portions within a specified number of working days after they have been notified to proceed with the Work.

## § 109-10 FINAL AGREEMENT

The Final Agreement will not be drawn and finalized until all Work required under the Contract Documents has been satisfactorily completed and materials have been rendered, considered, and if agreed to, made a part of such Final Agreement. Work remaining to be accomplished under an uncompleted Work agreement, shall be considered as completed Work for the purpose of the Final Agreement.

## § 109-11 FINAL ESTIMATE

The Engineer will approve a Final Estimate for final payment based on the Final Agreement as prepared and approved by the Engineer, less previous payments and any and all deductions authorized to be made by the Authority under the Contract.

## § 109-12 FINAL PAYMENT

After the final acceptance of the Work, the Engineer shall prepare a Final Agreement of the Work done from actual measurements and computations relating to the same, and the Engineer shall compute the value of such Work under and according to the terms of the Contract. This agreement shall be certified to as to its correctness by the Inspector. Upon approval of such Final Agreement by the Engineer, it shall be submitted to the Authority for final approval. The right, however, is hereby reserved to the Authority to reject the whole or any portion of the Final Agreement, should the said certificate of the Inspector be found or known to be inconsistent with the terms of the agreement or otherwise improperly given. All certificates, upon which partial payments may have been made being merely estimates, shall be subject to correction in the final certificate or Final Agreement.

## § 109-13 ACCEPTANCE OF FINAL PAYMENT

The acceptance by the Contractor, or by anyone claiming by or through him, of final payment shall constitute and operate as a release for the Authority from any and all claims of any liability to the Contractor for anything theretofore done or furnished for or relating to or arising out of the Work done thereunder, and for any prior act, neglect, default on the part of the Authority or any of its officers, agents, or employees unless the Contractor serves a detailed and verified statement of claim upon the Authority not later than forty (40) days after the mailing of such final payment. Such statement shall specify the items and details upon which the claim will be based and any such claim shall be limited to such items. Should the Contractor refuse to accept the final payment as tendered, it shall constitute a waiver of any right to interest thereon.

## § 109-14 CONTRACTOR'S COST RECORDS

The Contractor shall maintain records of all payrolls and of the details that comprise their total cost pursuant to any of the provisions under **§ 104-03, "CONTINGENCIES, EXTRA WORK, DEDUCTIONS,"** and the Contractor shall, at any time within 3 years following the date of acceptance of the Project, make such records available, upon request therefore, to the Authority for review and audit, if deemed necessary by the Authority. In case all or a part of such records are not made available, the Contractor understands and agrees that any items not supported by reason of such unavailability of the records shall be disallowed, or if payment therefore has already been made, the Contractor shall, upon demand in writing by the Authority, refund to the Authority the amount so disallowed.



## § 109-15 MAINTENANCE BOND

The Contractor shall secure a maintenance bond of a face value equal to twenty-five (25%) of the final Contract amount in a company approved by the Authority and in a form acceptable to the Authority guaranteeing their Work for a period of two (2) years from the date of final acceptance by the Authority. The Contractor shall leave the Work in perfect condition at completion and neither the final payment or agreement shall relieve the Contractor of the responsibility for negligence or faulty materials or workmanship within the extent and period provided herein, and upon written notice the Contractor shall remedy any defects due thereto and pay all expenses for any damage to other Work resulting therefrom.

The Contractor shall notify the Engineer in writing one (1) year after the acceptance of the job by the Authority. At that time the Contractor and Engineer will make a field inspection of the Project area, and the Contractor will correct any deficiencies that may exist.

The Contractor will notify the Engineer in writing sixty (60) days before the expiration of the maintenance bond and again the Engineer and Contractor will inspect the Project area for deficiencies.

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**Greater New Haven**
**Water Pollution Control Authority**

# TECHNICAL SPECIFICATIONS

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# DIVISION 01
# GENERAL REQUIREMENTS

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SECTION 01 11 00

SUMMARY OF WORK

## PART 1 GENERAL

### 1.01 SUMMARY

A. The work covered under this contract will be performed at the East Shore Water Pollution Abatement Facility at 345 East Shore Parkway, New Haven, CT 06512. The facility is owned and operated by the Greater New Haven Water Pollution Control Authority.

B. The Contractor must have a copy of the Greater New Haven Water Pollution Control Authority Standard Specifications. The requirements of these Techincal Specifications in Div 01 through 46 take precedence over the Standard Specifications.

### 1.02 DESCRIPTION OF OWNER'S PROJECT

A. The overall project will consist of improvements in four main areas. The areas include the FOG Receiving Building (Area 63), Maintenance Building (Area 78), Administration Building (Area 80) and the Fuel Storage Tank:

1. The work in the FOG Receiving Building (Area 63) generally includes the following:
   a. Demolition of existing 25,000 gallon single wall FRP underground fuel storage tank and miscellaneous appurtenances.
   b. Construction of new FOG Receiving Facility
   c. Installation of FOG receiving screen
   d. Installation of pumps, valves, heat exchangers, and piping.
   e. Installation of HVAC equipment
   f. Installation of instrumentation and control equipment.
   g. Installation of associated yard piping and site work.
   h. Installation of distribution panels, wire, conduit, and other appurtances to power new equipment.
2. The work in the Maintenance Building (Area 78) generally includes the following:
   a. Demolition of existing Boiler and assocatied pumps, piping and controls.
   b. Installation of new Boiler in Maintenance Building and associated pumps, piping, and controls.
   c. Installation of instrumentation and control equipment.
   d. Installation of wire, conduit, and other appurtances to power new equipment.
3. The work in the Administration Building (Area 80) generally includes the following:
   a. Installation of new pumps, hot water tank, heat exchangers, piping, valves and controls for the hydronic system in the basement of the Administration Building.
   b. Piping modifications and installation of new valves.
   c. Installation of instrumentation and control equipment.
   d. Installation of distribution panels, wire, conduit, and other appurtances to power new equipment.

4. The work in the Fuel Oil System generally includes the following:
    a. Installation of 12,000 gallon above grade fuel storage tank, fuel oil filter, duplex fuel oil pumps, fuel oil unloading system, and fuel piping.
    b. Installation of wire, conduit, and other appurtances to power new equipment.

## 1.03 CONTRACTS

A. The project will be performed by a single prime contract. The Contractor selected to do the work of this contract shall be solely responsible for the timely completion of this contract. Contractor shall coordinate and be responsible for all subcontractors work associated with the project. Direction of subcontractors shall be sole responsibility of Contractor, not Engineer or Authority.

**END OF SECTION**

SECTION 01 12 16

WORK SEQUENCE

## PART 1 GENERAL

### 1.01 CONTINUITY OF PLANT OPERATIONS

A. The existing wastewater treatment plant is currently and continuously receiving and treating sewage, and those functions shall not be interrupted except as specified herein. The Contractor shall coordinate the work to avoid any interference with normal operation of plant equipment and processes.

### 1.02 BYPASSING

A. Bypassing of untreated or partially treated sewage to surface waters or drainage courses is prohibited during construction. In the event accidental bypassing is caused by the Contractor's operations, the Authority shall immediately be entitled to employ others to stop the bypassing without giving written notice to the Contractor.

### 1.03 SUBMITTAL

A. In accordance with Section 01 33 00, the Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment, or structure from service. The schedule shall be coordinated with the construction schedule specified in the General Conditions of the Contract Documents and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the Contractor's method for preventing bypassing of other treatment units, the length of time required to complete said operation, the necessary plant, and equipment which the Contractor shall provide in order to prevent bypassing of associated treatment units.

B. The Contractor shall observe the following restrictions:
   1. Systems or individual equipment items shall be isolated, dewatered, decommissioned, deenergized, or depressurized in accordance with the detailed outage plan and schedule.
   2. The Engineer shall be notified in writing at least one week in advance of the planned operation.

### 1.04 SEQUENCE AND SCHEDULE OF CONSTRUCTION

A. The following items represent a general sequence of construction. Construction activities may be performed concurrently if it does not violate the constraints specifically listed below or if plant staff determines that it does not pose a risk to maintenance of treatment plant operations.

B. To permit continuous treatment of wastewater and compliance with effluent quality requirements, the construction schedule required in in the General Conditions of the Contract Documents shall provide for the following specific conditions:

C. Contractor shall perform activities in the following work sequence:
   1. Step 1:
      a. Conduct a sample-in-place program and characterization study in the area of the existing UST to determine if water from dewatering operations must be treated and if material from excvations must be hauled offsite. Refer to 02 60 00 for specific requirements.
         1) Following the characterization study the engineer shall make a determination on the treatment and disposal requirements of excavated soil and material assocatied with UST removal.
      b. Install and Commission Fuel Oil System.
         1) Refer to 26 32 13.15 for work constraints associated with connecting into existing fuel oil loop.
      c. Following determination of characterization study and successful commissioning of Fuel Oil System the Contractor can proceed to step 2.
   2. Step 2:
      a. Prepare and file all forms and permits required for the removal of the underground storage tank with CT DEEP and the City of New Haven.
      b. Demolish existing UST.
      c. Steps 1 needs to be completed prior to start of step 2.
      d. Contractor shall maintain continuous access to ash load out area and FOG unloading throughout demolition of the existing UST.
   3. Step 3:
      a. Install and Commission all components associated with the FOG Receiving Facility.
      b. Steps 1 and 2 need to be completed prior to starting step 3.
      c. The Authority will isolate DO, HWR/HWS, and FOG piping and equipment necessary for proposed interconnections in Administration Building.
      d. Provide temporary heating to maintenance building (area 78) while the existing boiler is removed and BLR-400 is installed and commissioned.
      e. Contractor shall maintain continuous access to ash load out area throughout construction of the new FOG Receiving Facility.
      f. Contractor shall notify the Authority 7 days in advance of any interruption of FOG receiving. FOG receiving can be offline for up to 7 day. If longer duration outages are required the Contractor must provide temporary piping to connect to existing pipe in the basement of the Administration building upstream of the Rock Trap.



**END OF SECTION**

SECTION 01 20 00

LUMP SUM ITEMS

(BID ITEM DESCRIPTIONS)

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Price make-up.

B. List of lump sum items.

C. Bid Item Descriptions - Attached pages.

### 1.02 PRICE MAKE-UP

A. Lump sum prices bid by Contractor are deemed to be full compensation for all required labor, products, tools, equipment, plant, transportation, testing, inspection, services, incidentals, administrative procedures, applicable taxes, permit fees, overhead, profit, and other miscellaneous expenses.

B. The five percent (5%) retainage specified in Article 9 of the Agreement applies to all payments including those for Mobilization.



### 1.03 LIST OF LUMP SUM ITEMS

| Bid Item No. and Title | |
|---|---|
| 1 | General Construction |
| 3 | Handling and disposal of regulated materials from dewatering activities in accordance with Section 02 61 50 Handling, Transportation, and Disposal of Regulated Materials |
| 4 | Miscellaneous Fuel Oil repairs in accordance with Section 01 20 01 |

### 1.04 BID ITEM DESCRIPTIONS

A. Bid Item Description pages are attached at the end of this Specification section.

## PART 2 PRODUCTS - NOT USED.

## PART 3 EXECUTION - NOT USED.

**END OF SECTION**

LUMP SUM ITEM BID ITEM 1

GENERAL CONSTRUCTION

A. DESCRIPTION — Under this item, furnish all materials, labor, tools, and construct the general construction work relating to all structural, architectural, civil, process equipment, process piping, HVAC, plumbing, electrical, and instrumentation as specified herein and as indicated in the Contract Documents and as outlined below.

B. WORK INCLUDED UNDER THIS ITEM — All Items of the work not specifically identified in Bid Items 2 through 5.

C. ASSOCIATED WORK NOT INCLUDED UNDER THIS ITEM — All other Bid Items.

D. METHOD OF PAYMENT — Payment will be made on a lump sum basis in accordance with the Contractor's Schedule of Values which shall include, as a minimum, all items listed herein under broken down into sufficient detail for Engineer to adequately review progress payment amounts.

ALLOWANCE ITEM BID ITEM 3

CONTINGENCY ALLOWANCE – HANDLING AND DISPOSAL OF REGULATED MATERIALS FROM DEWATERING ACTIVITIES

A. DESCRIPTION

Under this Item, the Contractor shall include a stipulated lump sum price to be utilized in paying for handling and disposal of regulated water from dewatering activities that will be identified during sample-in-place program and characterization study in the area of the existing UST. All regulated water shall be disposed of offsite. Contractor shall furnish all work necessary to complete miscellaneous additional work when authorized in writing by the Engineer. Miscellaneous additional work is not included in other lump sum bid items.

B. WORK INCLUDED UNDER THIS ITEM

Providing all labor, materials, tools, and incidentals required to perform unspecified additional work.

C. ASSOCIATED WORK NOT INCLUDED UNDER THIS ITEM

Sample-in-place program and characterization study.

Work required under other Bid Items.

Handling of groundwater not designated as regulated on site.

D. METHOD OF PAYMENT

Payment for this item will be made on a lump sum basis in accordance with an approved Contractor's change proposal and written authorization by the Engineer.

ALLOWANCE ITEM BID ITEM 4

CONTINGENCY ALLOWANCE – MISCELLANEOUS FUEL OIL REPAIRS

| | | |
|---|---|---|
| A. | DESCRIPTION | Under this Item, the Contractor shall include a stipulated lump sum price to be utilized in paying for unspecified repairs to existing Fuel Oil Loop. The project includes connection to the existing fuel oil loop, cleaning of existing fuel oil loop and testing in accordance with NFPA 31 and 37. Any repairs to the existing fuel oil loop identified and required to meet testing requirements will be included under Bid Item 4. |
| B. | WORK INCLUDED UNDER THIS ITEM | Repairs to existing fuel oil loop. |
| C. | ASSOCIATED WORK NOT INCLUDED UNDER THIS ITEM | New fuel oil piping shown on drawings, connection to existing fuel oil loop, cleaning of existing fuel oil loop, disposal of fuel oil in existing loop, and testing existing fuel oil loop.<br>Work Required Under Other Bid Items |
| D. | METHOD OF PAYMENT | Payment for this item will be made on a lump sum basis in accordance with an approved Contractor's change proposal and written authorization by the Engineer. |

SECTION 01 20 01

CONTINGENT UNIT PRICE ITEMS

(BID ITEM DESCRIPTIONS)

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Price make-up.

B. Description of contingent unit price items

C. List of contingent unit price items.

D. Bid Item Descriptions - Attached pages.

### 1.01 PRICE MAKE-UP

A. Payment for the work of contingent unit price items will be made at the Contractor's bid as stated in the Bid for each item included under this section.

B. No payment will be made under this section for work performed by the Contractor to replace defective work, work which is shown or specified, or which is outside the limits ordered. No payment will be made under this section for work related to the work of this section which is specifically included under other payment item sections.

C. The five percent (5%) retainage specified in Article 9 of the Agreement applies to all payments.

### 1.02 DESCRIPTION OF CONTINGENT UNIT PRICE ITEMS

A. Under this section, the Contractor shall perform the contingent unit price work ordered by the Engineer. All work under this section shall be done only upon specific direction of the Engineer and shall be only to the lines, grades and limits ordered.

B. The principal items of contingent unit price work scheduled herein are included under this section. The work also includes all accessories, appurtenances or other work required for the completion of contingent unit price items, except those related to the work of these items, but specifically included under other payment item sections of this Contract or other Contracts.

C. Prices for the contingent unit items shall be written by the Contractor in the space provided in the bid sheets and shall be extended by the given quantities. The contingent unit price items reflect work which is in addition to the work shown in the Contract Documents and may or may not be ordered by the Authority or Engineer. Should such contingent work be ordered by the Authority or Engineer, the Contractor shall make no claims whatsoever should the actual quantities of such work be different than the estimated quantities given in the bid sheets.

## 1.03 LIST OF CONTINGENT UNIT PRICE ITEMS - CONTRACT NO. BPI-1A: GENERAL

| Bid Item No. and Title | |
|---|---|
| 2 | Handling and Disposal of Regulate Materials from Excavation Activities |

## 1.04 BID ITEM DESCRIPTIONS

A. Bid Item Description pages are attached at the end of this Specification section.

## PART 2 PRODUCTS

Not used.

## PART 3 EXECUTION

Not used.

**END OF SECTION**

## HANDLING AND DISPOSAL OF REGULATE MATERIALS FROM EXCAVATION ACTIVITIES

A. DESCRIPTION

Under this item, the Contractor shall furnish all labor, materials, and equipment required for handling and disposal of regulated materials in accordance with Section 02 61 50. All regulated materials shall be disposed of offsite.

B. WORK INCLUDED UNDER THIS ITEM

Providing all labor, materials, tools, and incidentals required to perform unspecified additional work.

C. ASSOCIATED WORK NOT INCLUDED UNDER THIS ITEM

Sample-in-place program and characterization study.

Work required under of Bid Items.

Handling and disposal of soil not designated as Regulated on site.

D. METHOD OF PAYMENT

The quantity of regulated material disposed of under this project for which payment will be made will be the incremental costs associated with the disposal of regulated materials as compared to the handling and disposal of unclassified materials.

Measurement of regulated materials will be the actual number of cubic yards of regulated material, based on receipts from haulers and disposal facilities, as ordered by the Engineer.

The determination of material classification will be made by the Engineer upon receipt of the characterization study.

No payment will be made under this item for handling and disposal of unclassified materials.

SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE

## PART 1 GENERAL

### 1.01 SCOPE

A. This section specifies reports and schedules for planning and monitoring the progress of the work.

### 1.02 DESCRIPTION

A. The Contractor shall provide a graphic construction schedule indicating the various subdivisions of the work and the dates of commencing and finishing each. The schedule shall show the time allowed for testing and for other procedures which must be completed prior to the work being put into operation. The schedule will take into account the time of completion and the specific dates as specified in the Contract Documents and the work sequence described in Section 01 12 16.

### 1.03 SUBMITTAL PROCEDURES

A. Within 20 days after the date of the Notice to Proceed, the Contractor shall submit in accordance with Section 01 33 00, a construction schedule conforming to paragraph 1.02 Description. The submittal shall consist of a reproducible original and two copies.

B. Within 7 calendar days after receipt of the submittal, the Engineer shall review the submitted schedule and return one copy of the marked up original to the Contractor. If the Engineer finds that the submitted schedule does not comply with specified requirements, the corrective revisions will be noted on the submittal copy returned to the Contractor.



### 1.04 SCHEDULE REVISIONS

A. Revisions to the accepted construction schedule may be made only with the written approval of the Contractor and Authority. A change affecting the contract value of any activity, the completion time, and specific dates as specified in the Contract Documents and sequencing (Section 01 12 16) may be made only in accordance with applicable provisions of the General Conditions of the Contracto Documents.

### 1.05 PROJECT STATUS UPDATE

A. Project status review and update shall be provided each month as specified in the General Conditions of the Contract Documents.

**END OF SECTION**

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section specifies progress photographs to be provided for pre-construction, during construction, and post-construction.

### 1.02 SUBMITTALS

A. Photographs shall be submitted in accordance with Section 01 33 00 - Submittal Procedures.

## PART 2 PRODUCTS

### 2.01 PHOTOGRAPHS

A. Photographs shall be taken using a digital camera. Photographs shall be in color and shall have a minimum image area of 1600 X 1200 pixels.

B. High-definition video (1080p at 30 fps or higher).

C. Upload, maintain, and organize the photographs monthly using a commercially available photo management system. Organize files by area, year, and month. Assign file names that include location by area, direction, description and date taken.

D. Submit photographs in digital format on a monthly basis.



## PART 3 EXECUTION

### 3.01 GENERAL

A. Photographs shall be taken at locations designated by the Authority and Engineer.

B. The photographer shall be equipped to photograph interior and exterior exposures, with lenses ranging from wide-angle to telephoto and flash equipment as necessary for interior spaces.

C. The photographer shall be experienced in construction photography.

### 3.02 PRE-CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide preconstruction photographs prior to commencement of work on the Site.

### 3.03 CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall provide construction photographs showing the progress of the Work. The photographs shall be taken of such subjects as may be directed by the Authority and Engineer.

B. Photographs of all underground piping and structures prior to backfilling. Include associated location information.

## 3.04 POST-CONSTRUCTION PHOTOGRAPHS

A. Take the number of exposures specified until Final Acceptance of the Work. Locations shall be designated by the Authority and Engineer.

## 3.05 REQUIRED NUMBER OF PHOTOGRAPHS

A. For the work of this Contract, photographs shall provide the minimum number of photographs as follows:

| Category | Number of Photographs |
|---|---|
| Preconstruction | 200 |
| | 1 video documenting each area impacted by proposed work |
| Construction | 100 monthly |
| Acceptance | 200 |
| | 1 video documenting each area impacted by proposed work |

**END OF SECTION**

SECTION 01 33 00

SUBMITTAL PROCEDURES

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section includes administrative and procedural requirements for submittals.

### 1.02 ADMINISTRATIVE REQUIREMENTS

A. General:
   1. Furnish submittal items as specified in the Contract Documents.
   2. Review submittal information to verify it is accurate and fulfills specified submittal requirements before submitting for review and comment.
   3. Edit submittal content to clearly indicate only those items, models, or series of equipment, which are being submitted for review. Close out or otherwise obliterate extraneous materials.
   4. Ensure there is no conflict with other submittals and notify the Authority's Representative in each case where the submittal may affect the work of another contractor or the Authority.
   5. Coordinate submittals among subcontractors and suppliers including those submittals complying with unit responsibility requirements specified in the Contract Documents.
   6. For each submittal, certify field conditions, compliance with the Contract Documents, and review of the submittal prior to submitting for review.
   7. Designate the installation location within the facility, application, or intended purpose for each submittal item. Review comments are solely applicable to the circumstances designated in the submittal.
   8. Coordinate submittals with the work so that work will not be delayed. Coordinate and schedule different categories of submittals, so that one will not be delayed for lack of coordination with others.
   9. No extension of time will be allowed because of failure to properly schedule, coordinate or compile submittals.
   10. Submittals will be rejected for lack of legibility, lack of coordination, ambiguity, or are incomplete. Incomplete submittals will be returned without review.
   11. Do not proceed with work related to a submittal until the submittal process is complete. This requires that submittals for review and comment be returned to the Contractor stamped "No Exceptions Taken" or "Make Corrections Noted."
   12. If desired, authorize material or equipment suppliers to deal directly with the Authority's Representative regarding a submittal. Such dealings require written authorization from the Contractor and are limited to contract interpretations to clarify and expedite the work.

B. Request for Substitution Procedures:
   1. Requests for substitution for equipment specified by manufacturer or manufacturer's model number and listed below shall be in writing and shall be accompanied with sufficient information to permit the Engineer to identify the nature and scope of the

request. Information to be provided along with the request for substitution shall include:

a. All submittal information required for the specified equipment, including all deviations from the specified requirements necessitated by the proposed substitution.
b. Materials of construction, including material specifications and references.
c. Performance data, including performance curves and guaranteed power consumption, over the range of specified operating conditions.
d. Dimensional drawings, showing required access and clearances, including any changes to the work required to accommodate the proposed substitution.
e. Where controls are a part of the proposed substitution, piping, process and instrumentation drawings (P&IDs), produced in the project format and with project-specific symbols, along with control descriptions.
f. Where controls specified in the project manual require modification to accommodate the proposed substitution, piping, process and instrumentation drawings (P&IDs), produced in project format and with project-specific symbols, with all required modifications clearly highlighted.
g. Information and performance characteristics for all system components and ancillary devices to be furnished as a part of the proposed substitution.
h. Reproducible contract drawings, marked up to illustrate the alterations to all structural, architectural, mechanical, electrical and HVAC systems required to accommodate the proposed substitution.
i. A list of installations of the proposed substitution indicating application, location, Authority and date of first use.

2. Upon receipt of written application for substitution from the Contractor, including the information specified above, the Engineer will estimate the cost of evaluating the request and present the estimate to the Contractor. The Contractor is advised that the estimate is based upon the best information available to the Engineer at the time; however, the actual cost, based on time and expense, will be documented and applied in the final analysis of the substitution request. If the Contractor wishes to proceed with the request, he shall advise the Engineer in writing and submit sufficient additional information as may be requested by the Engineer. No evaluation will take place until such time as the Contractor has agreed to the estimate in writing and has authorized the Engineer to deduct the cost of the evaluation from monthly progress payments due the Contractor.



## 1.03 DEFINITITIONS

A. Action Submittals:
   1. Action Submittals content require review and response by the Authority's Representative before proceeding with incorporating the subject equipment, materials, or procedure into the work.
   2. Review comments on Action Submittals, and perform subsequent actions based on the REVIEW ACTION requirements specified below.

B. Informational Submittals:
   1. Informational Submittals are examined to verify that the specified submittal contents have been furnished as specified.

2. The Contractor's actions are not contingent on the disposition of review comments on Informational Submittals.
3. Review comments on Informational Submittals, and perform subsequent actions based on the REVIEW ACTION requirements specified below.

C. Closeout Submittals:
1. Closeout Submittals consist of documentation that is not available for review at the time Action Submittals are submitted for review or documentation that is typically generated or furnished following incorporation of the equipment, materials, or procedure into the work. Closeout submittals include spare parts inventory listing, spare parts, extra stock materials, special tools and other materials or components that are furnished separate from the installed and completed work.
2. Review comments on Closeout Submittals, and perform the subsequent actions based on the REVIEW ACTION requirements specified below.

D. Samples:
1. Samples include partial sections of components, cuts, or containers of materials, color range sets, and swatches showing color, texture and pattern.
2. Samples may be Action or Informational submittals.

E. Mock-Ups:
1. Mock-ups are scale representations of items to be constructed as part of the work as required in the Contract Documents.
2. Mock-ups are Action Submittals.

F. Review Actions:
1. The following definitions and actions are associated with the REVIEW ACTIONS DEFINED below:
a. NO EXEPTIONS TAKEN: If the review indicates that the material, equipment or work method complies with the Contract Documents, submittal will be marked "NO EXCEPTIONS TAKEN." Implement the work method or incorporate the material or equipment covered by the submittal.
b. MAKE CORRECTIONS NOTED: If the review indicates limited corrections are required, submittals will be marked "MAKE CORRECTIONS NOTED." Implement the work method or incorporate the material and equipment covered by the submittal in accordance with the noted corrections. Where submittal information will be incorporated in O&M data, provide a corrected copy.
c. AMEND AND RESUBMIT: If the review reveals that the submittal is insufficient or contains incorrect data, submittals will be marked "AMEND AND RESUBMIT." Do not undertake work until the submittal has been revised, resubmitted and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED".
d. REJECTED – SEE REMARKS: If the review indicates that the material, equipment, or work method does not comply with Contract Documents, the submittal will be marked "REJECTED - SEE REMARKS." Do not undertake the work covered by such submittals until a new submittal is made and returned marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" except at your own risk.

## 1.04 MASTER SUBMITTAL LIST

A. A minimum of ten (10) business days following the Notice to Proceed, the Contractor will provide the Authority's Representative a Master Submittal List listing anticipated submittal requirements for the contract.

B. Contractor shall update the list as submittals are completed and transmit to the Authority's Representative. Provide updated list to Authority's Representative monthly.

C. Include the following as a minimum in the updated list:
   1. Submittal number.
   2. Date submitted.
   3. Requested time for return of comments.
   4. Special requests, if any, for that particular submittal.

## PART 2 PRODUCTS - NOT USED

## PART 3 EXECUTION

## 3.01 SUBMITTAL PROCEDURES

A. General:
   1. Authority's Representative will review submittal information and indicate a REVIEW ACTION. Review of submittals does not relieve the Contractor of responsibility for performance of the work according to the Contract Documents.
   2. Coordinate submittal transmittal for related elements of work to ensure the submittals are processed as needed to meet the intent of the work and that delays are minimized.
   3. Submittal review activity will be prioritized based on the order received unless otherwise requested by the Contractor.
   4. Submittal sequencing should coincide with the Construction Schedule in Section 01 32 16 - Construction Progress Schedule.
   5. A review duration of 21 calendar days is allotted for each submittal, from the date of receipt by the Authority's Representative to the date of return to the Contractor.

B. Submittal Preparation:
   1. Excepting, mock-ups, spare parts, physical samples, and other items that cannot be converted to electronic media, furnish submittal contents electronically in a searchable PDF format.
      a. Include a table of contents and labeled divider sheets that are coordinated with the table of contents.
      b. Diagrams, drawings, pictures, and illustrations presented with a consistent orientation.
   2. Shop Drawings, Samples and Mock-ups
      a. Submit one electronic copy per the requirements described above and the following:
         1) Samples: three (3) samples
         2) Mock-up: As required by individual specification

3) Demonstrations: As required to facilitate installation and inspection

b. Reference applicable specifications for additional requirements

C. Submittal Completeness:

1. Submittals without all required information are not acceptable and may be marked "REJECTED" and returned without review.
2. For a submittal to be deemed complete, provide the information required below and specified in specification sections, including those elements in the special transmittal procedures where required.

D. In the event of the need to "revise and resubmit", provide a complete stand-alone submittal with corrections, revisions, and new information clearly identified.

E. Resubmit changes to submittals that require a stamp and signature by a licensed engineer or other certification with the requisite stamp and signature or certifications.

F. If the Engineer must review a submittal more than twice, the Contractor shall bear financial responsibility for each subsequent review.



## 3.02 TRANSMITTAL PROCEDURE

A. General:

1. Include the following information on the submittal transmittal form:
   a. Project names and date, including Authority's Project Number.
   b. Name of Contractor and Subcontractor
   c. Name of supplier and name of manufacturer
   d. Number and title of appropriate specification section
   e. Drawing number and detail references, as appropriate
2. Equipment and Material Submittals: Unless otherwise specified, complete the Transmittal Form 01 33 00-A - Submittal Transmittal Form specified in Section 01 99 90 - Reference Forms.
3. Operation and maintenance manuals, information and data Submittals: Complete the Transmittal Form 01 78 23-A - Operation and Maintenance Transmittal Form specified in Section 01 99 90 - Reference Forms.
4. Use a separate form for each specific item, class of material, equipment, and items specified in separate, discrete sections, for which a submittal is required. Identify the appropriate equipment numbers for submittal documents common to more than one piece of equipment. Submit a single form for multiple items, if the items taken together constitute a Supplier's package or are functionally related, to facilitate checking or reviewing the group or package as a whole.
5. Assign a unique sequential number to each transmittal form accompanying each item submitted.
   a. Format submittal numbers as follows: "SS SS SS-XXX"; where "SS SS SS" is the referenced 6-digit section number from the Specifications and "XXX" is the sequential number assigned by the Contractor.
   b. Format resubmittals as follows: : "SS SS SS-XXX-YY"; where "XXX" is the originally assigned submittal number and "YY" is a sequential number assigned for resubmittals, i.e., 00, 01, or 02 being the original, 1st, and 2nd resubmittals,

respectively. Submittal 43 23 50-001-02, for example, is the second resubmittal of submittal 001 pertaining to Section 43 23 50.

6. Deviation from contract: If deviations from the material, equipment or method of work are proposed, describe the proposed deviation and explain the reason for proposing the deviation under “deviations” on the transmittal form accompanying the submittal copies.

B. Document Management System Specific Procedures:
   1. Unless otherwise specified, submittals regarding material and equipment shall be submitted electronically using a document control program/website.
   2. Instructions will be provided to Contractor upon project award.

C. Check Marked Specification Transmittal Procedures:
   1. When submittal requirements require a “marked” copy of the specification, provide a copy of the specification marked as indicated below. Provide the following when transmitting the submittal:
      a. Provide a copy of the specification section(s) that specifies a marked copy of the specification. Include addendum updates and referenced specification sections, with addendum updates. Complete the following:
         1) Checkmark each paragraph to indicate submittal compliance with that specification requirement. Check marks (√) shall denote full compliance with that paragraph as a whole.
         2) Mark paragraphs where deviations are proposed by underlining text that is the subject of the proposed deviation. Denoting each proposed deviation with a number in the margin to the right of the identified paragraph and provide a detailed written explanation for each numbered deviation. The remaining portions of the paragraph not underlined signify compliance with specified requirements.
         3) The Engineer is the final authority for determining acceptability of requested deviations.
      b. For equipment specifications, provide a copy of the control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the subject equipment. Complete the following:
         1) Mark drawings or diagrams to show specific changes necessary for the equipment proposed in the submittal.
         2) If no changes are required, mark the drawings or diagrams with "no changes required".

D. Provide a Certificate of Unit Responsibility assigning unit responsibility in accordance with the requirements of the specification Section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with the Specifications.

E. Samples and Mock-ups:
   1. Submit samples and mock-ups in accordance with the Contract Documents. Package samples to facilitate review. Include the following with the Submittal Transmittal Form:
      a. Generic description of the sample

b. Sample source
c. Product name and name of manufacturer
d. Compliance with recognized standards
e. Submittal Number
f. Availability and delivery time
g. Specification Section

2. Submit samples and mock-ups before installation. Where variation in color, pattern, texture or other characteristics are inherent in the material, submit four units to show variation range.
3. Where samples are for selection of appearance characteristics from a range of standard choices, submit a full set of choices for the material or products.
4. Maintain sets of approved samples and mock-ups at the Project Site, for quality comparisons throughout the course of construction.
5. Demolish and remove all samples and mock-ups prior to substantial completion.

## 3.03 REVIEW PROCEDURE

A. General:
1. Authority's Representative will review each submittal, indicate a REVIEW ACTION, and return to the Contractor.
2. Returned submittals indicate one of the following REVIEW ACTIONS: NO EXEMPTIONS TAKEN, MAKE CORRECTIONS NOTED, AMEND AND RESUBMIT, or REJECTED – SEE REMARKS.

## 3.04 EFFECT OF REVIEW OF CONTRACTOR'S SUBMITTALS

A. General:
1. Review of contract drawings, methods of work, or information regarding materials or equipment the Contractor proposes to provide, does not relieve the Contractor of responsibility for errors therein and is not regarded as an assumption of risks or liability by the Authority's Representative or the Authority, or by any officer or employee thereof, and the Contractor has no claim under the contract on account of the failure, or partial failure, of the method of work, material, or equipment reviewed. A mark of "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED" means that the Authority has no objection to the Contractor, upon his own responsibility, using the plan or method of work proposed, or providing the materials or equipment proposed.

**END OF SECTION**

SECTION 01 35 43

ENVIRONMENTAL PROCEDURES

## PART 1 GENERAL

### 1.01 SITE MAINTENANCE

A. The Contractor shall be resposnsible for implementing and maintaining erosion control devices during construction.

B. The Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site when they are no longer necessary. Upon completion of the work and before final acceptance, the work site shall be cleared of equipment, unused materials, and rubbish to present a clean and neat appearance.

### 1.02 TEMPORARY DAMS

A. Except in time of emergency, earth dams are not acceptable at catch basin openings, local depressions, or elsewhere. Temporary dams of sand bags, asphaltic concrete, or other acceptable material will be permitted when necessary to protect the work, provided their use does not create a hazard or nuisance to the public. Such dams shall be removed from the site as soon as they are no longer necessary.

### 1.03 AIR POLLUTION CONTROL

A. The Contractor shall not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of any legally constituted authority. He shall also abate dust nuisance by cleaning, sweeping, and sprinkling with water, or other means as necessary. The use of water in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods.

### 1.04 NOISE CONTROL

A. Between 7:30 p.m. and 7:00 a.m., noise from Contractor's operations shall not exceed limits established by applicable laws or regulations and in no event shall exceed 86 dBA at a distance of 50 feet from the noise source.



**END OF SECTION**

SECTION 01 45 00

CONTRACTOR QUALITY CONTROL

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section specifies administrative and procedural requirements for quality control services, field inspections and field testing of civil and structural constructs required for this project.

B. The Contractor is responsible for the quality assurance and quality control of their respective work for the construction of this project in accordance with the Contract Documents.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.

1. Section 01 45 23 Testing and Inspection Services

### 1.03 DEFINITIONS

A. Quality Control System (QCS): The quality control, assurance, and inspection system established and carried out to ensure compliance with the Plans and specifications.

B. QCS Supervisor: That person in responsible charge of the work occurring, as designated by the Contractor in the QCS Plan.

C. QCS Inspector: Responsible, certified personnel inspecting the various constructs at specified milestones and during the project overall and designated by the Construction Manager.

D. Factory Test: Tests made on various materials, products and component parts prior to shipment to the job site.

E. Field Tests: Tests and analyses made at or in the vicinity of the job site in connection with the actual construction.

F. Certified Inspection Report: Reports signed by approved inspectors attesting that the items inspected meet the specification requirements other than any exceptions included in the report.

G. Certificate of Compliance: Certificate from the manufacturer of the material or equipment identifying said manufacturer, product and stating that the mateiral or equipment meet specified standards, and shall be signed by a designated officer of the manufacturer.

H. Standard Compliance: Condition whereby specified materials or equipment must conform to the standards of organizations such as the American National Standard Institute (ANSI), American Society for Testing and Materials (ASTM), Underwriters Laboratories (UL) or similar organization.

I. Quality Assurance: The day-to-day, in-process supervisory observations of work and materials conducted by the Contractor to assure that the proper methods and materials are being used and installed by tradesmen.

J. Source Quality Control: The in-process testing and inspections conducted by the QCS Inspector(s) to verify that the materials, equipment; workmanship and shop manufactured constructs are in compliance with the Contract Documents, applicable Codes and standards.

K. Field Quality Control: The testing and inspections conducted by the QCS Inspector(s) in the field during and at the completion of each construct to verify that the in-process and completed construction is in compliance with the Contract Documents, applicable Codes and standards.

L. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the local governing authorities having jurisdiction (AHJ) as having the competency necessary to inspect a particular type of construction requiring special inspection.

## 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.
   4. Written description of Contractor's proposed QCS plan in sufficient detail to illustrate adequate measures for verification and conformance to defined requirements. The QCS plan and submittal shall include a log showing anticipated inspections, QCS Inspectors, Special Inspections, and source and field Quality Assurance procedures. Submittal of the QCS plan shall be made prior to commencing field work.
   5. Contractor's proposed QCS Supervisor and QCS Inspectors (other than the Special Inspectors provided by Owner), including qualifications, responsibilities, and if requested, references.
   6. Complete structural system information describing Contractor designed structural systems, including sealed calculations, shop and erection drawings, product literature for the various components, International Code Council (ICC) Evaluation Reports for structural components, and a discussion of risk issues associated with the proposed system which could adversely impact overall project completion.
   7. If requested by the Construction Manager during the work, manufacturer's field services and reports.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturers' field services and reports unless requested by Construction Manager to be submitted for review.
   3. Special Inspection reports, unless otherwise directed in each technical specification Section.

## 1.05 REGULATORY REQUIREMENTS

A. GENERAL: Comply with all Federal, State, and local Codes as referenced herein. Such regulations apply to activities including, but not limited to, site work and zoning, building practices and quality, on and offsite disposal, safety, sanitation, nuisance, and environmental quality.

B. SPECIAL INSPECTION: Special Inspection shall be performed by the Special Inspector under contract with the Owner or registered design professional in responsible charge acting as the Owner's agent in conformance with the IBC. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.

C. STRUCTURAL OBSERVATION: Registered Design Professional shall make visual inspections of the work to assess general conformance with the Contract Documents at significant construction stages and at completion of the structural system in accordance with IBC 1704.6 Structural Observations requirements.



## 1.06 CONTRACTOR'S RESPONSIBILITIES

A. Monitor quality assurance over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Coordinate with, schedule specified inspections by, and provide normal and customary assistance to the QCS inspectors and Owner provided Special Inspectors.

C. Coordinate with, schedule specified structural observations by Engineer, and provide normal and customary assistance to Engineer performing structural observations.

D. Comply fully with manufacturers' instructions, including each step in sequence.

E. Should manufacturers' instructions conflict with Contract Documents, request clarification before proceeding from Construction Manager.

F. 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.

G. The Contractor shall retain the services of a licensed land surveyor, registered in the State of Connecticut to perform survey work including but not limited to establishing line and grade, in advance of the construction; and to perform other surveying services for the work included under the Contract. The surveyor to be retained by the Contractor shall not be the same surveyor engaged for the Engineer's use. The surveyor shall be

subject to the approval of the Engineer. Survey drawings shall be submitted to the Engineer for approval.

H. The Contractor shall take all necessary measurements in the field to verify pertinent data and dimensions shown on the Drawings or to determine the exact dimensions of the Work.

## 1.07 FIELD SAMPLE PROCEDURES

A. When field samples are specified in a unit of work, construct each field sample to include work of all trades required to complete the field sample prior to starting related field work. Field samples may be incorporated into the project after acceptance by Construction Manager. Remove unacceptable field samples when directed by Construction Manager. Acceptable samples represent a quality level for the work.

## 1.08 CONTRACTOR DESIGNED STRUCTURAL SYSTEMS

A. DESIGN ENGINEERING: Contractor shall employ and pay for engineering services from a Professional Engineer registered in the State of Connecticut for structural design of Contractor designed structural systems including but not limited to temporary shoring and bracing, formwork support, interior wall and ceiling systems, and support systems for fire sprinkler, plumbing, mechanical, and electrical systems and equipment.

B. TESTS AND INSPECTIONS OF CONTRACTOR DESIGNED STRUCTURAL SYSTEMS: Contractor shall pay for preliminary testing of concrete, grout, and mortar mix designs where required by Code or these specifications prior to start of work. Contractor shall pay for required shop and site inspection of Contractor designed structural systems where required by Code or these specifications.



## 1.09 JOB SITE CONDITIONS

A. Schedule to ensure all preparatory work has been accomplished prior to proceeding with current work. Proceeding with the work constitutes acceptance of conditions. Allow adequate time for materials susceptible to temperature and humidity to “stabilize” prior to installation. Establish and maintain environmental conditions (i.e., temperature, humidity, lighting) as recommended by the various material manufacturers for the duration of the work.

# PART 2 PRODUCTS

## 2.01 SOURCE QUALITY CONTROL

A. CONTRACTOR RESPONSIBILITIES: Provide source quality control according to the reviewed and accepted QCS plan and paragraph 1.06 herein. Coordinate with Construction Manager to facilitate the work of the Testing Laboratory specified in Section 01 45 23 and Special Inspector. Provide ready access to sampling and inspection locations and incidental labor customary in such sampling and inspections. Timely prepare and submit submittals, and revise as indicated by review comments. Comply with technical requirements in each specification Section that applies to the work.

B. CONSTRUCTION MANAGER RESPONSIBILITIES: Review Contractor's tracking of QCS activities at monthly meetings. Facilitate completion of submittal review per Section 01 33 00. Assist Contractor to ensure that Special Inspection occurs where and when specified.

C. ACCEPTANCE CRITERIA: Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

## PART 3 EXECUTION

### 3.01 FIELD QUALITY CONTROL

A. Field quality control responsibilities of the Contractor and Construction Manager are substantially the same as described in paragraph 2.01, with the exception that this work occurs primarily on the jobsite as the work progresses, and Special Inspection will occur more often than at the source.

B. Acceptable characteristics and quality of a particular item or construct is defined in that item's or construct's specification Section.

### 3.02 REGULATORY COMPLIANCE – SPECIAL INSPECTIONS

A. The types of work requiring Special Inspection are specified in the Construction Documents and required to obtain regulatory approval by State or required by local governing authorities having jurisdiction over the building permit of the project.

B. Section 01 45 23 describes Testing Laboratory sampling, testing and reporting.

C. Contractor designed structural systems are subject to the same Special Inspection requirements as all other work.

### 3.03 CORRECTION OF DEFECTIVE WORK

A. Any defective or imperfect Work, equipment, or materials furnished by the Contractor which is discovered before the Final Acceptance of the Work, or during a warranty period, shall be removed immediately even though it may have been overlooked by the Engineer and approved for payment. The Contractor shall repair such defect, without compensation, in a manner satisfactory to the Engineer.

B. Unsuitable materials and equipment may be rejected, notwithstanding that such defective Work, materials and equipment may have been previously overlooked by the Engineer and accepted or approved for payment.

C. If any workmanship, materials or equipment shall be rejected by the Engineer as unsuitable or not in conformity with the Specifications or Drawings, the Contractor shall promptly replace such materials and equipment with acceptable materials and equipment at no additional cost to Owner. Equipment or materials rejected by the Engineer shall be tagged as such and shall be immediately removed from the site.

D. The Engineer may order tests of imperfect or damaged Work equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor, and the

nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the Work, equipment, or material was not impaired, the Work, equipment or materials may be deemed acceptable, in the discretion of the Engineer. If the results of such tests reveal that the required functional capability of the questionable Work, equipment or materials has been impaired, then such Work, equipment or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect Work, equipment or material in lieu of performing the tests.

**END OF SECTION**

SECTION 01 45 23

TESTING AND INSPECTION SERVICES

## PART 1 GENERAL

### 1.01 SUMMARY

A. GENERAL REQUIREMENTS: Comply with the testing and inspection specified in this Section and elsewhere in the Construction Documents. For the purpose of this Section, all references made herein to Testing Agency or Special Inspector or Geotechnical Consulting Firm shall be referred to as those tests or inspections which will be conducted by an inspector provided by the Owner.

1. The Owner or registered design professional in responsible charge acting as the Owner's agent will select and employ an independent Testing Agency to conduct the tests and inspections in accordance with applicable standard methods of American Society for Testing and Materials (ASTM) or other standards specified by the local governing authorities having jurisdiction (AHJ) as a requirement of the building permit. The Owner may require other special inspection services to inspect and verify the Work installed is in accordance with the Construction Documents and construction industry standards.
2. The Contractor shall provide and pay for other inspection and testing services where specified in the Construction Documents or required to obtain regulatory approval by State or AHJ.



### 1.02 DEFINITIONS

A. Special Inspector – A qualified individual employed or retained by an approved agency and approved by the AHJ as having the competency necessary to inspect a particular type of construction requiring special inspection.

B. Testing Agency - firm responsible for performing specific inspections and/or tests as part of the Special Inspection program.

### 1.03 QUALITY ASSURANCE

A. QUALIFICATIONS: The inspector for all Work as hereinafter specified, except for geotechnical inspections, waterproofing and roofing, shall be a registered Special Inspector employed by an approved inspection and/or Testing Agency. All inspection personnel used on this Project are subject to being disapproved from the Project at the discretion of the Owner.

1. The Special Inspector shall have the required technical knowledge and experience for the product or construction element being installed.
2. Geotechnical Inspection will be performed by a licensed Geotechnical Consulting Firm.

### 1.04 DUTIES OF OWNER'S TESTING AGENCY

A. GENERAL: The Owner's Testing Agency will conduct testing and inspection services, interpret them, and evaluate the results for compliance with the building permit, the site development permit, and the Construction Documents; agency will report findings to the

Owner, Contractor, and AHJ. Testing and inspection services shall be in accordance with applicable standard methods of ASTM or other standards specified by AHJ, the Construction Documents, and construction industry standards. The Testing Agency will reasonably support overtime, second shift, and out-of-area activity if requested by the Contractor and approved at the Owner's sole discretion.

B. TESTING AND INSPECTION: Materials to be tested are specified by the building permit and as required by the Construction Documents, as directed by Owner, or required by AHJ. Quantities and extent of tests and inspections shall be as specified and/or required by the Owner's Inspector or AHJ.

C. NON-CONFORMING WORK: The Owner's Inspector shall document and immediately notify the Contractor and Owner of any Work found defective or not in accordance with the requirements of the Construction Documents. Non-conforming Work shall be corrected.

D. The Owner's inspectors are not authorized to do the following:
   1. Release, revoke, alter or enlarge on requirements of Construction Documents.
   2. Approve or accept any portion of the Work, except as allowed by the special inspection duties delegated by governing AHJ for building permit inspections and testing.
   3. Perform any duties of the Contractor.
   4. Stop Work.



## 1.05 COSTS

A. The Owner's Testing Agency and Special Inspector costs for initial testing and inspection as specified in the Construction Documents will be paid for by the Owner or registered design professional in responsible charge acting as the Owner's agent . Initial tests and inspections are defined as those required to complete the first tests and inspections specified. Costs for subsequent re-testing and re-inspection of items found not to be in compliance with Construction Documents shall be borne by the Contractor.

B. Additional tests and inspections not herein specified, but requested by the Owner, shall be paid for by the Owner. However, if the results of such tests or inspections are found to be not in compliance with Construction Documents, the Contractor will be back charged for all costs for initial testing as well as re-testing, re-inspection and Owner's Consultants services.

C. Costs for additional tests or inspections required because of Contractor changes to reviewed and accepted products or materials provided, or source, or supply shall be borne by the Contractor.

D. Costs for any Work which is required to correct any deficiencies shall be borne by the Contractor.

E. Costs of any testing which is required solely for the convenience of Contractor in its scheduling and performance of the Work shall be borne by the Contractor.

F. Costs for verification testing of Work done without prior notice, with improper supervision, or contrary to construction practice shall be borne by the Contractor.

G. Costs for testing of materials for which fabrication and mill reports are required but not furnished shall be borne by the Contractor.

H. The cost, if any, of providing access for inspections and tests shall be considered part of the normal expense of conducting business and therefore non-reimbursable.

I. In those instances where inspector(s) arrive at the agreed-upon location, at the agreed upon date and time, and find articles to be inspected are not ready for inspection, the inspector(s) shall return to their home office and all expenses incurred shall be borne by the Contractor.

## 1.06 TESTS AND INSPECTION REPORTS

A. Copies of Owner and Contractor test and inspection reports shall be distributed at weekly intervals. All reports will be signed by a Connecticut Association of Building Official certified Special Inspector or Professional Engineer registered in the State of Connecticut, as appropriate. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory; a final report should be submitted documenting corrective work done on of any unsatisfactory material and or work identified in the testing or inspection reports. Samples taken, but not tested, shall also be reported. Records of special sampling operations that are required shall also be reported. Test and inspection reports shall be distributed as follows:
   1. Owner
   2. Owner's Testing Agency
   3. Contractor
   4. Authority Having Jurisdiction

B. A report shall be prepared for each inspection and test and shall include:
   1. Date issued.
   2. Project title and number.
   3. Name and signature of inspector.
   4. Date of inspection or sampling and test.
   5. Record of temperature and weather.
   6. Identification of product and Specification Section.
   7. Location in Project.
   8. Type of inspection or test.
   9. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards.



## 1.07 CONTRACTOR'S RESPONSIBILITIES

A. COORDINATION: It is the Contractor's responsibility to initiate, coordinate, and conform to the required tests and inspections of governing State and AHJ. Inspection of the Work by the Owner's Special Inspectors and/or Testing Agency shall not relieve the Contractor from responsibility for compliance with the Construction Documents requirements. Owner's Special Inspectors and/or Testing Agency and Owner shall have authority to reject Work whenever the provisions of the Construction Documents are not being complied with, and the Contractor shall instruct his employees accordingly.

B. ACCESS FOR THE PURPOSE OF INSPECTION: Ensure the Owner's Special Inspectors and/or Testing Agency have free access to all parts of the Work and to the shops where the Work is in preparation; are provided proper facilities and safe access for such inspection; and are reasonably furnished access, equipment, tools, samples, certifications, test reports, design mixes, storage, and assistance as requested by the Owner's Inspector.

C. STORAGE FACILITIES: Furnish adequate storage facilities as approved by the Owner for the sole use of the Owner's Testing Agency for safe storage and curing of such specimens which must remain on the site prior to transport to the laboratory.

D. DATA: Furnish records, Contract Drawings and shop drawings, certificates, approved Change Orders, and similar data as required by Owner's Inspectors to perform their work to assure compliance with the Construction Documents.

E. NOTICE: Furnish notice to Owner and coordinate with Owner's Inspectors a minimum of five (5) working days in advance of all required tests and a minimum of forty-eight (48) hours in advance of all required inspections, unless otherwise specified.

F. NON-CONFORMING WORK: Remove and replace Non-conforming Work at no additional cost to the Owner prior to Final Completion. Where Non-conforming Work requires design modifications, such re-design shall be performed by the Engineer of Record and costs shall be borne by the Contractor.

G. CANCELLATIONS: Contractor shall give sufficient advance notice to Owner and Inspectors to allow rescheduling of their work load in the event of cancellation or time extension of any scheduled test or inspection.



## 1.08 TEST FAILURES

A. GENERAL: The Owner may require re-test of a sampled material when a sample or procedure has failed to pass the required tests. In the event any test or inspection indicates failure of a material or procedure to meet requirements of Construction Documents, all costs for re-testing or re-inspection shall be borne by the Contractor. The Contractor may opt to replace the imperfect Work, equipment or material in lieu of performing the tests.

## 1.09 REPORT TEST FAILURES

A. GENERAL: Immediately upon determination of a test failure, the Owner's Inspector shall notify the Owner and Contractor. By the end of the following day the Owner's Inspector shall send written test results to those named on the distribution list.

B. Contractor shall similarly report test failures to Owner resulting from work of testing agencies provided by the Contractor.

## PART 2 - NOT USED

## PART 3 - NOT USED

**END OF SECTION**

SECTION 01 61 45

AREA EXPOSURE DESIGNATIONS

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. SCOPE:

1. This section designates area exposure types for each location, room, area, or space at the site of the Work.
2. Area exposures are used to specify materials based on the corrosion environment that the material is exposed to when the materials for the component are not scheduled or otherwise identified for each specific installation (e.g., pipe, anchor bolts, pipe supports, coatings, etc.). Where materials are scheduled for specific individual components (e.g., equipment, instruments, conduit, panels, etc.), furnish materials as specified.

### 1.02 RELATED SECTIONS:

A. Section 01010 – Summary of Work

### 1.03 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

1. Atmospheric: Air space surrounding a structure or process.
2. Solution: Liquid or solid which may contain water or other free liquid.

B. EXPOSURE TYPE: Included as a supplement to this Section, the Area Exposure Table designates an Exposure Type for each room or area. Each Exposure Type, listed from least to most severe corrosion potential, is defined below:

1. Indoor Dry: locations inside a building or other enclosed structure not subjected to wash down and not in contact with a liquid holding or earth retaining wall.
2. Indoor Wet: locations inside a building or structure that are damp, subject to wash down, or surfaces of structures that are in contact with a liquid holding or earth retaining wall or slab.
3. Outdoor: locations not protected from the weather, or only partly protected by a roof or open enclosure, and exposed to exterior ambient conditions. Local ambient conditions may be expected to vary.
4. Buried: below grade wall or roofs; locations covered and in contact with earth/soil.
5. Submerged: locations inside a covered liquid or solids holding structure that are below a plane located 12 inches below the minimum operating level of the liquid in the tank or structure.
6. Process Corrosive: locations exposed to high humidity, frequent wash down and/or corrosive gases or vapors from the process stream. Process corrosive includes locations inside an open (not covered) liquid or solids holding structure that are above a plane located 12 inches below the minimum operating level of liquid in the structure and below the top of the wall of the structure.

7. Head Space: locations inside a covered liquid or solids holding structure that are above a plane that starts 1-foot below the minimum operating liquid level in the structure.
8. Chemical Corrosive: walls, ceilings, floors, trenches and other surfaces exposed to delivery, storage, transfer, use or containment of corrosive chemicals.

C. ENVIRONMENTAL CONDITIONS: Environmental conditions for each Exposure Type are tabulated below:

| Exposure Type | Environment | Chemical Exposure | Chemical Concentration |
|---|---|---|---|
| Indoor Dry | Atmospheric, Dry | None | Not Applicable |
| Indoor Wet | Atmospheric, Wet | None | Not Applicable |
| Outdoor | Atmospheric, Wet | None | Not Applicable |
| Buried | Solution | Earth/Soil | Not Applicable |
| Submerged | Solution | Various Chemicals | Dilute |
| Process Corrosive | Atmospheric | Hydrogen Sulfide<br>Trace Chemicals | 1 - 10 ppm<br>Dilute |
| Head Space | Low Oxygen, Wet | Hydrogen Sulfide<br>Other trace gases | 10 - 1500 ppm<br>Dilute |

D. AREA EXPOSURE TABLE: The Area Exposure Table schedules an Exposure Type for each location, room, area, or space at the site of the Work. The Area Exposure Table is provided in Part 4 of this Section.



## PART 2 NOT USED

## PART 3 EXECUTION

A. MATERIALSELECTION

1. Provide construction materials, coating systems, and lining systems consistent with materials requirements specified in individual equipment/material Specifications for the exposure assigned in the area exposure table. In the event of a conflict between the individual equipment/material specification and this Section, the individual equipment/material specification governs. In the event an area exposure is not designated for a particular location, the area exposure with the most severe corrosion potential from all area exposures for adjacent locations, rooms, areas, or spaces governs, and shall be the basis of the Contract Price.
2. Where components are assigned multiple area exposures, select the material and coating specified for the area exposure that has the most severe corrosion potential. When components cross, span, or straddle the boundary separating two or more area exposures, select materials specified for the area exposure that has the most severe corrosion potential. Where materials change at a boundary between exposures, change the material at the boundary or within the less severe exposure. At material transitions, separate dissimilar metals by a dielectric coupling or other suitable barrier.

## PART 4 AREA EXPOSURE TABLE

| Facility Number | Facility Name | Room Name / Delineation | Exposure Type |
|---|---|---|---|
| 05 | Site | Outside the perimeter of facilities, above grade | Outdoor |
| 05 | Site | Outside the perimeter of facilities, below grade | Buried |
| 05 | Site | Interior of below grade vaults, manholes and hand holes | Submerged |
| 63 | FOG Receiving Building | FOG Screening and Pumping Room | Process Corrosive |
| 63 | FOG Receiving Building | Electrical Room | Indoor dry |
| 63 | FOG Receiving Building | FOG Receiving Tank 1 & 2 above HWL | Head Space |
| 63 | FOG Receiving Building | FOG Receiving Tank 1 & 2, below HWL | Submerged |
| 78 | Maintenance Building | Maintenance Building Basement | Indoor wet |
| 80 | Administration Building | Administration Building Basement | Indoor wet |
| 80 | Administration Building | Belt Filter Press Room | Process Corrosive |
| 80 | Administration Building | Electrical Room – MCC-NR1 | Indoor dry |
| 80 | Administration Building | Electrical Room – MCC 9 | Indoor dry |
| 65 | Odor Control Facility | Electric Room | Indoor dry |



**END OF SECTION**

SECTION 01 64 00

OWNER FURNISHED EQUIPMENT INSTALLATION

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section includes requirements for coordination, unloading, storing, installing and testing of the Owner pre-purchased equipment and systems.

### 1.02 GENERAL DESCRIPTION

A. This contract is being constructed with the equipment in this Contract as well as installation of PLC-7 pre-purchased by Authority. The prepurchased equipment is being provided by NIC Systems Corporation, "Supplier" or alternate supplier as determined by the Authority.

B. The Contractor will coordinate, unload and install the equipment and provide all necessary assembly and installation of all interconnecting cable and conduits, and other parts and components provided by the Supplier.



## PART 2 PRODUCTS

### 2.01 MATERIALS PROVIDED BY CONTRACTOR

A. For material and installation required by the Contractor, refer to these specifications and Contract Drawings.

### 2.02 MATERIAL FURNISHED BY SUPPLIER

A. For a description of what is being provided by Supplier to be assembled and installed by Contract, refer to Sections 40 61 13.01 and associated referenced sections and P&IDs, layout drawings, etc. included within the Contract Drawings.

B. PLC cabinet will be provided with cable connections. All incidental parts and material, such as washers, bolts, gaskets, hardware, couplings, transition couplings and other components not specifically listed or shown or indicated "by others" shall be provided by the Contractor. Coordinate sizes and quantities with Supplier.

C. Contractor shall provide mounting brackets, anchor bolts for anchoring all equipment to floor slab, pads or walls. Refer to Section 43 05 13.

### 2.03 TRANSPORT OF EQUIPMENT

A. Contractor shall assume custody of the Authority furnished equipment when they are picked up, loaded and delivered to the project site and shall assume liability for damage to the equipment after they are picked up. Contractor will remain responsible for the Authority's equipment until Substantial Completion of the entire project.

B. All equipment, crates and boxes shall be unloaded, stored and protected by Contractor per manufacturer recommendations and per the requirements of Section 01 66 00.

C. Upon transfer of the Authority furnished equipment to Contractor, the Contractor representative and the Engineer will make a joint inspection of the condition of each

piece of equipment and shall note, in writing, the defects in said equipment. Any damage shall be reported to Supplier to cure. Damage or loss of equipment and materials after the date of their transfer to the Contractor shall be repaired or replaced at the Contractor's expense.

1. Contractor shall protect all equipment from vandalism, falling construction debris, paint sprays and any other construction activity that may damage the equipment.
2. Any damage to the equipment or supplies shall be repaired or replaced as acceptable by the Engineer at no cost to the Authority.

## PART 3 EXECUTION

### 3.01 COORDINATION

A. The following items require detailed coordination between the General Contractor and Supplier for installation:
   1. Selected Instrument Categories
      a. All items being provided by Supplier are shown on their drawings.
      b. All other items shown shall be provided and installed by the Contractor.
   2. Services of Supplier's Representative
      a. The Contractor will provide notice to the Authority to arrange for representatives from the equipment Supplier to be on site for advisory services as needed for installation, commissioning, and testing of the equipment per the requirements set forth in Section 40 61 13.01.
      b. The notice shall be received by the Engineer 14 days prior to the date that the Supplier's representative is required to be on site.
      c. The services of the Supplier's representative will be limited to the equipment supplied under the pre-purchase contract. If additional service in excess of the specified days is required due to the mechanisms not being fully installed and ready for operation at the time of service requested by the Contractor, the additional service days will be reimbursed to the Authority at the Contractor's expense. Reimbursement for labor and expenses shall be in accordance with the terms and rates specified in the Procurement Contract between the Authority and Seller.
   3. Conduits and Wires
      a. Contractor is responsible for power and control conduits and wiring to all Supplier equipment.
      b. The PLC panel provided by Supplier shall be mounted on walls and floors by Contractor per the requirements of Section 26 00 00.
   4. Programming/Testing Controls
      a. After completion of the equipment PLC and instrument installation, and individual component testing, representatives from Supplier will be on site to assist with the overall testing and equipment calibration.



**END OF SECTION**

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

## PART 1 GENERAL

### 1.01 DAMAGE

A. Equipment, products and materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Engineer.

### 1.02 PIPE

A. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes with paint, tape coatings, linings or the like shall be stored to protect the coating or lining from physical damage or other deterioration. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.



## PART 2 EQUIPMENT

### 2.01 PACKAGE AND MARKING:

A. All equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

B. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or subassembled units where possible.

### 2.02 IDENTIFICATION:

A. Each item of equipment and valve shall have permanently affixed to it a label or tag with its equipment or valve number designated in this contract. Marker shall be of stainless steel. Location of label will be easily visible.

### 2.03 SHIPPING:

A. Bearing housings, vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.

B. Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the work. The Contractor shall bear the costs arising out of dismantling, inspection, repair and reassembly.

### 2.04 FACTORY APPLIED COATINGS:

A. Unless otherwise specified, each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied epoxy prime coating as specified in Section 09 90 00 . The prime coating shall be applied over clean dry surfaces in accordance with the coating manufacturer's recommendations. The prime coating will serve as a base for

field-applied finish coats. Electrical equipment and materials shall be painted by manufacturer as specified in Section 09 90 00-3.03 Electrical and Instrumentation Equipment and Materials.

## 2.05 STORAGE:

A. During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Manufacturer's recommendations shall be adhered to in addition to these requirements.

B. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above ground. Temporary power shall be provided to energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

## 2.06 PROTECTION OF EQUIPMENT AFTER INSTALLATION:

A. After installation, all equipment shall be protected from damage from, including but not limited to, dust, abrasive particles, debris and dirt generated by the placement, chipping, sandblasting, cutting, finishing and grinding of new or existing concrete, terrazzo and metal; and from the fumes, particulate matter, and splatter from welding, brazing and painting of new or existing piping and equipment. As a minimum, vacuum cleaning, blowers with filters, protective shieldings, and other dust suppression methods will be required at all times to adequately protect all equipment. During concreting, including finishing, all equipment that may be affected by cement dust must be completely covered. During painting operations, all grease fittings and similar openings shall be covered to prevent the entry of paint. Electrical switchgear, unit substation, and motor load centers shall not be installed until after all concrete work and sandblasting in those areas have been completed and accepted and the ventilation systems installed.



**END OF SECTION**

SECTION 01 73 24

DESIGN REQUIREMENTS FOR
NON-STRUCTURAL COMPONENTS AND NON-BUILDING STRUCTURES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Minimum structural requirements for the design, anchorage, and bracing of non-structural components such as architectural/mechanical/HVAC/electrical components, equipment, or systems, and non-building structures such as tanks.

B. The requirements of this section apply to design of the structural elements and features of equipment and to platforms/walkways that are provided with equipment or non-building structures.

C. This section applies to non-building structures and non-structural components that are permanently attached to structures as defined below and in ASCE 7.

D. Design and conform to criteria and design codes listed within this section. Engineering design is not required for attachments, anchorage, or bracing detailed on the Drawings or where the size of attachments, anchorage, or bracing is defined in specific technical specification sections.

E. The following non-structural components are exempt from seismic design loading requirements of this section.
   1. Components in Seismic Design Category A.
   2. Furniture (except permanent floor supported storage cabinets over 6 ft tall).
   3. Temporary or movable equipment.
   4. Architectural components in Seismic Design Category B other than parapets supported by bearing walls or shear walls provided that the component importance factor, $I_p$, is equal to 1.0.
   5. Mechanical and electrical components in Seismic Design Category B.
   6. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, $I_p$, is equal to 1.0.
   7. Mechanical and electrical components in Seismic Design Categories D, E, or F where all of the following apply:
      a. The component importance factor, $I_p$, is equal to 1.0;
      b. The component is positively attached to the structure;
      c. Flexible connections are provided between the component and associated ductwork, piping, and conduit;
      d. And either:
         1) the component weighs 400 lb or less and has a center of mass located 4 ft or less above the adjacent floor level; or
         2) the component weighs 20 lb or less, or in the case of a distributed systems, 5 lb/ft or less.

## 1.02 RELATED SECTIONS

A. This section contains specific references to the following related section. Additional related sections may apply that are not specifically listed below.
   1. Section 05 05 20 Anchor Bolts

## 1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| Aluminum Design Manual | Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures |
| AAMA | American Architectural Manufacturer's Association |
| ACI 318 | Building Code Requirements for Structural Concrete |
| ACI 350 | Code Requirements for Environmental Engineering Concrete Structures |
| ACI 350.3 | Seismic Design of Liquid-Containing Concrete Structures |
| AISC 341 | Seismic Provisions for Structural Steel Buildings |
| ACI 360 | Specification for Structural Steel Buildings |
| ASCE 7 | Minimum Design Loads for Buildings and Other Structures |
| ASTM C635 | Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings |
| ASTM C636 | Installation for Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings |
| AWS D1.1 | Structural Welding Code – Steel |
| AWS D1.2 | Structural Welding Code - Aluminum |
| AWS D1.6 | Structural Welding Code – Stainless Steel |
| AWS D1.8 | Structural Welding Code – Seismic Supplement |
| CONN-OSHA | CT Occupational Safety and Health |
| IBC | International Building Code with local amendments |
| NFPA-13 | Installation of Sprinkler Systems |
| OSHA | U.S. Dept. of Labor, Occupational Safety and Health Administration |
| SMACNA | Seismic Restraint Manual Guidelines for Mechanical Systems |



## 1.04 DEFINITIONS

A. Structure: The structural elements of a building that resist gravity, seismic, wind, and other types of loads. Structural components include columns, posts, beams, girders, joists, bracing, floor or roof sheathing, slabs or decking, load-bearing walls, and foundations.

B. Non-structural Components: Non-structural portions of a building include every part of the building and all its contents, except the structural portions, that carry gravity loads and that may also be required to resist effects of wind, snow, impact, temperature and seismic loads. Non-structural components include, but are not limited to, ceilings, partitions, windows, equipment, piping, ductwork, furnishings, lights, etc.

C. Non-building Structures: Self-supporting structures that carry gravity loads and that may also be required to resist the effects of wind, snow, impact, temperature and seismic loads. Non-building structures include, but are not limited to, pipe racks, storage racks, stacks, tanks, vessels and structural towers that support tanks and vessels.

## 1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
   4. For structural elements of non-structural components and non-building structures required to be designed per this section, provide drawings and design calculations stamped by a Connecticut licensed professional engineer qualified to perform structural engineering.
   5. List of non-structural components and non-building structures requiring wind and seismic design and anchorage.
   6. Shop drawings showing details of complete wind and seismic bracing and anchorage attachment assemblies including connection hardware, and embedment into concrete.
   7. Shop drawings showing plans, elevations, sections and details of equipment support structures and non-building structures, including anchor bolts, structural members, platforms, stairs, ladders, and related attachments.
   8. Identify interface points with supporting structures or foundations, as well as size, location, and grip of required attachments and anchor bolts. Clearly indicate who will be providing each type of attachment/anchor bolt. Equipment vendor shall design anchor bolts, including embedment into concrete, and submit stamped calculations.
   9. Calculations for supports, bracing, and attachments shall clearly indicate design criteria applied. Coordinate concrete embedment calculations with thickness and strength of concrete members. Submit a tabulation of the magnitude of unfactored (service level) equipment loads at each support point, broken down by type of loading (dead, live, wind, seismic, etc.). Indicate impact factors applied to these loads in design calculations.

## 1.06 QUALITY ASSURANCE

A. Quality Control By Authority:
   1. Special Inspection of non-structural components and non-building structures, and their anchorages shall be performed by the Special Inspector under contract with the Authority and in conformance with IBC Chapter 17. Special Inspector(s) and

laboratory shall be acceptable to the Authority in their sole discretion. Special Inspection is in addition to, but not replacing, other inspections and quality control requirements. Where sampling and testing required conforms to Special Inspection standards, such sampling and testing need not be duplicated.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Provide materials in conformance with information shown on the Drawings and in other technical specification sections. See individual component and equipment specifications for additional requirements.

### 2.02 DESIGN CRITERIA

A. Design Codes

| Design | Code |
|---|---|
| Buildings/Structures: | International Building Code 2018 and ASCE 7-16 |
| Reinforced concrete: | ACI 350-06 and ACI 350.3-06 for Concrete Liquid Containing Structures, ACI 318-14 for all other reinforced concrete |
| Structural steel: | AISC 360-10 and AISC 341-10 |
| Aluminum: | Aluminum Design Manual, Latest Edition |
| Welding: | AWS Welding Codes, Latest Edition |
| Occupational health and safety requirements: | OSHA and CONN-OSHA |

*Note: When conflicting requirements occur, the most stringent requirements will govern the design.*



B. Design Loads

1. Design non-structural components and non-building structures for the following minimum loads: (Do not apply wind and snow loads to non-structural components and non-building structures that are located inside buildings.)
2. Dead Loads:
   a. Add an additional allowance for piping and conduit when supported and hung from the underside of equipment and platforms.
   b. Typical allowance for piping and conduit: 20 psf
3. Uniform Live Loads:

| | |
|---|---|
| Elevated grating floors: | 100 psf |
| Columns: | No column live load reduction allowed |
| Exitways, stairs and landings: | 100 psf |
| Equipment platforms, walkways/catwalks (other than exitways): | 60 psf |
| Utility bridges: | 75 psf per level |

4. Snow Loads:

| | |
|---|---|
| Code: | IBC 2018 & ASCE 7 |
| Risk Category: | III (Wastewater Treatment facilities are Risk Category III) |
| Ground Snow Load ($p_g$): | 30 psf |
| Exposure Factor ($C_e$): | C |
| Thermal Factor ($C_t$): | 1.0 |
| Importance Factor ($I_s$): | 1.1 |
| Flat Roof Snow Load ($p_f$): | 27.7 psf |
| Drifting: | Per ASCE 7 |

5. Wind Loads:

| | |
|---|---|
| Code: | IBC 2018 & ASCE 7-10 |
| Risk Category: | III (Wastewater Treatment Facilities are Risk Category III) |
| Basic Wind Speed (Ultimate, 3-second gust) for Risk Category Shown Above: | 130 mph |
| Exposure: | C |
| Topographic Factor ($K_{zt}$) | 1.0 |

*Note:*

1. *Design exterior non-strutural components and non-building structures, unless located in a pit or basin, to withstand design wind loads without consideration of shielding effects by other structures.*

6. Seismic Loads:

| | |
|---|---|
| Code: | IBC 2018 & ASCE 7-10 |
| Risk Category: | III (Wastewater Treatment Facilities are Risk Category III) |
| 0.2 Sec. Mapped Spectral Response, $S_S$: | 0.201 g |
| 1.0 Sec. Mapped Spectral Response, $S_1$: | 0.054 g |
| Site Class: | D |
| 0.2 Sec. Design Spectral Response, $S_{DS}$: | 0.214 g |
| 1.0 Sec. Design Spectral Response, $S_{D1}$: | 0.086 g |
| Importance Factor ($I_e$): | 1.25 |
| Component Importance Factor ($I_p$): | 1.0, except $I_p$=1.5 for components identified in Section 13.1.3 of ASCE 7 |
| Seismic Design Category | D |

*Notes:*

1. *Calculate seismic loads on the basis of governing building code. Include equipment operating loads in structure dead load.*
2. *Check individual members for seismic and full member live load acting simultaneously, except that flooded equipment loads (infrequent occurrence) need not be combined with seismic loads. Combine equipment operating loads with seismic loads.*

7. Impact Loads:
    a. Consider impact loads in design of support systems.
    b. Use the following impact load factors unless recommendations of the equipment manufacturer will cause a more severe load case:

| | |
|---|---|
| Rotating machinery: | 20% of moving load |
| Reciprocating machinery: | 50% of moving load |
| Monorail Hoists: | |
| • Vertical | 25% of lifted load |
| • Longitudinal | 10% of lifted load |
| Hangers supporting floors and platforms: | 33% of live and dead load |

8. Temperature:
    a. Include effects of temperature in design where non-structural components and non-building structures are exposed to differential climatic conditions. See climatic conditions below for temperature extremes.

C. Load Combinations
    1. Design non-structural components and non-building structures to withstand load combinations as specified in the governing building code. Where the exclusion of live load or impact load would cause a more severe load condition for the member under investigation, ignore the load when evaluating that member.

D. Design Considerations
    1. Design non-structural components and non-building structures for the following conditions:
    2. Climatic Conditions:

| | | |
|---|---|---|
| Maximum design temperature: | 90 | degrees Fahrenheit |
| Minimum design temperature: | 15 | degrees Fahrenheit |

    3. Foundations:
        a. Extend foundations supporting non-structural components and non-building structures below the frost line, or support on non-frost susceptible structural fill down to the frost line.

| | |
|---|---|
| Frost line for foundations: | 48 inches |

*Note: Consult project geotechnical report for allowable soil bearing recommendations at location of structure.*

E. Column Base Fixity
    1. Design column bases as pinned connections. No moments shall be assumed to be transferred to foundations.
    2. Where significant shear loads (greater than 5,000 lb. per anchor bolt) are transferred at column base plates, provide a shear key designed to transfer shear load.

F. Deflection
   1. Maximum beam deflection as a fraction of span for walkways and platforms: L/240 for total load and L/360 for live load.
   2. Maximum total load deflection for equipment support: L/450.

## PART 3 EXECUTION

### 3.01 GENERAL

A. Make attachments and braces in such a manner that component force is transferred to the lateral force-resisting system of the structure. Base attachment requirements and size and number of braces per calculations submitted by Contractor.

B. Anchorage of equipment is specified to be made by cast-in anchor bolts in concrete elements unless specifically noted otherwise on the Drawings or other specification sections. Contractor is responsible for remedial work or strengthening (of concrete elements because of superimposed seismic loading) if anchor bolts are improperly installed or omitted due to lack of submittal review or improper placement for any reason, at no additional cost to Authroity.

C. Provide anchor bolts in accordance with Section 05 05 20. Base size of anchor bolts and embedment on submitted calculations.

D. Submit details of and calculations for anchorages prior to placement of concrete or erection of other structural supporting members. Submittals received after structural supports are in place will be rejected if proposed anchorage method would create an overstressed condition of the supporting member. Contractor is responsible for revisions to anchorages and/or strengthening of structural support so that there is no overstress condition, at no additional cost to Authroity.



**END OF SECTION**

SECTION 01 73 29

CUTTING AND PATCHING

## PART 1 GENERAL

### 1.01 STRUCTURES

A. The Contractor shall take all precautions necessary to protect the integrity and usefulness of all existing plant facilities. If necessary, the Contractor may, with the approval of the Authority, remove such existing structures, including curbs, gutters, pipelines and utility poles as may be necessary for the performance of the work, and shall rebuild the structures thus removed in as good a condition as found with the requirements specified. He shall also repair existing structures which may be damaged as a result of the work under this contract.

### 1.02 ROADS AND STREETS

A. Unless otherwise specified, roads and streets in which the surface is removed, broken, or damaged, or in which the ground has caved or settled during the work under this contract, shall be resurfaced and brought to the original grade and section. Roadways used by the Contractor shall be cleaned and repaired. Before resurfacing material is placed, edges of pavements shall be trimmed back far enough to provide clean, solid, vertical faces, and shall be free of loose material. All paved surfaces shall be cut with a pavement saw. Rough cuts are not allowed. Repair work shall conform to the paving specifications.



### 1.03 CULTIVATED AREAS AND OTHER SURFACE IMPROVEMENTS

A. Cultivated or planted areas and other surface improvements which are damaged by actions of the Contractor shall be restored as nearly as possible to their original condition. Restoration shall take place within 1 week or sooner as directed by the Engineer.

B. Existing guard posts, barricades, and fences shall be protected and replaced if damaged.

### 1.04 PROTECTION OF EXISTING INSTALLATIONS

A. The Contractor shall protect all existing operating facilities and structures from damages. However, if damage occurs, the Contractor shall immediately correct or replace existing equipment, controls, systems, structures, or facilities which are damaged in any way as a result of his operations.

**END OF SECTION**

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

## PART 1 GENERAL

### 1.01 SCOPE

A. Operation and maintenance (O&M) instructions shall be provided in accordance with this section and as required in the technical sections of this project manual. O&M information shall be provided for each maintainable piece of equipment, equipment assembly or subassembly, and material provided or modified under this contract.

B. O&M instructions must be submitted and accepted before on-site training may start.

### 1.02 TYPES OF INFORMATION REQUIRED

A. General:

1. O&M information shall contain the names, addresses, and telephone numbers of the manufacturer, the nearest representative of the manufacturer, and the nearest supplier of the manufacturer's equipment and parts. In addition, one or more of the following items of information shall be provided as applicable.

B. Operating Instructions:

1. Specific instructions, procedures, and illustrations shall be provided for the following phases of operations:
   a. Safety Precautions: List personnel hazards for equipment and list safety precautions for all operating conditions.
   b. Operator Prestart: Provide requirements to set up and prepare each system for use.
   c. Start-Up, Shutdown, And Postshutdown Procedures: Provide a control sequence for each of these operations.
   d. Normal Operations: Provide control diagrams with data to explain operation and control of systems and specific equipment.
   e. Emergency Operations: Provide emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
   f. Operator Service Requirements: Provide instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.
   g. Environmental Conditions: Provide a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

C. Preventive Maintenance:

1. The following information shall be provided for preventive and scheduled maintenance to minimize corrective maintenance and repair:

a. Lubrication Data: Provide lubrication data, other than instructions for lubrication in accordance with paragraph 1.02 Operator Service Requirements.

1) A table showing recommended lubricants for specific temperature ranges and applications;

2) Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities; and

3) A lubrication schedule showing service interval frequency.

b. Preventive Maintenance Plan And Schedule: Provide manufacturer's schedule for routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft.

D. Corrective Maintenance:

1. Manufacturer's recommendations shall be provided on procedures and instructions for correcting problems and making repairs.

a. Troubleshooting Guides And Diagnostic Techniques: Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

b. Wiring Diagrams And Control Diagrams: Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job-specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type identically to actual installation numbering.

c. Maintenance And Repair Procedures: Provide instructions and list tools required to restore product or equipment to proper condition or operating standards.

d. Removal And Replacement Instructions: Provide step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required. Instructions shall include a combination of test and illustrations.

e. Spare Parts And Supply Lists: Provide lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonably delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead time to obtain.

f. Corrective Maintenance Manhours: Provide manufacturer's projection of corrective maintenance man-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

E. Appendices:

1. The following information shall be provided; include information not specified in the preceding paragraphs but pertinent to the maintenance or operation of the product or equipment.

a. Parts Identification: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

b. Warranty Information: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

c. Personnel Training Requirements: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

d. Testing Equipment And Special Tool Information: Provide information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.



## 1.03 TRANSMITTAL PROCEDURE

A. Unless otherwise specified, O&M manuals, information, and data shall be transmitted in accordance with Section 01 33 00 accompanied by Transmittal Form 01 78 23-A and Equipment Record Forms 01 78 23-B and/or 01 78 23-C, as appropriate, all as specified in Section 01 89 90. The transmittal form shall be used as a checklist to ensure the manual is complete. Only complete sets of O&M instructions will be reviewed for acceptance.

B. Two hard copies and one electronic copy of the specified O&M information shall be provided. For ease of identification, each manufacturer's brochure and manual shall be appropriately labeled with the equipment name and equipment number as it appears in the project manual. The information shall be organized in the binders in numerical order by the equipment numbers assigned in the project manual. The binders shall be provided with a table of contents and tab sheets to permit easy location of desired information.

C. If manufacturers' standard brochures and manuals are used to describe O&M procedures, such brochures and manuals shall be modified to reflect only the model or series of equipment used on this project. Extraneous material shall be crossed out neatly or otherwise annotated or eliminated.

## 1.04 FIELD CHANGES

A. Following the acceptable installation and operation of an equipment item, the item's instructions and procedures shall be modified and supplemented by the Contractor to reflect any field changes or information requiring field data.

**END OF SECTION**

SECTION 01 78 25
ASSET MANAGEMENT INFORMATION

## PART 1 GENERAL

### 1.01 DEFINITIONS

A. Preliminary Asset Summary Information: Initial and subsequent submissions for Engineer's review.

B. Final Asset Summary Information: Engineer-accepted data, submitted as specified herein.

C. Preliminary Maintenance Summary Information: Initial and subsequent submissions for Engineer's review.

D. Final Maintenance Summary Information: Engineer-accepted data, submitted as specified herein.

E. Maintenance Tasks: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.



### 1.02 SEQUENCING AND SCHEDULING

A. Asset Data:
   1. Preliminary Asset Summary Information: Submit no later than 30 days after equipment installation. Preliminary Asset Summary Information requires approval by the Engineer prior to manufacturer's startup.
   2. Final Asset Summary Information: Submit no later than 30 days after manufacturer startup.

B. Maintenance Data:
   1. Preliminary Maintenance Summary Information: Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer. Preliminary Maintenance Summary Information requires approval by the Engineer prior to manufacturer's startup.
   2. Final Maintenance Summary Information: Submit no later than 30 days after manufacturer startup.

### 1.03 SUBMITTALS

A. All information submitted to the Engineer for review shall be prepared by the manufacturer/ manufacturer's representative and Contractor as indicated on the forms and submitted in accordance with Section 01 33 00.

B. Prepare Preliminary Information:
   1. Submit completed Asset Summary Form and Maintenance Summary Form in an electronic format.
      a. See Attachments A & B for examples.

2. Submit attachments in an electronic format.

C. Prepare Final Information in a Compilation Format:
   1. Compile all Engineer-accepted preliminary Asset Summary Information and Maintenance Information into separate hard-copy, hard-bound sets, with USB for electronic files.
   2. Each set shall consist of the following:
      a. Engineer approved Asset Summary Form, hardcopy and Excel file format
      b. Engineer approved Maintenance Summary Form, hardcopy and Excel file format
      c. Attachments
         1) Engineer approved Startup Report
         2) Engineer approved O&M Manual, PDF format divided into files not to exceed 50 mb.
         3) Digital Photograph of Installed Asset not to exceed 1 mb.

## 1.04 DATA FOR EQUIPMENT AND SYSTEMS

A. Asset Summary Forms:
   1. Compile individual Asset Summary Forms for each applicable equipment item, respective unit or system, and for components or sub-units.
   2. Format:
      a. An electronic copy of the Asset Summary Form can be provided by the Engineer upon request.
      b. Each Asset Summary Form may take as many pages as required.
      c. Use only 8-1/2-inch by 11-inch size pages.
      d. All files submitted to the Engineer shall be in Excel and/or PDF Format. Files submitted shall be fully functional and viewable in most recent version of Adobe Acrobat. No handwritten forms will be accepted.
   3. Required Information
      a. All relevant fields on the Asset Summary Form are to be filled out in their entirety before submission to the engineer for review. Incomplete forms will not be accepted by the engineer.
      b. Information fields on the form that are not relevant to the installed equipment are to be entered with “Not Applicable”.
      c. Engineer holds the right to determine information relevance or to request additional information based on equipment/asset type.

B. Maintenance Summary Forms:
   1. Compile individual Maintenance Summary Forms for each applicable equipment item, respective unit or system, and for components or sub-units.
   2. Format:
      a. An electronic copy of the Maintenance Summary Form can be provided by the Engineer upon request.
      b. Each Maintenance Summary may take as many pages as required.
      c. Use only 8-1/2-inch by 11-inch size pages.

d. All files submitted to the Engineer shall be in PDF Format. Files submitted shall be fully functional and viewable in most recent version of Adobe Acrobat. No handwritten forms will be accepted.

3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
   a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.

## 1.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are part of this Specification.
   1. Forms: Asset Summary Form, Maintenance Summary Form.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION (NOT USED)

END OF SECTION

# ASSET SUMMARY FORM

**For Completion by Manufacturer's Representative:**

**Owner Name:** GNHWPCA **Project Number/Name:** _____

**Facility Site:** _____ **Shown on Plan Sheet:** _____

**General:**

Description: _____ Tag #: _____

Type: _____

Area: _____

Building/Room: _____

Vendor: _____ Website: _____

Manufacturer: _____ Website: _____

Model #: _____ Serial #: _____ Mfg Job #: _____
if serial # is unavailable

Install Date: _____ Purchase Date: _____

Start-up Date: _____ Warranty End Date: _____

Budgetary Value of Equipment (FOB Site): $ _____



**Specification(s):**

| Pump Size/Size | Pump Flow | Pump Head | Pump Media |
|---|---|---|---|
| | | | |

| HP | Frame | RPM | Voltage |
|---|---|---|---|
| | | | |

**Component(s):**

| | | Specifications (if applicable) | | | |
|---|---|---|---|---|---|
| ID | Component Name - Mfg. | HP | Frame | RPM | Voltage |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

# ASSET SUMMARY FORM cont.

**For Completion by Contract Holder:**

Installed Cost: $ _____

**Attachment(s):**

| ID | Attachment Name |
|---|---|
| 1 | |
| 2 | |
| 3 | |

**Existing Asset(s):**

If replacing existing asset, record the tag and descripition of each existing asset:

| Tag | Description |
|---|---|
| | |
| | |
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| | |



**Contact Information:**

General Contr.: _____ Email: _____

Phone: _____

Design Engineer: _____ Email: _____

Phone: _____

Sub-Contractor: _____ Email: _____

Phone: _____

**For Owner Use Only:**

Representative: _____ CMMS Upload Date: _____

CMMS Asset ID: _____

**For Completion by Manufacturer's Representative:**

# MAINTENANCE SUMMARY FORM

Manufacturer's Local Rep: _____

Name: _____

Address: _____

Telephone: _____

Weight of Individual Components (Over 100 Pounds): _____

**Maintenance Requirements:**

| Maintenance Task | Frequency | Lubricants |
|---|---|---|
| List each maintenance operation required and refer to specific information in the manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.) | List required frequency of each maintenance operation | Refer by symbol to lubricant required. |
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# MAINTENANCE SUMMARY FORM cont.

**Lubricant List:**

| Reference Symbol | Shell | Exxon Mobile | Chevron Texaco | BP Amoco | Or Equal |
|---|---|---|---|---|---|
| List symbols used in No. 7 above. | List equivalent lubricants, as distributed by each manufacturer for the specific use recommended. | | | | |
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**Recommended Spare Parts for Owners Inventory:**

| Part No. | Description | Unit | Qty | Unit Cost | **Stored Location** |
|---|---|---|---|---|---|
| | | | | | |
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Note: Identify parts provided by this Contract with two asterisks.
**Stored Location is recorded by Owner**

**RECOMMENDED OUTSIDE SERVICE ACTIVITIES**

| Maintenance Task | Frequency | Authorized Vendor(s) |
|---|---|---|
| List each maintenance operation to be performed by an Authorized Vendor | List required frequency of each maintenance operation | Provide Authorized Vendor and Contact Information. |
| | | |
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# ASSET SUMMARY FORM - EXAMPLE 1 - ATTACHMENT A

**For Completion by Manufacturer's Representative:**

**Owner Name:** GNHWPCA **Project Number/Name:** CWF2010-01
**Facility Site:** ESWPAF **Shown on Plan Sheet:** 80-D-202

**General:**

Description: Return Activiated Sludge Pump 6 Tag #: P-32-1-06

Type: Centrifugal Pump Horizontal

Area: North Basement

Building/Room: Facility 52 Activated Sludge Pump Station

Vendor: Website:

Manufacturer: Website:

Model #: K250-400/G-3-F Serial #: 315707 Mfg Job #:
if serial # is unavailable

Install Date: 1/1/2016 Purchase Date: 12/1/2014

Start-up Date: 3/5/2016 Warranty End Date: 3/5/2017

Budgetary Value of Equipment: $15,000



**Specification(s):**

| Pump Size/Size | Pump Flow | Pump Head | Pump Media |
|---|---|---|---|
| 10" X 10" | 3475 gpm | 40 | RAS |

| HP | Frame | RPM | Voltage |
|---|---|---|---|
| 50 | | 1180 | 460 |

| | **Component(s):** | Specifications (if applicable) | | | |
|---|---|---|---|---|---|
| ID | Component Name | HP | Frame | RPM | Voltage |
| 1 | Horizontal Motor - WEG | 50 | 365T | 1180 | 460 |
| 2 | Coupling Drive | | | | |
| 3 | Check Valve - Surge Buster | | | | |
| 4 | Discharge Plug Valve - Milliken | | | | |
| 5 | Suction Plug Valve - Milliken | | | | |

# ASSET SUMMARY FORM cont.

**For Completion by Contract Holder:**

Installed Cost: $30,000

**Attachment(s):**

| ID | Attachment Name |
|---|---|
| 1 | RAS Pump O&M Manual |
| 2 | Electronic Photo - Pump 6 |
| 3 | Start up/COPI |

**Existing Asset(s):**

If replacing existing asset, record the tag and descripition of each existing asset:

| Tag | Description |
|---|---|
| Ex29765 | Centrifugal Pump Horizontal |
| | |
| | |
| | |
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**Contact Information:**

General Contr.: _____ Email: _____

Phone: _____

Design Engineer: _____ Email: _____

Phone: _____

Sub-Contractor: _____ Email: _____

Phone: _____

**For Owner Use Only:**

Representative: _____ CMMS Upload Date: _____

CMMS Asset ID: _____

# ASSET SUMMARY FORM - EXAMPLE 2 - ATTACHMENT B

**For Completion by Manufacturer's Representative:**

**Owner Name:** GNHWPCA **Project Number/Name:** CWF2010-01
**Facility Site:** ESWPAF **Shown on Plan Sheet:** 80-D-202

**General:**

Description: Air Flow Control Valve Tag #: FCV-21-4 - 1

Type: Flow Control Valve

Area: BRB Basin 1 - Zone 3

Building/Room: Facility 50 - BRB Basins

Vendor: Website:

Manufacturer: Website:

Model #: Series 400 Serial #: AH145900 Mfg Job #:
if serial # is unavailable

Install Date: 7/27/2015 Purchase Date: 5/27/2015

Start-up Date: 7/27/2015 Warranty End Date: 7/27/2016

Budgetary Value of Equipment: $5,000



**Specification(s):**

| Pump Size/Size | Pump Flow | Pump Head | Pump Media |
|---|---|---|---|
| 6" | | | |

| HP | Frame | RPM | Voltage |
|---|---|---|---|
| | | | |

**Component(s):**

| | | Specifications (if applicable) | | | |
|---|---|---|---|---|---|
| ID | Component Name | HP | Frame | RPM | Voltage |
| 1 | Electric Valve Actuator - GNH | | | | 460 |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

# ASSET SUMMARY FORM cont.

**For Completion by Contract Holder:**

Installed Cost: $7,500

**Attachment(s):**

| ID | Attachment Name |
|---|---|
| 1 | Valve O&M Manual |
| 2 | Electronic Photo - ABZ Valve |
| 3 | Start up/COPI |

**Existing Asset(s):**

If replacing existing asset, record the tag and descripition of each existing asset:

| Tag | Description |
|---|---|
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**Contact Information:**

General Contr.: _____ Email: _____

Phone: _____

Design Engineer: _____ Email: _____

Phone: _____

Sub-Contractor: _____ Email: _____

Phone: _____

**For Owner Use Only:**

Representative: _____ CMMS Upload Date: _____

CMMS Asset ID: _____

**For Completion by Manufacturer's Representative:**

# MAINTENANCE SUMMARY FORM - Example 1 - ATTACHMENT A

Manufacturer's Local Rep: Rodnev Co.

Name: John Daley

Address: 345 Main St. New Haven, CT 06511

Telephone: 203-555-5555

Weight of Individual Components (Over 100 Pounds): 2850 lbs

**Maintenance Requirements:**

| Maintenance Task | Frequency | Lubricants |
|---|---|---|
| List each maintenance operation required and refer to specific information in the manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.) | List required frequency of each maintenance operation | Refer by symbol to lubricant required. |
| Inspect Coupling Rubber inserts for wear | 1/yr | NA |
| Grease Motor Bearings | 1-2 years or 15,000 hrs | mobil polyrex em |
| Change seal oil | 1-2 years or 10,000 hrs | Vegetable oil or any SAE 30 non detergent oil |
| | | |
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# MAINTENANCE SUMMARY FORM cont.

**Lubricant List:**

| Reference Symbol | Shell | Exxon Mobile | Chevron Texaco | BP Amoco | Or Equal |
|---|---|---|---|---|---|
| List symbols used in No. 7 above. | List equivalent lubricants, as distributed by each manufacturer for the specific use recommended. | | | | |
| Bearing Grease | | Mobile Polyrex EM | | | |
| Seal Oil | | | | | Vegetable |
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**Recommended Spare Parts for Owner's Inventory:**

| Part No. | Description | Unit | Qty | Unit Cost | **Stored Location** |
|---|---|---|---|---|---|
| **433.01 | Inner Seal | | 2 | | |
| 433.02 | Outer Seal | | 2 | | |
| 502 | Case Wear Ring | | 2 | | |
| 932,01-4 | Circlip | 4 | 2 | | |
| 421.01,421.02 | Lip Seals | 2 | 2 | | |
| 411 | Oring Kit | | 4 | | |

Note: Identify parts provided by this Contract with two asterisks.
**Stored Location is recorded by Owner**

**RECOMMENDED OUTSIDE SERVICE ACTIVITIES**

| Maintenance Task | Frequency | Authorized Vendor(s) |
|---|---|---|
| List each maintenance operation to be performed by an Authorized Vendor | List required frequency of each maintenance operation | Provide Authorized Vendor and Contact Information. |
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**For Completion by Manufacturer's Representative:**

# MAINTENANCE SUMMARY FORM - Example 2 - ATTACHMENT B

Manufacturer's Local Rep: Rodnev Co.

Name: John Daley

Address: 345 Main St. New Haven, CT 06511

Telephone: 203-555-5555

Weight of Individual Components (Over 100 Pounds): N/A

**Maintenance Requirements:**

| Maintenance Task | Frequency | Lubricants |
|---|---|---|
| List each maintenance operation required and refer to specific information in the manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.) | List required frequency of each maintenance operation | Refer by symbol to lubricant required. |
| Verify position feed back to actual valve position | 1/yr | NA |
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# MAINTENANCE SUMMARY FORM cont.

**Lubricant List:**

| Reference Symbol | Shell | Exxon Mobile | Chevron Texaco | BP Amoco | Or Equal |
|---|---|---|---|---|---|
| List symbols used in No. 7 above. | List equivalent lubricants, as distributed by each manufacturer for the specific use recommended. | | | | |
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**Recommended Spare Parts for Owners Inventory:**

| Part No. | Description | Unit | Qty | **Stored Location** |
|---|---|---|---|---|
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Note: Identify parts provided by this Contract with two asterisks.
**Stored Location is recorded by Owner**

**RECOMMENDED OUTSIDE SERVICE ACTIVITIES**

| Maintenance Task | Frequency | Authorized Vendor(s) |
|---|---|---|
| List each maintenance operation to be performed by an Authorized Vendor | List required frequency of each maintenance | Provide Authorized Vendor and Contact |
| | | |
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ASSET SUMMARY FORM

**Owner Name:** _____ **Project Number/Name:** _____

**Facility Name:** _____

General Contractor: _____ Email: _____ Phone: _____

Design Engineer: _____ Email: _____ Phone: _____

Sub-Contractor: _____ Email: _____ Phone: _____

| Tag # | Description | Type | Area | Building/Room | Vendor | Website | Manufacturer | Website | Model # | Serial # | Mfr Job # | Install Date | Start-up Date | Purchase Date | Pump Size | Pump Flow | Pump Head | Pump Media | HP | Frame | RPM | Voltage | Component(s) | HP | Frame | RPM | Voltage | Existing Asset(s) | Attachment(s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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**For Owner Use Only:**

Representative: _____ CMMS Upload Date: _____

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

## PART 1 GENERAL

### 1.01 DRAWINGS

A. Record Documents refer to those documents maintained and annotated by the Contractor during construction and are defined as:
   1. A neatly and legibly marked set of Contract Drawings showing the final location of piping, appurtenances, equipment, electrical conduits, outlet boxes and cables;
   2. Additional documents such as schedules, lists, drawings, electrical and instrumentation diagrams included in the specifications;
   3. Contractor layout and installation drawings such as loop drawings, single line diagrams, control schematics/elementary diagrams, control panel drawings, and wiring drawings; and

B. Unless otherwise specified, record drawings shall be full size.

### 1.02 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.

## PART 2 PRODUCTS – NOT USED

## PART 3 EXECUTION

### 3.01 USE DURING CONSTRUCTION

A. Record Documents shall be maintained in a clean, dry, and legible condition.

B. Record Documents shall not be used for construction purposes and shall be available for review by the Engineer during normal working hours at the Contractor's field office.



### 3.02 UPDATES

A. Marking of the Record Documents shall be kept current and shall be done at the time the material and equipment are installed.

B. Annotations to the Record Documents shall be made with an erasable colored pencil conforming to the following color code:
   1. Additions – Red
   2. Deletions – Green
   3. Comments – Blue
   4. Dimensions – Graphite*

   **Legibly mark to record actual depths, horizontal and vertical location of underground raceways, cables, and appurtenances referenced to permanent surface improvements.*

C. Monthly Review Meetings:
   1. During the monthly project meetings, the Contractor and Engineer shall review the record documents.
   2. At that time the Contractor and Engineer shall review the working set of record drawings and initial the accepted areas where everyone has agreed that the location, elevation and/or other construction modification is at the indicated final location.
   3. At the conclusion of each meeting, the Contractor shall submit the up-to-date Record Drawings to the Engineer.

D. Underground Utilities:
   1. Contractor shall provide digital photographs of underground piping and conduits, a fixed measurement on the record drawings, and/or GPS coordinates showing locations from buildings or structures prior to burying piping or electrical conduit.
   2. Contractor shall note the depth of buried piping and electrical conduit.

## 3.03 SUBMISSION

A. At the completion of the work, prior to final payment, all record drawings shall be submitted to the Engineer.

B. The electrical and instrumentation record drawings are typically the last mark ups to be completed. Final payment shall be withheld until the Contractor and Engineer have reviewed, verified and agreed on the final electrical and instrumentation record drawings.

**END OF SECTION**

SECTION 01 79 00

DEMONSTRATION AND TRAINING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section contains requirements for training the Authority's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this contract.

### 1.02 QUALITY ASSURANCE

A. Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Authority's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

### 1.03 SUBMITTALS

A. The following information shall be submitted to the Engineer in accordance with the provisions of Section 01 33 00. The material shall be reviewed and accepted by the Engineer as a condition precedent to receiving progress payments in excess of 50 percent of the contract amount and not less than 3 weeks prior to the provision of training.
   1. Lessons plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
   2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

B. Following the training session the Manufacturer shall provide the Video Recording in MP4 format on a hard drive. The hard drive shall be labeled with the training session, specification number and title, training date, and the project title.



## PART 2 PRODUCTS

### 2.01 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the Authority's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session.

### 2.02 LOCATION

A. Training sessions shall take place at the East Shore WPAF.

## 2.03 LESSON PLANS

A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

B. One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Authority and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish 10 copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

## 2.04 FORMAT AND CONTENT

A. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:
   1. Familiarization
      a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
      b. Check out the installation of the specific equipment items.
      c. Demonstrate the unit and indicate how all parts of the specifications are met.
      d. Answer questions.
   2. Safety
      a. Using material previously provided, review safety references.
      b. Discuss proper precautions around equipment.
   3. Operation
      a. Using material previously provided, review reference literature.
      b. Explain all modes of operation (including emergency).
      c. Check out Authority's personnel on proper use of the equipment.
   4. Preventive Maintenance
      a. Using material previously provided, review preventive maintenance (PM) lists including:
         1) Reference material.
         2) Daily, weekly, monthly, quarterly, semiannual, and annual jobs.
      b. Show how to perform PM jobs.
      c. Show Authority's personnel what to look for as indicators of equipment problems.
   5. Corrective Maintenance
      a. List possible problems.
      b. Discuss repairs--point out special problems.
      c. Open up equipment and demonstrate procedures, where practical.
   6. Parts
      a. Show how to use previously provided parts list and order parts.
      b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives
    a. Where to order parts: name, address, telephone.
    b. Service problems:
        1) Who to call.
        2) How to get emergency help.
8. Operation and Maintenance Manuals
    a. Review any other material submitted.
    b. Update material, as required.

## 2.05 VIDEO RECORDING:

A. The Manufacturers will provide video documentation to record each training session. Video recording shall be performed by a qualified, professional video production company, Contractor shall submit qualificiations of video production company for approval.

# PART 3 EXECUTION

## 3.01 SUMMARY

A. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Provide two sessions of each training module to accommodate multiple shifts of the Authority's personnel. Training sessions shall start at different times. Training shall be certified on Form 43 05 11-B specified in Section 01 99 90.

B. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Authority prior to the start of any training. Video taping shall take place concurrently with all training sessions.

C. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.
    1. As a minimum classroom equipment training for operations personnel will include:
        a. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
        b. Purpose and plant function of the equipment.
        c. A working knowledge of the operating theory of the equipment.
        d. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
        e. Identify and discuss safety items and procedures.
        f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
        g. Operator detection, without test instruments, of specific equipment trouble symptoms.

h. Required equipment exercise procedures and intervals.
i. Routine disassembly and assembly of equipment if applicable (as judged by the Authority on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:
   a. Identify location of equipment and review the purpose.
   b. Identifying piping and flow options.
   c. Identifying valves and their purpose.
   d. Identifying instrumentation:
      1) Location of primary element.
      2) Location of instrument readout.
      3) Discuss purpose, basic operation, and information interpretation.
   e. Discuss, demonstrate, and perform standard operating procedures and round checks.
   f. Discuss and perform the preventative maintenance activities.
   g. Discuss and perform start-up and shutdown procedures.
   h. Perform the required equipment exercise procedures.
   i. Perform routine disassembly and assembly of equipment if applicable.
   j. Identify and review safety items and perform safety procedures, if feasible.
3. Classroom equipment training for the maintenance and repair personnel will include:
   a. Theory of operation.
   b. Description and function of equipment.
   c. Start-up and shutdown procedures.
   d. Normal and major repair procedures.
   e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
   f. Routine and long term calibration procedures.
   g. Safety procedures.
   h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.
4. Hands-on equipment training for maintenance and repair personnel shall include:
   a. Locate and identify equipment components.
   b. Review the equipment function and theory of operation.
   c. Review normal repair procedures.
   d. Perform start-up and shutdown procedures.
   e. Review and perform the safety procedures.
   f. Perform Authority approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

**END OF SECTION**

SECTION 01 91 00

COMMISSIONING, TESTING, AND START-UP

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section establishes the Contractor's responsibilities for developing and conducting the complete commissioning, including testing and startup, of all equipment, systems, and facilities (new or existing) which are defined within the Contract Documents. This effort and the associated experience requirements are significant and critical to a safe and successful startup that meets the project schedule requirements.

B. This Section provides the overarching guidelines for commissioning but does not supersede specific testing requirements found elsewhere in the Contract Documents. Where there is any discrepancy, Contractor shall assume the more stringent requirements control unless confirmed otherwise by the Engineer. Refer to Division 26 and Division 40 for specific execution requirements related to electrical and instrumentation components and systems. For pre-commissioning activities, refer to other technical specifications, including Division 03 for requirements for testing of concrete hydraulic structures and Section 40 05 01 for testing requirements of hydraulic structures and piping.

C. All commissioning activities must be coordinated early in the project to minimize interference with the operation of the existing facility, or delays to the project schedule; see Section 01 12 16 for project work sequence and constraints. Unless otherwise specified, or agreed to in advance by the Engineer and Authority Engineer, no commissioning activities will be scheduled to take place on a weekend or holiday recognized by the Authority.

D. This Section contains specific references to the following related specification sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 11 00 Summary of Work
   2. Section 01 12 16 Work Sequence
   3. Section 01 32 16 Construction Progress Schedule
   4. Section 01 33 00 Submittal Procedures
   5. Section 01 45 23 Testing and Inspection Services

E. The Contractor shall provide an experienced Commissioning Manager who will be responsible for overseeing, organizing, administering, recording, and documenting all aspects of the commissioning efforts.

F. A representative or representatives of the equipment manufacturer(s) shall participate in the commissioning phases per the requirements of the Specifications.

1. Commissioning Overview: The sequence of the commissioning shall proceed as follows. Variations to this sequence may be requested by the Contractor and may be authorized by the Engineer where necessary to meet other constraints described in these Contract Documents. Any requested changes to the extent of testing quality control checks, related sequencing, and/or level or frequency of documentation shall be considered a deviation from the accepted Commissioning Plan and require resubmittal. The equipment and facility startup is a bottom-up approach, where testing starts at the component level, which is then followed by testing at the system, and then facility level.
    a. Phase 1 Commissioning: Component Test Phase. The Component Test Phase is comprised of the following three parts.
        1) Part 1 – Component Installation Review
        2) Part 2 – Component Operational Test
        3) Part 3 – Component Network Communications Test
    b. Phase 2 Commissioning: Functional Test Phase
        1) Part 1 – Functional Test of Individual Components and Independent Systems
        2) Part 2 – Comprehensive Functional Test of Integrated Systems
    c. Phase 3 Commissioning: Operations Test Phase. The Operations Test Phase is comprised of the following two parts.
        1) Part 1 – Walkdown
        2) Part 2 – Seven (7) Day Operations Test
    d. Phase 4 Commissioning: Acceptance Test Phase
    e. Optimization/Performance Commissioning Phase
2. Unless otherwise specified or agreed to in writing by the Engineer, all testing activities required as part of facility construction will occur prior to initiation of Phase 1 Commissioning. These include, but are not limited to, testing hydraulic structures for water tightness, pressure testing of piping systems, etc. Refer to applicable specification sections for specific requirements.



## 1.02 CONTRACTOR COMMISSIONING MANAGER RESPONSIBILITIES AND QUALIFICATIONS

A. The Contractor shall provide an experienced Commissioning Manager who will be responsible for overseeing, organizing, administering, recording, and documenting all aspects the testing and startup efforts, including development of System Commissioning Plans. Refer to paragraph 1.02 Contractor Commissioning Manager Responsibilities and Qualifications for experience requirements.

B. At 30 days prior to the commencement of the first component testing, the Commissioning Manager shall be assigned to the project, and actively engaged in planning for all project testing activities.

C. The Commissioning Manager's responsibilities shall include, but are not limited to, the following activities.

1. Direct and oversee the development of all commissioning planning documents.
2. Coordinate and be responsible for all testing and startup activities.

3. Coordinate activities with overall Contractor's project schedule, providing a schedule update at each meeting.
4. Serve as liaison between the Contractor and the Engineer/Engineer for all testing and startup activities. Coordinate directly with Authority's staff as directed by the Engineer.
5. Organize, lead, and provide minutes for Commissioning Meetings from the initial development of the System Commissioning Plans until the completion of all testing and startup activities.
6. Maintain the System Commissioning Plans and provide monthly updates to the Startup Team until the month prior to startup, then provide weekly updates until commissioning is complete.
7. Oversee and administer all testing activities, including either direct participation in the testing, and/or oversight and monitoring of all testing, and related documentation.
8. Assure that all tests have been successfully completed in accordance with the submitted testing procedures.
9. Develop, compile, review for completeness and compliance to the specifications, and submit all required completed test submittals and other related documentation in a timely manner
10. Work with the Contractor's Safety Supervisor to provide safe work conditions during commissioning.
11. Prior to submittal, review and approve the content of all training sessions to assure that the training includes all applicable operation, maintenance, safety, and functional, operations, and acceptance testing information.

D. Commissioning Manager's Statement of Qualifications:
   1. A minimum of 10 years of construction experience and 5 years of experience serving in a role with responsibilities similar to those described in this Section.
   2. Experience in the startup of similar systems on at least one completed wastewater facility, and including pumping, pipelines, process equipment, liquid and/or solids treatment process modifications, networked controls, and electrical infrastructure.



## 1.03 DEFINITIONS

A. Commissioning:
   1. The systematic process composed of all elements and requirements related to testing and startup of the Work.

B. Commissioning Hierarchy:
   1. Area
      a. A collection of systems usually constructed within or primarily within the confines of a single building or structure.
      b. Generally, the Drawings are compiled by Area number, in ascending order. Area numbers used in the Drawings correspond with the numbering system utilized during the last several facility upgrades.
      c. In most cases, Areas correspond with treatment processes. In some cases, however, multiple treatment processes are included in the same Area and/or a single treatment process is incorporated into multiple Areas.

2. System
    a. An arrangement of components or other systems so related or connected to perform a specific function and which form an identifiable, unified, functional, operational, safe, and independent part of the Authority's facility.
    b. A system may consist of solely new equipment installed as part of the Work, or as a combination of new equipment installed as part of the Work and existing equipment operating in conjunction with each other.
    c. A system may include equipment and facilities in more than one Area.
3. Component
    a. Components comprise every discrete item associated within the Work.
    b. Example components include but are not limited to the following:
        1) Structural system components include: buildings, tanks and slabs.
        2) Architectural system components include: floors, walls, doors, windows, ceilings and roofs.
        3) Process system components are usually discrete pieces of equipment and their respective motors and include: pumps, fuel tank and system components, heat exchangers, screening equipment, and other types of treatment equipment.
        4) Piping system components include: the piping, the piping connections, and the valves, whether manual or powered.
        5) Electrical system components include: wiring, equipment including but not limited to panelboards, MCCs, starters, and VFDs.
        6) Control system components include: Wiring, instruments, control panels, human-machine interfaces (HMIs'), computers, programmable logic controllers (PLCs), instrument networks, and process control networks
        7) Heating, ventilation and air conditioning (HVAC) system components include: pumps discrete pieces of HVAC equipment, and their respective motors and include: pumps, heat pumps, heat exchangers, water quality systems, valves, fans, louvers and ductwork.
        8) Plumbing system components include: pumps, strainers, valves, water supply piping, and area collection/drainage for system
        9) Indoor and outdoor lighting control systems and interface to other systems.



C. Summary of Test Phases. Reference paragraph 3.05 Testing for comprehensive test phase requirements.
    1. Phase 1 Commissioning: Component Test Phase. The Component Test Phase is intended to:
        a. Perform inspection and testing in a logical, stepwise sequence to ensure that the installed components have been safely and properly assembled, serviced, aligned, adjusted, connected, and calibrated prior to operation.
        b. Perform operational tests to prove that the components are operating as needed, intended, and specified.
        c. Perform component network communications tests to prove that all network reporting, data received, and control aspects for a given component are being correctly performed as needed, intended and specified.

2. Phase 2 Commissioning: Functional Test Phase. The Functional Test Phase is performed on a system, multiple integrated systems and/or a facility to prove that they function as required in conformance with the performance requirements and as needed, intended and specified. Functional tests use plant water, non-potable water, air, or simulated signals, not the specified media.
3. Phase 3 Commissioning: Operations Test Phase. The Operations Test Phase prepares a system, multiple integrated systems or a facility for the Acceptance Test Phase, proves that all systems are correctly set up and that the facility will reliably function over time in real world conditions. The Operations Test Phase is intended to:
    a. Provide for operations testing to prove compliance with performance requirements using either plant water, non-potable water, air, or the specified media, depending on the tests performed. For systems exposed to untreated or partially treated wastewater, operations testing is the final step prior to introducing the wastewater.
    b. Perform a complete inspection (walkdown) by the commissioning team to verify readiness for the 7-day operational test.
    c. Provide for 7-day operations test which shall consist of a continuous un-interrupted seven-day run period using the specified media.
4. Phase 4 Commissioning: Acceptance Test Phase. The Acceptance Test Phase operates a system, multiple integrated systems or a facility with the specified media, by the Authority (with assistance from the Contractor), for 30 days, without operational or performance failure to demonstrate satisfactory performance with the performance requirements specified. Performance tests, specified in individual specification sections to verify guaranteed performance, are performed during Phase 4 Commissioning.
5. Optimization Commissioning Phase: Some systems may be specified with Optimization Testing which is intended to provide the Manufacturer's services to optimize specific systems.

D. Other Key Terms:
1. Tests: Unless otherwise specified, denotes all field-testing including component tests, functional tests, operational tests, acceptance tests, and optimization/performance tests.
2. Startup Constraints: Startup constraints are identified throughout these Contract Documents with major construction constraints with reference to the effects on process startup are being discussed in Section 01 12 16.
3. Commissioning Team. Led by the Commissioning Manager, the Commissioning Team is comprised of key operations and maintenance personnel of the Authority, the Engineer, the Engineer and key representatives of the Suppliers.
4. Commissioning Manager: A testing and startup expert employed by the Contractor who is responsible for overseeing, organizing, administering, recording, and documenting all aspects the commissioning efforts.
5. Temporary Provision: Outages, re-routes, systems, components, materials, or equipment which is temporarily required to allow any test to occur.
6. Integrator: party responsible for control panel fabrication or alteration
7. Programmer: responsible for configuration of controllers (PLC, DCS, RTUs), HMI software. This may be separate from the party responsible for the control panel, fabrications or alternation, instrument installation and configuration.

8. Vendor Programmer: party responsible for controllers or local interface on vendor package equipment, defined as separate from plant or area SCADA systems.

## 1.04 SYSTEMS FOR PRE-COMMISSIONING AND COMMISSIONING

A. The following are list the major areas and systems within those areas to be commissioned as individual packages:
   1. Fuel Oil System:
      a. Fuel Storage Tank
      b. Fuel Filter System
      c. Duplex Fuel Oil Pump System
      d. Fuel Oil Unloading System
      e. Fuel piping, containment, and leak detection
   2. Area 63: FOG Receiving Facility:
      a. FOG Screening
      b. FOG Pumping
      c. FOG Heat Exchangers
      d. HVAC
   3. Area 78: Maintenance Building
      a. Boiler and associated pumping equipment
   4. Area 80: Administration Building
      a. Hot water supply and return system
   5. For all areas, facilities, equipment not explicitly included in the areas listed above, Contractor to provide listing of systems and equipment.



## 1.05 COMMISSIONING PLAN

A. A Master Commissioning Plan for the Work shall be prepared. The Master Commissioning Plan shall be divided into several sub-plans, the first of which is an overall Project Commissioning Plan for the Work, with more detailed System Startup Plans prepared for each system. The number of System Startup Plans is dependent on the number of facilities and systems involved in the Work, the minimum number of which is defined later in this Section.
   1. Project Commissioning Plan. The Project Commissioning Plan shall provide an overview of the efforts related to the testing and startup for the Work. At a minimum this plan shall cover the following.
      a. An organizational chart of the Commissioning Team and a description of the roles and responsibilities for each member.
      b. A general approach, sequencing and analysis of major constraints at the facility and system level to performing the testing and startup for the Work.
      c. A listing and brief description of each system to be commissioned.
      d. Updated Construction progress schedule (see Section 01 32 16) which integrates the commissioning plan and schedule into the overall construction schedule. The updated schedule shall identify the schedule duration of each of the system commissioning activities specified in paragraph 1.05 B below; detailed schedule of each system commissioning activity can be provided with each system commissioning plan, as specified in paragraph 1.05 B.3 below.

B. System Commissioning Plans. A System Commissioning Plan shall be created for each system identified in paragraph 1.04 Systems for Pre-Commissioning and Commissioning. The System Commissioning Plan shall be kept updated as testing progresses. At a minimum these plans shall include the following.

1. System Description. Provide a description of the system and each facility and area(s) into which that the system extends.
2. Testing Descriptions and Sequencing
   a. Overall Testing Description
      1) Provide a summary of the testing activities to be performed for that system.
      2) Provide a summary of the sequencing of the testing to be performed for the system.
      3) Provide a description of how signals from existing equipment not yet integrated into the work, or from new equipment that cannot yet be actuated, will be simulated or actuated in order to test the system.
   b. Component Testing
      1) Provide a listing, description and sequencing of each component test.
      2) The sequencing of the component testing shall be optimized to minimize the length of the phase.
      3) Record of field or factory calibration such as for instruments, or configuration specific to requirements specified such as VFD settings.
      4) Instrumentation and control loop tests.
      5) Electrical acceptance tests.
      6) Arc flash hazard and protective device requirements of Division 26.
   c. Functional Testing
      1) For each system or multiple integrated systems or facilities which will undergo functional testing, provide a list, description and sequencing of each functional test. The description shall include a narrative of the scenarios to be tested and shall include how the full operational range will be tested.
         a) Local control of all equipment and systems must be tested first. Successful testing of any field interlocks and hardwired controls before proceeding to remote control.
         b) Local control and remote check out are to be structured around the submitted I/O list, as specified in Division 40.
         c) All field terminations, loop checks, and modification within a control panel must be complete commencement of functional testing.
      2) Project process and instrumentation diagrams (P&IDs) shall be marked-up and provided which schematically represent the process and controls of the final construction of the system and shall be marked up noting temporary features necessary for Functional testing.
   d. Operations Testing
      1) For the system, provide a description of the walkdown process.
      2) For the system, provide a list, description and sequencing of each startup test. The description shall include a narrative of the scenarios to be tested and shall include how the full operational range will be tested.

3) Project P&IDs shall be marked-up and provided that schematically represent the process and controls of the final construction and shall be marked up noting temporary features necessary for Operations Testing.
4) Plan drawings shall also be provided, marked up to show the final construction and temporary features required for Operations Testing.

e. Acceptance Testing
1) For the system, provide a list, description and sequencing of each acceptance test.

f. Optimization/Performance Testing
1) If required for the facility, provide a list, description and sequencing of each optimization/performance test.

3. Comprehensive Testing Schedule
a. For each System Commissioning Plan, list all equipment to be tested by specification section number and name, and provide a comprehensive schedule showing the following for each.
1) Section number and/or paragraph number within a section.
2) Forecasted installation completion dates.
3) Forecasted visit dates by the manufacturer.
4) The system within which each equipment item is included and will be tested.
5) Forecasted start and completion for each test (component, functional, operations, acceptance).
6) Forecasted submittal dates for test reports.

b. Update Comprehensive Testing Schedule monthly and coordinate it with the Overall Project Schedule.

4. Control Descriptions. Provide a listing of the control description(s) involved. Provide control descriptions as part of the System Commissioning Plan.
5. Drawings. Provide a listing of the following drawings.
a. All drawings that are part of the Contract Documents and are directly related to the facility undergoing testing.
b. Shop drawings including wiring diagrams relevant to the facility.
c. List of package system PLCs and their I/O's and wire diagrams for the system.
6. Instruments. Provide a list of the instruments involved with an appendix which includes the correct set points and ranges for the instruments.
7. Testing Consumables. Provide tables with descriptions that describe the consumables and estimated quantities required during testing, including but not limited to potable water, plant water, chemicals, fuels, oils, lubricants and filters.
8. Testing Equipment Calibration. Provide a description of the measurement devices and the calibration method for the measurement devices which will be used to measure process performance characteristics.
9. Temporary Provisions
a. Provide a listing and description of temporary provisions required to perform all tests, including calibration equipment.

b. Where testing requires a source of water, gas or other medium other than the process fluid, identify the source of the water or fluid, the temporary provisions to employed to deliver the water or fluid to the testing location, the temporary provisions to circulate the water or fluid through the facilities to be tested.

c. Identify the location and method of disposal of the test media (water or fluid, or specified media). Identify temporary provisions required to safely deliver spent media to point of disposal.

10. Hazard Analysis. Provide a description of each potential hazard during the testing activities in the facility and mitigation measures planned for each.

11. A listing of and a short resume for the Manufacturer's representatives who will be involved in testing.

12. Forms: Provide in an appendix with each form and checklist to be used. Starting with forms provided in Section 01 99 90, edit each form to make specific to the components included in each System to be commissioned. Provide additional forms as needed to fully document the commissioning activities specified.

## 1.06 MANUFACTURER'S FIELD SERVICES

A. Where manufacturer's services are specified in this Section or other specification sections, furnish an authorized representative of the manufacturer who is factory-trained, knowledgeable and experienced in the technical aspects of their products and systems supplied on the Project and qualified to provide these services. Manufacturer representatives shall be available during equipment installation, commissioning and training of Authority's personnel.

B. Manufacturer's representatives shall be subject to the acceptance of the Engineer as a submittal with each System Commissioning Plan. No substitute representatives will be allowed without prior written approval from the Engineer.

C. Manufacturer's Certifications:

1. After equipment installation and before equipment energization, each manufacturer's representative shall prepare a written Manufacturer's Installation Certification Form, Form 43 05 11-A in Section 01 99 90, certifying that each equipment specified in Divisions 26 through 46 that the manufacturer supplied is properly installed and lubricated, has been properly maintained by the Contractor, is in accurate alignment, is free from any undue stress imposed by connecting piping and anchor bolts, and is in accordance with the manufacturer's installation instructions.

2. During Phase 4 Commissioning, each manufacturer's representative shall prepare a written Manufacturer's Operation Certification Form, Form 43 05 11-D in Section 01 99 90, certifying that each equipment specified in Divisions 26 through 46 that the manufacturer supplied is properly lubricated; has been properly maintained by the Contractor; is in accurate alignment; is free from any undue stress imposed by connecting piping and anchor bolts; and has been operated under all design conditions and meets the performance criteria in accordance with the requirements in the applicable specification sections and the manufacturer's operating requirements.

D. The Manufacturer's authorized representative shall perform all services when Manufacturer's services are specified in the individual specification sections. The authorized representative shall be factory-trained and experienced in the technical applications, installation, operation and maintenance of the equipment, subsystem or system.

E. The scheduling of all visits to the site by the manufacturer's field services representative shall be determined by the Contractor and coordinated through the Commissioning Manager. The Contractor shall notify the Engineer a minimum of 7 days in advance of all visits.

F. The Manufacturer's authorized representative shall not independently determine any requirements can be omitted, reduced or otherwise change testing requirements, protocols, or required documentation without submitting a request for deviation to the accepted Commissioning Plan or other related submittals.

## 1.07 SUBMITTALS

A. Action Submittals: The following minimum submittals shall be submitted in accordance with Section 01 33 00.
   1. Within 60 days following Notice to Proceed.
      a. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (") shall denote full compliance with a paragraph as a whole.
      b. If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations.
      c. The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
      d. Commissioning Manager qualifications and past work experience including contact names, addresses, and current telephone numbers that can be used to verify the accuracy of the provided information.
   2. Within 120 days following Notice to Proceed.
      a. Master Commissioning Plan.
   3. Not less than 120 days prior of the initiation of the first planned component testing in a system.
      a. System Commissioning Plan for the system within which the first components will be tested. Submit system test plans in two parts as described below:
         1) Submit the portion of the system commissioning plan for Component and Functional testing.

2) After successful completion of the Component testing, submit the test plan for the remaining phases of testing and commissioning.

b. Submit remaining System Commissioning Plans not less than 120 days prior to first planned component testing within each system, following the same two-part submittal process described above.

4. Qualifications of equipment manufacturer's representatives, to be submitted with each System Commissioning Plan.
5. Within 7 days following completion of each phase of Commissioning for each System Commissioning Plan, submit documentation demonstrating successful completion of the testing phase for that system. Any issues identified during the testing phase shall be identified along with the actions taken, or planned to be taken, to rectify the issue.
6. Certificates of instrument calibration, provided upon request from the Engineer.

B. Informational Submittals: The following minimum informational submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00.
   1. Updates to Comprehensive Testing Schedule.

C. Closeout Submittals: The following minimum closeout submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00.
   1. Manufacturer's Certificates of Proper Installation, Form 43 05 11-A in Section 01 99 90, or reference to completed certificates provided under separate submittals where specified.
   2. Test Reports, including completed test forms as specified in Section 01 99 90, and paragraph 1.05 Commissioning Plan, or reference to completed test forms provided under separate submittals where specified.
   3. Certificate of Testing and Commissioning
   4. Certificate of Training Completion, Form 43 05 11-B in Section 01 99 90, or reference to completed Certificates of Training Completion provided under separate submittals where specified.
   5. Manufacturer's Certificates of Proper Operation, Form 43 05 11-D in Section 01 99 90, or reference to completed Manufacturer's Certificate of Proper Operation provided under separate submittals where specified.

D. Samples:
   1. Reference the individual specifications within the Contract Documents for items requiring samples to be submitted.

E. Mock-ups:
   1. Reference the individual specifications within the Contract Documents for items requiring mock-ups to be submitted.

## PART 2 PRODUCTS

### 2.01 TEST MATERIALS AND EQUIPMENT

A. Provide calibrated test gauges, meters, recorders and monitors, reagents and test gases and associated assemblies, as required, to supplement or augment the Work specified in the Contract Documents to facilitate compliance with requirements of the commissioning. Select devices designed to measure the performance of the specific equipment and systems incorporated into the Work.

B. When testing requires the use of temporary provisions such as, but not limited to equipment, power, compressed air, or instrumentation which have not yet been placed in service, provide substitute sources acceptable to both the Authority and Engineer, and capable of meeting the requirements needed to perform the testing.

## PART 3 EXECUTION

### 3.01 GENERAL

A. The Contractor shall install all equipment in accordance with Manufacturer's requirements and the Contract Documents. Notify the Engineer of any conflict between a manufacturer's installation recommendations and the Contract Documents.

B. The Contractor shall perform component testing, functional testing, and startup testing, of all installed component and systems. Unless specified otherwise, the Authority shall be responsible for operating the facility during acceptance testing, with assistance and support from the Contractor in performing specific testing activities.

C. The Contractor shall provide the services of all technical and craft personnel required to support the Work throughout the duration of all testing phases, except as otherwise noted in this Section.

D. The Contractor shall maintain the appropriate staff (either on-site or on-call) to be able to respond immediately (24-hours per day) to deficiencies discovered during the Operations Test Phase and the Acceptance Test Phase for the critical systems listed below. The Contractor's qualified personnel must be capable of being on-site within a maximum of 2 hours of notice to correct any deficiencies.
   1. Fuel Storage Tank
   2. Fuel Oil Pump System
   3. Hot Water Loop Boiler
   4. Main Hot Water Loop Pumps

E. Authority's Operations and Maintenance Responsibility during Testing:
   1. Systems, multiple integrated systems, or facilities in the Operations Test Phase which require wastewater to be treated and disposed of shall be operated by the Authority with guidance from the Commissioning Manager.
   2. Unless specified otherwise, systems, multiple integrated systems, or facilities in the Acceptance Test Phase shall be operated by the Authority with assistance and support from the Commissioning Manager.

F. Until completion of the Acceptance Test Phase, the Contractor shall maintain all facilities undergoing testing. This includes, but is not limited to, manufacturer recommended preventative maintenance, repairs as needed, consumables such as lubricants, coating touch-up, etc.

G. The Contractor shall provide temporary systems, piping, valving, drains, power, controls, etc. to facilitate any of the tests, as needed to cycle water or air through the facilities in a manner that simulates the ultimate operation of the system.

H. All testing that may affect the operation of the existing facilities shall be coordinated with the Authority, including the proper isolation (e.g., lock out/tag out) procedures and features prior to commencing Work.

I. Timing of Testing:
   1. No testing shall commence until the related specific System Commissioning Plan has been submitted, reviewed, and received a review action of No Exceptions Taken, or Make Corrections Noted.
   2. No testing shall commence until the O&M Manual for the equipment involved has been reviewed and received a review action of No Exceptions Taken or Make Corrections Noted.
   3. Progression from one test phase to the next shall only be allowed at the written approval of the Engineer, following submission of written documentation from the Contractor signifying that the intent of that testing phase has been met with satisfactory results. The written approval will include a listing of items still owed by the Contractor regarding the testing which has occurred.
   4. Operations Testing shall not commence until all tagging and labeling including but not limited to piping, conduit, wires, panels, and equipment, have been completed.
   5. Acceptance Testing shall not commence until training has been completed.
   6. All life-safety systems, including but limited to ventilation, fire monitoring and alarms, hazard monitoring and alarms, communication systems, associated with a specific system, must have successfully completed operations testing prior to proceeding with Functional Testing of the system.

J. At the satisfactory conclusion of each test phase, the Contractor shall dismantle and remove all temporary valving, hoses, and other equipment used during the test, and return the facilities to conditions as existed before the test.

K. All deficiencies found during any test phase and subsequent correction thereof, must be inspected and approved by the Engineer prior to re-testing or continuation of testing. The contractor shall correct all noted deficiencies.

## 3.02 TESTING AND STARTUP MEETINGS AND WEEKLY REPORTS

A. The Commissioning Manager shall conduct regular commissioning meetings.

B. The first meeting shall be at least 1 month prior to submitting the Project Commissioning Plan and shall include preliminary discussions regarding this plan. Commissioning meetings shall then be held monthly prior to the first planned Component Testing. Ongoing development of the individual System Commissioning Plans will be among the topics discussed in these meetings.

C. Commissioning meetings shall be attended by the Engineer, key members from the Contractor staff, Subcontractors, key representatives of the Manufacturers, along with representatives for the Authority.

D. The Commissioning Manager shall prepare meeting minutes from the Testing and Start-up and distribute to all attendees not later than 5 days prior to the next meeting, or within 3 working days of each meeting, whichever is sooner. These should be issued as draft with a request for comments within 3 business days, followed by a final issuance.

E. Weekly Test Reports:
   1. During testing activities, submit weekly test reports describing the tests performed, test methods, test strategies implemented during the test, summary of successful testing completed, and specific highlight of any problems and/or deficiencies found during testing.
   2. For all troubleshooting, describe the troubleshooting strategy, methods, and final resolution.

## 3.03 EQUIPMENT AND MATERIALS REQUIRED FOR TESTING

A. It shall be the Contractor's responsibility to ensure that all required materials and test and repair equipment are on hand during all planned testing activities. Spare parts, specified to be provided as part of the work, shall not be used for testing without the written approval of the Engineer.

B. All instruments used to measure performance shall be calibrated. Certificates of calibration shall be current (as required in Division 40), and shall be at the job site during testing, and provided upon request or when specified.

C. Contractor is required to provide all expendables during all tests (not including Acceptance Testing, unless otherwise specified), including but not limited to, chemicals, fuel, oil and filters (e.g. air, fuel, natural gas, oil, media, etc.). Upon completion of Operational Testing (or Acceptance Testing, where specified) all expendables shall be replaced with new.



## 3.04 TEMPORARY PROVISIONS

A. Maintain temporary provisions until the testing phase requiring the temporary facilities are complete, or until the permanent facilities are in service where specified.

## 3.05 TESTING

A. Phase 1 Commissioning: Component Test Phase: The Component Test Phase shall be comprised of the following three parts.
   1. Part 1 – Component Installation Review
      a. Perform inspection and testing in a logical, stepwise sequence to ensure that the installed components have been safely and properly assembled, serviced, aligned, adjusted, connected, and calibrated prior to operation.
      b. Perform all changes, adjustments, and replacements required to make the equipment operate properly.

c. The Component Installation Review includes but is not limited to the following activities.
    1) Verification of adherence to manufacturer's installation and pre-startup requirements and procedures.
    2) For structures and tanks, perform and confirm compliance of structural leakage tests in accordance with Division 03 of these specifications.
    3) For piping, perform and confirm compliance of piping testing in accordance with Section 40 05 01.
    4) Verify wiring continuity for all components, equipment, instruments, panels, and devices. Check power, control, and monitoring circuits for continuity prior to connection to power source. Reference Division 26 and Division 40 for additional specifics regarding installation review of electrical and controls components including, but not limited to:
        a) Electrical acceptance tests per Section 26 08 00, complete.
        b) Arc flash hazard and coordination study, protective device settings, and labeling completed.
    5) Confirm cleanliness of connecting piping systems.
    6) Confirm alignment of connected machinery.
    7) Confirm correct lubrication.
    8) Confirm valve orientation and position status for manual operating mode.
    9) Confirm correct tagging and identification
    10) Confirm proper functioning of all safety components.
    11) Confirm proper connections, alignment, calibration and adjustment.
    12) Manually rotate or move all moving parts to assure freedom of movement.
    13) Confirm all safety equipment is installed per contract requirements, including but not limited to eye wash stations, warning signs, ventilation systems and equipment etc.
    14) Provide Manufacturer's Certificate of Proper Installation following the completion of this review.

2. Part 2 – Component Operations Test
    a. Perform testing showing that the component is operating as needed, intended, and specified for the Work including but not limited to the following.
        1) Bump electric motors to verify power and direction of rotation.
        2) Verify correct voltage and phase sequence of all circuits.
        3) Verify correct amperage.
        4) Loop tests per Section 40 61 21.
        5) Complete testing of all control circuits including interlocks.
        6) Verify that every component is operational through its entire range of operation.
    b. Reference Division 26 and Division 40 for specific execution requirements related to electrical and instrumentation components and systems.
    c. Unless otherwise specified or allowed by the Engineer, the test media for component operational testing shall be plant water or non-potable water.

3. Part 3 – Component Network Communications Test
    a. The component network communication tests shall prove that all network reporting, data received, and control aspects for a given component are being correctly performed as needed, intended, and specified.
    b. Perform network tests for all network panels, network hardware, network cables, and all other network systems that are required to be installed and operational for each component.
    c. Refer to Division 40 for specific execution requirements for the component network tests.

B. Phase 2 Commissioning: Functional Test Phase:
    1. Functional testing shall be performed on all components and systems as required to prove that they function as required in conformance with the performance requirements and as needed and intended to complete the Work. All components of a system shall be operated together during functional testing.
        a. The Functional Test Phase is required for all process equipment, HVAC equipment, other equipment, piping, electrical, instrumentation, controls, and package system equipment.
        b. Testing for all SCADA controls associated with all components with SCADA monitoring or SCADA controls shall be performed and coordinated with the Authority's PLC Panel supplier and integrator. This test shall include testing of multiple components that have interfaces between them. For packaged equipment this shall include testing of interfaces and interlocks between equipment supplied by the Supplier of the packaged equipment and equipment supplied in other technical specification sections. The contractor's commissioning team will be responsible for troubleshooting components installed as part of their scope of work when required during commissioning.
        c. When testing requires the use of auxiliary systems such as electrical power, compressed air, controls, or instrumentation which have not yet been placed in service, provide acceptable substitute sources, capable of meeting the requirements of the component or system.
        d. Functionally test each system as an independent system.
            1) Tests shall include all the functional requirements provided in Division 26 and Division 40, within the individual requirements in the Specifications and as required by the Supplier.
            2) Demonstrate that each, and every, component within the system interacts and functionally operates as specified throughout its entire range of operation.
            3) Coordinate and test each interlock for the system, all local controls, and all DCS controls with the Authority's PLC panel supplier and integrator.
        e. Functionally test multiple integrated systems. The testing shall include individual components and systems that were previously tested independently.
            1) Test in a step-by-step method to accomplish orderly and systematic testing of integrated systems to simulate the functionality of the completed Work.
            2) Tests shall be run through normal operating ranges and to prove specific performance requirements as required by the Specifications or otherwise needed to prove compliance with the Specifications.

3) To the greatest extent practical, test at conditions which represent the full range of operating parameters (or specified test parameters if greater) as defined in the Contract Documents.

4) The tests shall include all network controls, all network interlocks, all inter-process interlocks, and all operations interfaces.

5) The tests shall be performed until the specified operating modes or performance has been accomplished without interruption for the specified duration as indicated in the Specifications or in no instance less than 4 hours.

6) Should the functional testing of the integrated systems be halted for any reason, the testing shall be repeated until it has been accomplished without interruption.

7) Coordinate with Engineer such that Engineer can witness each individual step in the procedures.

f. Following the testing perform the following.

1) Check equipment for loose connections, unusual movement or other indications of improper operating characteristics.

2) Disassemble and inspect equipment which exhibits unusual or unacceptable operating characteristics. Re-align machines identified as out of alignment. Repair, or remove and replace with new if unable to pass the requirement of the testing. Test until the equipment meets the requirements of the Specifications.

g. Unless otherwise specified or allowed by the Engineer, the test media for functional testing shall be the water identified in the System Commissioning Plan (e.g., plant water, non-potable water, air, or specified media, depending on the system).

C. Phase 3 Commissioning Operations Test Phase:

1. General Requirements of the Operations Test Phase

a. Tests shall be performed using the specified media.

b. Disposal of test media shall follow all laws and regulations and with proper permits.

c. Unless otherwise indicated in these Contract Documents or permitted by the Engineer, training shall be performed during the Operations Test Phase.

d. The Operations Test Phase shall be conducted at a time and date which is requested by the Contractor and agreed to by the Authority.

e. Coordinate with the Authority for introduction of specified media, disposal (or return to treatment plant) of specified material, and operation of facilities with specified media.

f. Prior to commencement of the Operations Test Phase, the facility shall be fully operational, capable of accepting design flows and performing functions as designed.

g. The Operations Test Phase shall test for normal operational sequence as an integrated system conforming to the requirements of the Specifications through full specified operating range. Test network control logic across multiple systems.

h. During the Operations Test Phase, tests shall be executed for all components. Tests shall include all the operations tests as specified in the individual equipment technical specification sections. This includes vibration tests where specified.

i. Provide required support to the Authority such that the facility attains its fully operational mode.

2. Part 1 -Walkdown: After the completion of the functional testing, a complete inspection by the Startup Team shall be performed to determine if the facility is ready for the Seven (7) Day Operational Test.

a. Walk through the facility with the Engineer Authority and the Engineer to acknowledge facility is ready for the Seven (7) Day Operational Test.

b. A working punch-list will be developed and provided by the Engineer.

c. The punch-list shall be identified by the following ranking criteria:

1) Level 1: Significant impact item and no further tests shall be performed until resolved. Requires a signoff prior to proceeding.

2) Level 2: Minimal impact item that can be corrected later and does not affect continuation of testing.

3. Part 2 - Seven (7) Day Operational Test. The Operations Test Phase shall consist of a continuous un-interrupted seven-day run period using the specified media.

D. Phase 4 Commissioning: Acceptance Test Phase:

1. The Acceptance Test Phase shall be a test of a system or multiple systems by the Authority using the specified media, without operational or performance failure to demonstrate conformance with the performance requirements specified. The minimum duration of the Acceptance Test Phase shall be 30 days, unless otherwise specified within individual equipment specifications. This is the final test to demonstrate the facility including new and existing processes operate together as needed, intended, and specified.

a. During this test, vary operational parameters during the day, with steady state conditions overnight.

b. Conduct performance testing where required in individual specification sections. Where practical, coordinate timing of performance testing to fall within the nominal 30 days allocated for Acceptance Testing; however, performance testing outside of this 30-day period may be required in order to fully comply with specified performance testing requirements.

c. The Acceptance Test Phase shall be judged completed wholly at the discretion of the Engineer.

d. This test may last significantly longer than the specified calendar days listed if deficiencies are found, and the test is restarted one or more times. The Contractor shall coordinate with the Authority and provide support as necessary.

e. After satisfactory completion the facility shall be placed into normal operation.

f. Provide documentation of successful performance testing where required in individual equipment specifications.

g. Provide Manufacturer's Certificates of Proper Operation.

E. Optimization Testing:

1. Provide optimization testing as required in individual equipment specifications.

## 3.06 RETESTS

A. If any portion of a test does not pass, the Contractor shall correct the problem in a timely manner and repeat the test until it passes to the satisfaction of the Engineer and Authority.
   1. Functional testing of equipment or a system shall be considered complete when, in opinion of the Engineer, the system, facility, or designated portion has operated in manner intended for (7) continuous days without significant interruption, unless otherwise agreed upon.
   2. Operational testing of the system, the entire facility or any portion thereof shall be considered complete when, in opinion of the Engineer, the system, facility, or designated portion has operated in manner intended for (28) continuous days without significant interruption, unless otherwise agreed upon.
   3. Significant Interruption: May include any of the following events:
      a. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
      b. Failure of any critical equipment or unit process that is not satisfactorily corrected within 6 hours after failure.
      c. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 24 hours after failure.
   4. Operational testing of the system, the entire facility or any portion thereof shall be considered complete when, in opinion of the Engineer, the system, all specified testing has been successfully completed, and all deficiencies have been corrected.

B. If a failure of any component or system occurs during any phase of commissioning, the entire phase shall be re-started. If the Commissioning Manager determines that the failure is minor and recommends continuation of the test rather than re-starting, then the Commissioning Manager shall request continuation in writing to the Engineer, who, if in agreement, may permit continuation of testing.



## 3.07 ENGINEERAFTER TESTS

A. Once testing has been completed, and until the Engineer has issued a certificate of Final Completion, all equipment shall be rechecked once by the Contractor (or more often if specified) for proper alignment and realigned, if necessary. All equipment shall be checked for loose connections, unusual movement, or other indications of improper operating characteristics. Any deficiencies shall be corrected to the satisfaction of the Engineer. All equipment or devices which exhibit unusual or unacceptable operating characteristics shall be disassembled, inspected and shall then be repaired or removed from the Site and replaced at no cost to the Authority.

**END OF SECTION**

SECTION 01 99 90

REFERENCE FORMS

## PART 1 FORMS

### 1.01 DESCRIPTION

A. The forms listed below and included in this section are referenced from other sections of the project manual:

| Form No. | Title |
|---|---|
| 01 33 00-A | Submittal Transmittal Form |
| 01 45 20-A | Equipment Test Report Form |
| 01 78 23-A | Operation and Maintenance Transmittal Form |
| 01 78 23-B | Equipment Record Form |
| 01 78 23-C | Equipment Record Form |
| 09 90 00-A | Coating System Inspection Checklist |
| 26 05 00-A | Wire and Cable Resistance Test Data Form |
| 26 05 00-B | Installed Motor Test Data Form |
| 26 05 00-C | Dry Transformer Test Data Form |
| 40 61 13-A | Loop Wiring and Insulation Resistance Test Data Form |
| 40 61 13-B | Control Circuit Piping Leak Test Form |
| 40 61 13-C | Controller Calibration Test Data Form |
| 40 61 13-D | Panel Indicator Calibration Test Data Form |
| 40 61 13-E | Recorder Calibration Test Data Form |
| 40 61 13-F | Signal Trip Calibration Test Data Form |
| 40 61 13-G | Field Switch Calibration Test Data Form |
| 40 61 13-H | Transmitter Calibration Test Data Form |
| 40 61 13-I | Miscellaneous Instrument Calibration Test Data Form |
| 40 61 13-J | Individual Loop Test Data Form |
| 40 61 13-K | Loop Commissioning Test Data Form |
| 43 05 11-A | Manufacturer's Installation Certification Form |
| 43 05 11-B | Manufacturer's Instruction Certification Form |
| 43 05 11-C | Unit Responsibility Certification Form |
| 43 05 13-A | Rigid Equipment Mount Installation Inspection Checklist |
| 43 05 21-A | Motor Data Form |

## 01 33 00-A. SUBMITTAL TRANSMITTAL FORM

### Submittal Transmittal

| Submittal Description: | Submittal No:[1] | Spec Section: |
|---|---|---|

| | Routing | Sent | Received |
|---|---|---|---|
| Owner: | Contractor | | |
| Project: | Engineer | | |
| | Engineer | | |
| Contractor: | Contractor | | |

We are sending you:
☐ Attached
☐ Under separate cover via _____
☐ Submittals for review and comment
☐ Product data for information only
Remarks: _____

| Item | Copies | Date | Section No. | Description | Review action[a] | Reviewer initials | Review comments attached |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

[a]*Note: NET = No exceptions taken; MCN = Make corrections noted; A&R = Amend and resubmit; R = Rejected*
*Attach additional sheets if necessary.*



### Contractor

Certify either a or b:

a. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements, including coordination with all related work, specified (no exceptions).

b. ☐ We have verified that the material or equipment contained in this submittal meets all the requirements specified except for the attached deviations.

| No. | Deviation |
|---|---|
| | |
| | |

Certified by: _____

Contractor's Signature: _____

[1]See *Section 01 33 00-1.04. A, Transmittal Procedure.*

## 01 45 20-A. EQUIPMENT TEST REPORT FORM

*NOTE: This example equipment test report is provided for the benefit of the Contractor and is not specific to any piece of equipment to be installed as a part of this project. The example is furnished as a means of illustrating the level of detail required for the preparation of equipment test report forms for this project.*

**City Of Sample**

Example Water Treatment Plant

Stage IV Expansion Project

ABC Construction Company, Inc., General Contractor
XYZ Engineering, Inc., Construction Manager

**Equipment Test Report**

- Equipment Name: Sludge Pump 2
- Equipment Number: P25202
- Specification Ref: 11390
- Location: East Sedimentation Basin Gallery



| | Contractor | | Construction Manager | |
|---|---|---|---|---|
| | Verified | Date | Verified | Date |
| **A. Preoperational Checklist** | | | | |
| 1. Mechanical | | | | |
| a. Lubrication | | | | |
| b. Alignment | | | | |
| c. Anchor bolts | | | | |
| d. Seal water system operational | | | | |
| e. Equipment rotates freely | | | | |
| f. Safety guards | | | | |
| g. Valves operational | | | | |
| h. Hopper purge systems operational | | | | |
| i. Sedimentation tank/hopper clean | | | | |
| j. O&M manual information complete | | | | |
| k. Manufacturer's installation certificate complete | | | | |
| 2. Electrical (circuit ring-out and high-pot tests) | | | | |
| a. Circuits: | | | | |
| 1) Power to MCC 5 | | | | |
| 2) Control to HOA | | | | |
| 3) Indicators at MCC: | | | | |
| a) Red (running) | | | | |
| b) Green (power) | | | | |
| c) Amber (auto) | | | | |
| 4) Indicators at local control panel | | | | |
| b. Wiring labels complete | | | | |
| c. Nameplates: | | | | |
| 1) MCC | | | | |
| 2) Control station | | | | |
| 3) Control panel | | | | |

| | Contractor | | Construction Manager | |
|---|---|---|---|---|
| | Verified | Date | Verified | Date |
| d. Equipment bumped for rotation | | | | |
| 3. Piping Systems | | | | |
| a. Cleaned and flushed: | | | | |
| 1) Suction | | | | |
| 2) Discharge | | | | |
| b. Pressure tests | | | | |
| c. Temporary piping screens in place | | | | |
| 4. Instrumentation and Controls | | | | |
| a. Flowmeter FE2502F calibration | | | | |
| 1) Calibration Report No. | | | | |
| b. Flow recorder FR2502G calibrated against transmitter | | | | |
| c. VFD speed indicator calibrated against independent reference | | | | |
| d. Discharge overpressure shutdown switch calibration | | | | |
| e. Simulate discharge overpressure Shutdown | | | | |
| **B. Functional Tests** | | | | |
| 1. Mechanical | | | | |
| a. Motor operation temperature satisfactory | | | | |
| b. Pump operating temperature satisfactory | | | | |
| c. Unusual noise, etc? | | | | |
| d. Pump operation: 75 gpm/50 psig | | | | |
| (1) Measurement: | | | | |
| (a) Flow: | | | | |
| (b) Pressure: | | | | |
| (c) Test gage number: | | | | |
| e. Alignment hot | | | | |
| f. Dowelled in | | | | |
| g. Remarks: | | | | |
| 2. Electrical | | | | |
| a. Local switch function: | | | | |
| 1) Runs in HAND | | | | |
| 2) No control power in OFF | | | | |
| 3) Timer control in AUTO | | | | |
| b. Overpressure protection switch PS2502C functional in both HAND and AUTO | | | | |
| c. Overpressure protection switch PS2502C set at 75 psig | | | | |
| d. PLC 2500 set at 24-hour cycle, 25 min ON | | | | |
| **C. Operational Test** | | | | |
| 1. 48-hour continuous test. Pump cycles as specified, indicators functional, controls functional, pump maintains capacity, overpressure protection remains functional, hour meter functional | | | | |

RECOMMENDED FOR BENEFICIAL OCCUPANCY:

| Engineer | Date |
|---|---|

ACCEPTED FOR BENEFICIAL OCCUPANCY

| Owner's Representative | Date |
|---|---|

## 01 78 23-A. OPERATION AND MAINTENANCE TRANSMITTAL FORM

| | |
|---|---|
| Date: | Submittal No:[2] |
| To: | Contract No: |
| | Spec. Section: |
| | Submittal Description: |
| Attention: | From: |

| Checklist | Contractor | | Construction Manager | |
|---|---|---|---|---|
| | Satisfactory | N/A | Accept | Deficient |
| 1. Table of contents | | | | |
| 2. Equipment record forms | | | | |
| 3. Manufacturer information | | | | |
| 4. Vendor information | | | | |
| 5. Safety precautions | | | | |
| 6. Operator prestart | | | | |
| 7. Start-up, shutdown, and postshutdown procedures | | | | |
| 8. Normal operations | | | | |
| 9. Emergency operations | | | | |
| 10. Operator service requirements | | | | |
| 11. Environmental conditions | | | | |
| 12. Lubrication data | | | | |
| 13. Preventive maintenance plan and schedule | | | | |
| 14. Troubleshooting guides and diagnostic techniques | | | | |
| 15. Wiring diagrams and control diagrams | | | | |
| 16. Maintenance and repair procedures | | | | |
| 17. Removal and replacement instructions | | | | |
| 18. Spare parts and supply list | | | | |
| 19. Corrective maintenance man-hours | | | | |
| 20. Parts identification | | | | |
| 21. Warranty information | | | | |
| 22. Personnel training requirements | | | | |
| 23. Testing equipment and special tool information | | | | |



Remarks:

Contractor's Signature :

[2] See Section 01 33 00-1.04.A, Transmittal Procedure.

## 01 78 23-B. EQUIPMENT RECORD FORM

| | | | |
|---|---|---|---|
| Equip Descrip | | Equip Loc | |
| Equip No. | Shop Dwg No. | Date Inst | Cost |
| Mfgr | | Mfgr Contact | |
| Mfgr Address | | | Phone |
| Vendor | | Vendor Contact | |
| Vendor Address | | | Phone |

| Maintenance Requirements | D | W | M | Q | S | A | Hours |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Lubricants: Recommended:

Alternative:

Misc. Notes:



| Recommended Spare Parts | | | |
|---|---|---|---|
| Part No | Quan | Part Name | Cost |
| | | | |
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| Electrical Nameplate Data | | | |
|---|---|---|---|
| Equip | | | |
| Make | | | |
| Serial No. | | Id No. | |
| Model No. | | Frame No. | |
| Hp | V | Amp | Hz |
| Ph | Rpm | Sf | Duty |
| Code | Insl. Cl | Des | Type |
| Nema Des | C Amb | Temp Rise | Rating |
| Misc. | | | |

| Mechanical Nameplate Data | | | |
|---|---|---|---|
| Equip | | | |
| Make | | | |
| Serial No. | | Id No. | |
| Model No. | | Frame No. | |
| Hp | Rpm | Cap | Size |
| Tdh | Imp Sz | Belt No. | Cfm |
| Psi | Assy No. | Case No. | |
| Misc | | | |

## 01 78 23-C. EQUIPMENT RECORD FORM

| | | | |
|---|---|---|---|
| Equip Descrip | | Equip Loc | |
| Equip No. | Shop Dwg No. | Date Inst | Cost |
| Mfgr | | Mfgr Contact | |
| Mfgr Address | | | Phone |
| Vendor | | Vendor Contact | |
| Vendor Address | | | Phone |

| Maintenance Requirements | D | W | M | Q | S | A | Hours |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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## 09 90 00-A COATING SYSTEM INSPECTION CHECKLIST

| Project Name | | | |
|---|---|---|---|
| Owner | | Coating System Manufacturer (CSM) | |
| General Contractor (GC) | | Coating System Applicator (CSA) | |
| Area or Structure | | Location within Structure | |
| Coating System (eg E-1) | | Coating Type (eg Epoxy, etc.) | |

### Coating System Inspection Checklist

| Step | Description | | Name | Signature | Date |
|---|---|---|---|---|---|
| 1 | Completion of cleaning and substrate decontamination prior to abrasive blast cleaning. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 2 | Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 3 | Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 4 | Completion of Surface Preparation for Substrates to Be Coated. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 5 | Completion of Primer Application. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 6 | Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 7 | Completion of Concrete Filler/ Surface Application to Concrete. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 8 | Completion of First Finish Coat Application and of Detail Treatment at Transitions or Terminations. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |

## Coating System Inspection Checklist

| Step | Description | | Name | Signature | Date |
|---|---|---|---|---|---|
| 9 | Completion of Second Finish Coat Application and of Detail Treatment at Transitions and Terminations. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 10 | Completion of Full and Proper Cure of Coating System. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 11 | Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 12 | Completion of Localized Repairs to Coating System Following Testing. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |
| 13 | Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CSM's Quality Requirements. | GC QC | | | |
| | | CSM QC | | | |
| | | CSA QC | | | |

## 26 05 00-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.:_____ Temperature, °F: _____

| Location of Test | Insulation resistance, megohms |
|---|---|
| 1. | |
| 2. | |
| 3. | |
| 4. | |
| 5. | |
| 6. | |
| 7. | |

.

CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 26 05 00-B. INSTALLED MOTOR TEST DATA FORM

Motor Equipment Number: _____ Date of test: _____

Equipment Driven: _____

MCC Location: _____

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Ambient temp | °F |
| Resistance: | | | | | | | |
| Insulation resistance phase-to-ground megohms: | | | | | | | |
| Phase A | | Phase B | | Phase C | | | |
| Current at Full Load: | | | | | | | |
| Phase | | | | Current, amps | | | |
| Phase | | | | Current, amps | | | |
| Phase | | | | Current, amps | | | |
| Thermal Overload Device: | | Manufacturer/catalog # | | | Amperes | | |
| Circuit breaker (MCP) setting: | | | | | | | |

Motor Nameplate Markings:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mfr | | Mfr Model | | Frame | | HP | |
| Volts | | Phase | | RPM | | Service factor** | |
| Amps | | Freq | | Ambient temp rating | | | °C |
| Time rating | | | | Design letter** | | | |
| | | (NEMA 1-10.35) | | | | (NEMA MG-1.16) | |
| Code letter | | | | Insulation class | | | |

**Required for 3-phase squirrel cage induction motors only.



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 26 05 00-C. DRY TRANSFORMER TEST DATA FORM

*(Note: Use Data Form for dry type transformers with voltage rating of 600 Vac or less and sizes to 167 kVA single phase and 500 kVA three phase. Use NETA Test Forms and Test Procedures for higher voltages and larger transformers.)*

Equipment Tag No.: _____ Temperature Rating: _____

Description/Location: _____ Feeder size/Source: _____

Primary Voltage: _____ Secondary Voltage: _____ Winding Connection: _____

A. VISUAL INSPECTION

| Transformer Inspection | Pass | Fail | Note |
|---|---|---|---|
| 1. Nameplate data as specified | | | |
| 2. Mechanical condition | | | |
| a. Free of dents and scratches | | | |
| b. Anchored properly | | | |
| c. Shipping brackets removed | | | |
| d. Spacing from wall per nameplate | | | |
| 3. Grounding * | | | |
| a. Equipment grounding | | | |
| b. System grounding | | | |



B. INSULATION-RESISTANCE TESTS:

Perform tests with calibrated megohmmeter. Apply 1000 Vdc test voltage for 60 seconds and record readings in megohms at 30-seconds and 60-seconds intervals.

| Test Group | Resistance between | | 30-second reading | 60-second reading | Absorption Ratio Index 60-sec. / 30-sec. |
|---|---|---|---|---|---|
| Primary Winding to ground | A | GRD | | | |
| | B | GRD | | | |
| | C | GRD | | | |
| Secondary Winding to ground with * N-G Bond removed | a | GRD | | | |
| | b | GRD | | | |
| | c | GRD | | | |
| Primary Winding to Secondary Winding | A | a | | | |
| | B | b | | | |
| | C | c | | | |

Submit resistance readings to the Engineer immediately after the tests that are less than the manufacturer's recommended value or less than 10-megohms. Record the Absorption Ratio Index values for future reference. Ratio must be 1.0 or greater, with infinity (∞) equal to 1.0.

Contractor Representative Certified: _____ Date _____

Owner Representative Witnessed:_____ Date _____

## 40 61 13-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM

Loop No.: _____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

| Wire No. | Panel Tie | Field TB | Continuity Resistance[a] | | Insulation Resistance[b] | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Cond./ Cond. | Cond./ Shield | Shield/ Gnd. | Shield/ Cond. | Cond./ Gnd. | Shield/ Shield |
| A | | | -- | (A/SH) | | | | |
| B | | | (A/B) | -- | | | | |
| C | | | (A/C) | -- | | | | |
| D | | | (A/D) | -- | | | | |
| etc. | | | | | | | | |

NOTES:

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 40 61 13-B. CONTROL CIRCUIT PIPING LEAK TEST FORM

Loop No.:_____

List tubing associated with loop in table below. Make applicable measurements after isolating any air consuming pilots from circuit.

| Tube No. | Tubing Equivalent Length of 1/4-Inch Copper[a] | Test Period (seconds) | Permitted Pressure Drop (psi)[b] | Measured Pressure Drop (psi) |
|---|---|---|---|---|
| A | | | | |
| B | | | | |
| C | | | | |
| D | | | | |
| etc. | | | | |

NOTES:

a. Convert actual tubing and air motor volume to equivalent 1/4-inch copper tubing.

b. Pressure drop shall not exceed 1 psi per hundred feet 1/4-inch tubing per 5 seconds.



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 40 61 13-C. CONTROLLER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____ Process Variable (PV) Scale: _____

Output: _____ Output Scale: _____

PV Scale Calibration

| % of Range | Input | Expected Reading | Actual Reading | % Deviation |
|---|---|---|---|---|
| 0 | | | | |
| 50 | | | | |
| 100 | | | | |
| | | | % Deviation Allowed: | |

Connect output to PV for following tests:

| Set Point (SP) Indicator Accuracy | | | Output Meter Accuracy | | | Controller Accuracy | | |
|---|---|---|---|---|---|---|---|---|
| SP | PV Reading | Expected % Dev. | Actual Reading | Expected Reading | Actual % Dev. | OUTPUT | OUTPUT | % Dev. |
| (0%) | | | | | | | | |
| (50%) | | | | | | | | |
| (100%) | | | | | | | | |
| % Deviation Allowed: | | | % Deviation Allowed: | | | % Deviation Allowed: | | |



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 40 61 13-D. PANEL INDICATOR CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.:_____ Serial No.:_____

Input: _____

Scale: _____ Range: _____

PV Scale Calibration

| % of Range | Input | Expected Reading | Actual Reading | % Deviation |
|---|---|---|---|---|
| 0 | | | | |
| 50 | | | | |
| 100 | | | | |
| | | | % Deviation Allowed: | |



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

**40 61 13-E. Recorder Calibration Test Data Form**

**NOT USED**

## 40 61 13-F. SIGNAL TRIP CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Scale: _____ Range: _____

Set Point(s): _____

After setting set point(s), run signal input through entire range and calculate deadband.

| Set Point | Incr. Input Trip Point | Decr. Input Trip Point | Calc. Deadband | Required Deadband |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
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| | | | | |



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 40 61 13-G. FIELD SWITCH CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

| Set Point | Incr. Input Trip Point | Decr. Input Trip Point | Calc. Deadband | Required Deadband |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
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| | | | | |



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 40 61 13-H. TRANSMITTER CALIBRATION TEST DATA FORM

Tag No. and Description: _____

Make & Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

| % of Range | Input | Expected Reading | Actual Reading | % Deviation |
|---|---|---|---|---|
| 0 | | | | |
| 50 | | | | |
| 100 | | | | |
| | | | % Deviation Allowed: | |



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 40 61 13-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 40 61 13-J. INDIVIDUAL LOOP TEST DATA FORM

Loop No.: _____

Description: (Give complete description of loop's function using tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:

(Attach test form 40 61 13-A)

b. Instrumentation tubing/piping tested:

(Attach test form 40 61 13-B)

c. Instruments calibrated:

(Attach test forms 40 61 13-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Construction Manager's approval.



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 40 61 13-K. LOOP COMMISSIONING TEST DATA FORM

Loop No.: _____

a. Loop tested:

(Attach test form 40 61 13-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:



CERTIFIED _____ Date _____

Contractor's Representative

WITNESSED _____ Date _____

Owner's Representative

## 43 05 11-A. MANUFACTURER'S INSTALLATION CERTIFICATION FORM

| Contract No: | Specification section: |
|---|---|

Equipment name:

Contractor:

Manufacturer of equipment item:

The undersigned manufacturer of the equipment item described above hereby certifies that he has checked the installation of the equipment and that the equipment, as specified in the project manual, has been provided in accordance with the manufacturer's recommendations, and that the trial operation of the equipment item has been satisfactory.

Comments:



| Manufacturer | Contractor |
|---|---|
| Signature of Authorized Representative | Signature of Authorized Representative |
| Date | Date |

## 43 05 11-B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

| Contract No: | Specification Section: |
|---|---|
| Equipment name: | |
| Contractor: | |
| Manufacturer of equipment item: | |

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

**Operations Check List (check appropriate spaces)**

| | |
|---|---|
| **Start-up procedure reviewed** | |
| **Shutdown procedure reviewed** | |
| **Normal operation procedure reviewed** | |
| **Others:** | |
| | |
| | |

**Maintenance Check List (check appropriate spaces)**

| | |
|---|---|
| **Described normal oil changes (frequency)** | |
| **Described special tools required** | |
| **Described normal items to be reviewed for wear** | |
| **Described preventive maintenance instructions** | |
| **Described greasing frequency** | |
| **Others:** | |
| | |



| | |
|---|---|
| Manufacturer | Signature of Contractor Representative Date |
| Signature of Authorized Representative | |
| Date | Signature of Authorized Representative Date |

## 43 05 11-C. UNIT RESPONSIBILITY CERTIFICATION FORM

[PROJECT TITLE]

CERTIFICATE OF UNIT RESPONSIBILITY

FOR SPECIFICATION SECTION _____

_____

[SECTION TITLE]

**In accordance with Section 43 05 11-1.02 Unit Responsibility of the contract documents, the undersigned manufacturer of driven equipment ("manufacturer") accepts unit responsibility for all components of equipment furnished to the Project under specification Section_____ , and for related equipment manufactured under** sections**_____ _____, _____, and _____ .**

We have reviewed the requirements for sections 43 05 11 and 43 23 03 where applicable, and all sections referencing this (these) section(s), including but not limited to drivers, supports for driving and driven equipment and all other specified appurtenances to be furnished to the Project by manufacturer. And, we have further reviewed, and modified as necessary, the requirements for associated variable speed drives and motor control centers. We hereby certify that all specified components are compatible and comprise a functional unit suitable for the specified performance and design requirements whether or not the equipment was furnished by us. We will make no claim nor establish any condition that problems in operation for the product provided under this specification Section _____ are due to incompatibility of any components covered by this Certificate of Unit Responsibility. Nor will we condition or void any warranty for the performance of the product of this specification Section _____ due to incompatibility of any components covered under this Certificate of Unit Responsibility.

Our signature on this Certificate of Unit Responsibility does not obligate us to take responsibility for, nor to warrant the workmanship, quality, or performance of related equipment provided by others under specification sections _____, _____, and _____. Our obligation to warranty all equipment provided by us shall remain unaffected.



| | |
|---|---|
| Notary Public | Name of Corporation |
| Commission expiration date | Address |
| Seal: | By: |
| | Duly Authorized Official |
| | Legal Title of Official |
| | Date |

## 43 05 13-A. RIGID EQUIPMENT MOUNT INSTALLATION INSPECTION CHECKLIST

[CLIENT, PROJECT NAME]

Equipment Tag No.: _____ Date: _____

Grout Product Name and Type: _____

Grouting System Manufacturer: _____

Grouting Application Contractor: _____

General Contractor: _____

| | | |
|---|---|---|
| **Step 1: Verify Equipment Anchor Installation Conformance to Equipment Pad Details** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Millwright | | Date |
| **Step 2: Completion of Cleaning and Concrete Substrate Preparation Prior to Grouting** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Grouting Contractor Rep. | | Date |
| Name: Grout Manufacturer's Technical Rep. | | Date |
| **Step 3: Equipment Leveling** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Millwright | | Date |
| **Step 4: Installation of Protection of Adjacent Surfaces or Structures NOT TO BE GROUTED** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Grouting Contractor Rep. | | Date |
| Name: Grout Manufacturer's Technical Rep. | | Date |
| **Step 5: Preparation and Construction of Forms and Epoxy Grout Filling Standpipes** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Grouting Contractor Rep. | | Date |
| Name: Grout Manufacturer's Technical Rep. | | Date |
| **Step 6: Completion of Ambient Condition Control in Structure or Building Area and Acceptance of Ambient Conditions as They Apply to Application and Curing Requirements for the Grouting System** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Grouting Contractor Rep. | | Date |
| Name: Grout Manufacturer's Technical Rep. | | Date |
| **Step 7: Epoxy Grout Installation** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Grouting Contractor Rep. | | Date |
| Name: Grout Manufacturer's Technical Rep. | | Date |
| **Step 8: Completion of Full and Proper Cure of Epoxy Grout** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Grouting Contractor Rep. | | Date |

| | | |
|---|---|---|
| Name: Grout Manufacturer's Technical Rep. | | Date |
| **Step 9: Completion of Localized Repair of Grout Voids** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Grouting Contractor Rep. | | Date |
| Name: Grout Manufacturer's Technical Rep. | | Date |
| **Step 10: Final Acceptance of Grouting System Installation Including Final Clean-Up of the Work Site Complying with All Specification Requirements and the GSM's Quality Requirements** | | |
| Name: Contractor Rep. | | Date |
| Name: Engineer | | Date |
| Name: Grouting Contractor Rep. | | Date |
| Name: Grout Manufacturer's Technical Rep. | | Date |

## 43 05 21-A. MOTOR DATA FORM

Equipment Name: _____ Equipment No(s): _____

Project Site Location: _____

Nameplate Markings

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mfr: | | Mfr Model: | | Frame: | | Horsepower: | |
| Volts: | | Phase: | | RPM: | | Service Factor: | |
| FLA: | | LRA: | | Frequency: | | Amb Temp Rating: | °C |

| | | | |
|---|---|---|---|
| Time rating: | | Design Letter: | |
| | (NEMA MG1-10.35) | | (NEMA MG-1.16) |
| KVA Code Letter: | | Insulation Class: | |

The following information is required for explosion-proof motors only:

A. Approved by UL for installation in Class _____, Div _____, Group _____
B. UL frame temperature code ____ (NEC Tables 500.6B)

The following information is required for all motors 1/2 horsepower and larger:

A. Guaranteed minimum efficiency _____
(Section 43 05 21-2.04 Motor Efficiency)

B. Nameplate or nominal efficiency _____



Data Not Necessarily Marked on Nameplate

| | | | | | |
|---|---|---|---|---|---|
| Type of Enclosure: | | | Enclosure Material: | | |
| Temp Rise: | °C (NEMA MG1-12.41,42) | | | | |
| Space Heater included? | ☐ Yes | ☐ No | If Yes: | Watts | Volts |
| Type of motor winding over-temperature protection, if specified: | | | | | |

Provide information on other motor features specified:

_____

# DIVISION 02
# SITE CONSTRUCTION

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SECTION 02 41 00

DEMOLITION

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Demolition and removal of Underground Storage Tank.
   2. Demolition and removal of exposed piping and appurtenances.
   3. Demolition and removal of buried piping.
   4. Photographs showing details of equipment to be demolished.

### 1.02 DEFINITIONS

A. Remove or Demolish: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Authority.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

E. Abandon-In-Place: Render item permanently nonoperational in its existing location, detach from any existing construction and cease to maintain.



### 1.03 REFERNCES

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section prevail.

| Reference | Title |
|---|---|
| RCSA Title 22a-449 | Department of Energy and Environmental Protection Underground Storage Tank System Management |
| API Recommended Practice 1604 | Closure of Underground Petroleum Storage Tank |
| API Publication 1628 | A Guide to the Assessment and Remediation of Underground Petroleum Releases |
| API Publication 1629 | Guide for Assessing and Remediating Petroleum Hydrocarbons in Soils |
| ASTM E 1599 | Standard Guide for Corrective Action for Petroleum Releases |
| ASTM E 1739 | Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites |

| Reference | Title |
|---|---|
| ASTM E 1912 | Standard Guide for Accelerated Site Characterization for Confirmed or Suspected Petroleum Releases |
| ASTM E 1943 | Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites |
| IFC 3404.2.14.1 | International Fire Code Removal and Disposal of Tanks |
| NFPA 30 | Flammable and Combustible Liquids Code |
| NFPA 329 | Recommended Practice for Handling Releases of Flammable and Combustible Liquids and Gases |

## 1.04 PRE-DEMOLITION MEETINGS

A. Pre-demolition Conference: Conduct conference at Project site.
   1. Inspect and discuss condition of construction to be demolished.
   2. Review structural load limitations of existing structure.
   3. Review and finalize demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Review requirements of work performed by other trades that rely on substrates exposed by demolition operations.
   5. Review areas where existing construction is to remain and requires protection.

## 1.05 SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of Demolition Activities: Schedule the following activities in conjunction with the requirements of Section 01 12 16:
   1. Detailed sequence of demolition and removal work, with starting and ending dates for each activity. Ensure Authority's on-site operations are uninterrupted.
   2. Interruption of utility services. Indicate how long utility services will be interrupted.
   3. Coordination for shutoff, capping, and continuation of utility services.

C. Coordination of Authority's continuing occupancy of portions of existing building and of Authority's partial occupancy of completed Work.
   Inventory: Submit a list of items to be removed and salvaged and deliver to Authority prior to start of demolition.

D. Pre demolition Photographs or Video: Submit before Work begins.

E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Qualifications of Contractor in abandonment of Underground Storage Tanks

G. Copy of Notification of Scheduled Permanent Closure of UST submitted to CT DEEP

## 1.06 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged and items that have been removed and disposed.

B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

C. Tank Closure Report for underground storage tank.

D. New Haven Fire Marshal Underground Tank Removal Inspection Report.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Provide all materials and equipment in suitable and adequate quantity as required to accomplish the demolition work shown, specified herein, and as required to complete the Project.

# PART 3 EXECUTION

## 3.01 GENERAL

A. Major obstructions encountered that are not shown or indicated on the Drawings, or could not have been foreseen by visual inspection of the site prior to bidding, should immediately be brought to the attention of the Authority. Authority will make a determination for proceeding with the work.



## 3.02 SAFETY REQUIREMENTS

A. All debris, materials, piping, and miscellaneous waste products from the demolition process shall be removed safely from the project site as soon as possible. Dispose of in accordance with applicable federal, state and local regulations. Contractor is responsible for determining these regulations and shall bear all costs associated with disposal of these items.

B. Hazardous Materials:
   1. Existing facilities, or portions thereof, to be demolished may contain hazardous materials such as:
      a. Asbestos cement piping.
      b. Asbestos-containing pipe insulation.
      c. Residual chemicals in existing or abandoned piping.
      d. Lead-based paint.
      e. Or other unknown hazardous materials.
   2. Take all necessary precautions when handling these materials. Protect work area at all times until hazardous materials are stored in specially treated containers and the area has been cleaned.

3. Remove and dispose of hazardous materials in accordance with federal, state and local regulations.
4. Obtain all permits necessary to perform demolition work on hazardous materials.

## 3.03 UTILITIES

A. Determine whether there are utilities in demolition areas that are needed for continued service to other facilities. Relocate such utilities before demolition work begins.

B. Provide temporary services during interruptions to existing utilities as acceptable to Authority and Authority of utilities.

C. Utilities serving facilities to be demolished shall be isolated as shown on the Drawings or as may be directed by the Authority. Isolation shall occur at a point closest to the remaining active portion of the utility.

D. Remove utility lines that are exposed by demolition excavation. Likewise, remove all manholes, catch basins, and vault type structures no longer in use.

E. Plug gravity lines with concrete to prevent groundwater infiltration. Interior of pipe shall be cleaned and then completely filled with concrete for a length of at least three pipe diameters from the ends.

## 3.04 DEMOLITION

A. The demolition drawings are based on available information, but the structures may differ from what is presented. The Contractor shall be responsible for determining the scope and extent of the required work by inspecting the site prior to submittal of bid. Additional record drawings are available from the Authority.
   1. Demolition Photographs are included in the drawings to supplement the demolition drawings. The photographs show elements of the demolition work that are not apparent from the drawings but are not intended to be all encompassing. Drawings, in general, show more demolition work than shown on the Demolition Photographs. In addition, photographs represent site conditions at the time photograph was taken. Site conditions may have altered since the taking of the photographs.



B. Equipment and materials, including piping within the limits of demolition, unless otherwise specified, will become the property of the Contractor.

C. Drawings define minimum portion of facilities and structures to be removed. Unless otherwise shown, clean saw cuts shall be made to limits of demolition shown. If cuts or breaks are made exceeding limits shown, repair the cuts or breaks back to the dimensions shown on Drawings at the Contractor's expense. Submit repair procedures for Authority's review. Provide saw cut at all pavement surface and curb removal limits and where neat connection lines are required.

D. Protect structures and equipment from damage during demolition work. No equipment shall be removed without the written approval of the Authority.

E. Remove piping from areas to be backfilled. Piping to be abandoned in place shall be capped with a watertight plug at demolished end in a manner that will prevent entrance

of soil, groundwater or moisture. Restrained caps or plugs shall be installed at demolished ends for pressurized services and where shown on the Drawings.

F. Only equipment specified herein, shown on the Drawings, designated by the Authority in the field for removal, or approved by the Authority during construction shall be removed. Contractor shall be responsible for the sequence of equipment removal and shall remove it with minimal damage. The limits of removal of equipment shall be as specified on the Drawings or as directed by the Authority. Equipment removal shall include removal of such items as equipment, piping and accessories, supports, piping and tubing supports, fasteners, anchor bolts, and other items. Removal of equipment shall include removal of conduits and wiring from equipment back to nearest junction box. Removal of equipment shall include removal of concrete pads that support equipment, piping and other accessories.

G. All other areas of the plant not within the limits of demolition work shown on the Demolition Photograph, Drawings or as specified herein shall be left undisturbed. Any damage to these areas during the demolition process shall be repaired or replaced to original pre-contract conditions at the Contractor's expense.

H. In areas where concrete portions are to be removed from a structure, the edge of removal shall be cut with a concrete saw to leave a perpendicular edge or core drilled when required removal is circular in shape. All reinforcing shall be cut and removed unless otherwise shown or instructed. Cracked or damaged concrete shall be removed to solid concrete. Spalled edges may be required to be re-sawn at the discretion of the Authority.

I. Cut off concealed or embedded conduit, boxes, anchor bolts, or other materials a minimum of 1 inch below final finished surface. Where necessary, empty conduits shall be plugged with fireproof sealant to maintain fire rating for wall. For existing circuits no longer needed, remove conductors from the conduit. Remove all surface-mounted conduit that is no longer needed. For conduit below grade or concealed within wall, cap and abandon conduit in place. For existing circuits to remain operational, intercept existing conduit at the most convenient location or as shown and splice and extend conduit to new location. Install new conductors where required to accomplish indicated results. New conductors shall be continuous without splices between J-boxes.



## 3.05 PARTIAL DEMOLITION

A. Remove all facilities that are scheduled for demolition to their full depth, including foundation slabs and footings, unless otherwise shown or specified for partial demolition.

B. Partial demolition includes those facilities where a portion of a structure is to remain. Partial demolition also includes the removal and disposal of all pipe, pipe hangers, mechanical equipment, equipment supports, structural attachments and supports, and embedded items from below grade portion of facilities that will be left in place and backfilled. Limits of partial demolition are shown on the Drawings.

C. Partial demolition procedures shall not impair the integrity of the existing structure that is to remain. Where necessary, and where shown, the Contractor shall saw cut or line core drill the existing structure to prevent rupturing or cracking facilities that remain in use. Those structures damaged by the Contractor that are to remain in service shall be repaired to the satisfaction of the Authority at the Contractor's expense.

D. Cut off all pipes, structural attachments, and embedded metal supports that project into the demolition area flush with the wall, floor or ceiling.

E. Remove all pipe hangers, mechanical equipment, mechanical attachments, and supports. Where necessary, empty pipes shall be plugged with fireproof sealant to maintain fire rating for wall.

F. Unless otherwise noted on the drawings where concrete removal occurs, existing reinforcing that is exposed shall be burned off at least 1 inch into the remaining concrete. All holes shall be patched with epoxy concrete to form a smooth wall or floor finish.

G. Removal of buried pipe shall be in accordance with Section 31 23 00. Backfill of the vicinity of the pipe removal shall be with Native soil conforming to the requirements of Section 31 23 00, and meeting a minimum 95% compaction, in accordance with the ASTM D1557.

## 3.06 REMOVAL OF UNDERGROUND STORAGE TANK

A. Removal of underground storage tank shall be performed in accordance with RCSA Section 22a-449(d)-107(e).

B. Removal of underground storage tank shall occur after characterization study to determine treatment and disposal requirements of water from dewatering operations and material from excavations.

C. The Authority will remove as much fuel oil as possible through existing fuel pump. Contractor shall remove and dispose of all remaining diesel fuel oil in existing piping and tank.

D. Remove all pipe, valves, controls, and accessories associated with underground storage tank from the tank back to the Administration Building.



## 3.07 MISCELLANEOUS DEMOLITION

A. All existing pavement, landscaping, and other surface features demolished because of the Contractor's activities shall be replaced back to its original condition unless other restoration work is called for on the Drawings.

## 3.08 PROTECTION

A. The Contractor shall provide protection devices including barricades, fencing, warning signs, lights, and whatever else is necessary to ensure the security of, and within, the facility during all phases of demolition. Requirements of federal, state and local statutes and regulations dealing with demolition or public safety shall be strictly adhered to by the Contractor.

## 3.09 DISPOSAL OF DEMOLITION DEBRIS

A. Remove demolition debris from the work site and dispose in accordance with all local laws, codes and ordinances at the Contractor's expense.

## 3.10 EQUIPMENT TO BE SALVAGED OR RELOCATED

A. Do not remove equipment and materials without approval of the Authority.

B. Existing equipment shall not be damaged during removal. Any damaged equipment shall be repaired by the Contractor to the satisfaction of the Authority or replaced at the Contractor's expense.

C. Properly store and maintain equipment and materials in same condition as when removed.

D. Authority will determine condition of equipment and materials prior to removal.

## 3.11 PHOTOGRAPHS AND VIDEOS

A. Prior to the removal of existing construction, create photographs or videos of the existing construction to be removed to provide documentation of this facility and its surroundings. These photographs and /or videos shall be submitted to the AUTHORITY during the pre-demolition meetings described herein.

**END OF SECTION**

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SECTION 02 60 00

EXCAVATED SOIL AND MATERIAL MANAGEMENT

## PART 1 GENERAL

### 1.01 GENERAL PROVISIONS

A. Provide all facilities, labor, materials, equipment, transportation, supervision, and related work necessary to complete the work specified in this Section, and as shown on the Drawings.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. All work under this Section of the Specifications shall be performed in accordance with Division 01 (General Requirements).

C. Coordinate work with that of all other trades affecting or affected by the Work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

D. All work shall be performed in accordance with applicable codes, permits and regulations, and the requirements of all local, state, and federal agencies having jurisdiction over the work.



### 1.02 DESCRIPTION OF WORK

A. This Section provides procedures and requirements that shall be referenced for all on-site and off-site management of excavated soils and materials. Material classification; stockpiling; off-site transportation; off-site reuse, recycling, treatment, and disposal; measures to control dust, odors, and gases; and contingencies are also included. The following Work shall be undertaken by the Contractor:

1. On-site processing and on-site reuse of excavated soils in accordance with the criteria contained herein and all applicable state and federal laws and regulations.
2. Excavate, handle, re-handle, load, and transport soils and materials from the site to legal off-site disposition (i.e., reuse, recycling, treatment, and disposal facilities) or temporary stockpiling facilities in accordance with the criteria contained herein and all applicable state and federal laws and regulations.
3. Determine appropriate off-site temporary stockpiling facility/facilities using the precharacterization data, obtain approvals, and contract directly (if applicable) with each facility that is approved by the Owner and Environmental Consultant. As necessary, arrange for and pay for additional investigations to support chemical testing required by the Environmental Consultant for Contractor-proposed off-site stockpiling facilities.
4. Determine appropriate off-site reuse, recycling, treatment, and disposal destination facility/facilities using the precharacterization data, obtain approvals, and contract directly with each facility that is approved by the Owner and Environmental Consultant. As necessary, arrange for and pay for additional on-site investigations to support chemical testing required by the Contractor-proposed off-site receiving

facilities (this does not include payment for chemical testing). Refer to Section 1.7 for additional details.

5. At the direction of the Environmental Consultant, temporarily stockpile excavated soils that have not been precharacterized either on-site or at approved off-site stockpiling facilities and reuse these excavated, uncharacterized soils to the extent possible from the locations and depths of their original excavation.
6. At the direction of the Environmental Consultant, temporarily stockpile soils on-site that appear inconsistent with precharacterization data based on visual or olfactory evidence of contamination, require additional chemical testing before on-site reuse or leaving the site, or are otherwise required to remain on-site until off-site disposition (e.g., certain contaminated soils) or on-site reuse is approved by the Environmental Consultant and Owner.
7. If off-site temporary stockpiling facilities are used for storage of soils designated for on-site reuse, load, handle, transport, convey, and place soils on the site. As necessary, the Environmental Consultant will conduct chemical testing of excess soils located at off-site temporary stockpiling facilities for disposal by the Contractor at approved off-site receiving facilities.
8. Prepare, submit for Owner acceptance and implement an OSHA-compliant, site-specific Contractor's Health and Safety Plan (CHASP).
9. Obtain and pay for (except those obtained and paid for by the Owner described herein), and comply with all required permits, licenses, and approvals. Hazardous waste storage-related permitting may be required depending on how soils that exceed Toxicity Characteristic Regulatory Levels are handled and/or stockpiled.

## 1.03 RELATED SECTIONS

A. Section 31 23 00 Excavation and Fill

## 1.04 DEFINITIONS, ABBREVIATIONS, AND REFERENCE STANDARDS

A. CTDEEP: Connecticut Department of Energy and Environmental Protection

B. MADEP: Massachusetts Department of Environmental Protection

C. EPA: U.S. Environmental Protection Agency

D. RSR: CTDEEP Remediation Standard Regulations

E. MCP: MADEP Massachusetts Contingency Plan

F. PID: Photoionization detector

G. PMC: Pollutant Mobility Criteria

H. RDEC: Residential Direct Exposure Criteria

I. RSVC: Residential Soil Vapor Criteria

J. CMR: Code of Massachusetts Regulations

K. CHASP: Contractor's Health and Safety Plan (aka Site Specific Safety Plan). A submitted and accepted document prepared by the Contractor's QHP identifying project-specific health and safety requirements including: potential exposures of any worker (including subcontractors) or the general public to contaminated soil or groundwater, and the means and methods to be employed to address these exposures to protect the health and safety of all workers (including subcontractors); and the means and methods to prevent adverse environmental impacts during the course of the Work.

L. QHP: Qualified Health Professional. A person retained by the Contractor to prepare the CHASP and for quality control as specified herein. The QHP shall have a minimum of five years' experience in this work, certification as a safety professional qualified by training and experience to act in this capacity, and certification as having completed the 40 hr. OSHA health and safety training course, with current 8-hr. refresher training and 8-hr. OSHA manager's training. The QHP may assume the role of Site Health and Safety Officer.

M. SHSO: Site Health and Safety Officer (may be the same as the QHP). A person retained by the Contractor to perform field testing for evaluation of environmental contaminants and compounds of concern in air, soil, and groundwater in accordance with the CHASP and as directed by the QHP.

N. Polluted Soil: Soil affected by a release of a regulated substance at a concentration above the analytical detection limit for such substance but below applicable RSR criteria.

O. Polluted Fill: Soil or sediment which contained polluting substances at the time such soil or sediment was deposited as fill material.

P. Contaminated Soil: Soil affected by a known or suspect release and determined, or reasonably expected to contain substances exceeding RDEC or GA PMC. Handling of contaminated soil shall be done in accordance with Section 5 of the CTDEEP General Permit for Contaminated Soil and/or Sediment Management (Staging & Transfer).

Q. Underground Storage Tank (UST): UST and associated underground piping.



## 1.05 QUALITY CONTROL AND ASSURANCE

A. The Environmental Consultant will monitor the Contractor's activities associated with the Work of this Section. The Contractor shall coordinate all Work with the Owner and Environmental Consultant by providing a minimum 3-day notice of Work activities. This monitoring may include the following activities.

1. Monitor excavated soils on a part- or full-time basis. Soils will be monitored for visual and olfactory evidence of contamination based on observed discoloration, texture, and odor to confirm that their quality is consistent with the precharacterization data. In addition, excavated soils may be monitored with a PID to screen for the presence of volatile organic compounds (VOCs). Screening will occur in the excavation area (ambient) and will be periodically performed in jar samples headspace. Ambient PID readings will be performed in the Work zone and within 6 in. of the excavated material.
2. Establishing requirements for stockpiling, segregating, and handling if the quality of the excavated soils is not consistent with the precharacterization data.

3. Reviewing requests from Contractor-proposed off-site reuse, recycling, treatment, and disposal facilities for additional chemical testing.
4. Confirming that the Contractor supplies the appropriate paperwork to accompany each load of excavated soil and material that is transported from the site (at the time the load leaves the site); and
5. Confirming that on-site temporary stockpiling and reuse and off-site temporary stockpiling, reuse, and/or disposal of soil and material is conducted in general accordance with this Section.

B. The Contractor shall be solely responsible for exercising reasonable precaution to protect the health and safety of all on-site personnel, the general public, and the environment during the course of the Work. The Contractor shall comply with all applicable provisions of federal, state, and local health and safety and occupational health and safety statutes and codes.

C. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soils and groundwater. The Contractor shall notify the Environmental Consultant of the presence of potentially hazardous conditions immediately, if encountered.

D. The Contractor shall not undertake any Work until the Owner has approved the Contractor's Health and Safety Plan.

E. No excavated soil or material shall leave the site without the prior approval of the Owner and Environmental Consultant.



## 1.06 SUBMITTALS

A. Off-site Temporary Stockpiling, Reuse, Recycling, Treatment, and Disposal Facilities
   1. As part of the bid submittal, provide the name, address, telephone number, and contact person for each proposed off-site temporary stockpiling, reuse, recycling, treatment, and disposal facility or location to the Owner and Environmental Consultant for review. This bid submittal is to prescreen the Contractor's proposed off-site receiving facilities prior to the Owner's awarding of the Contract.
   2. A minimum of 30 days prior to transport of any soils from the site, submit documentation from each Contractor-proposed receiving or stockpiling facility or location with the information below. The submittal will not be considered complete without all of this information. The Owner will review up to two facilities for each soil group. Additional reviews will be conducted at the Contractor's expense.
      a. A statement from the facility indicating that the facility has reviewed the applicable precharacterization data and soil disposal quantity information provided by the Contractor, and can legally accept the material. This statement shall also include any contingencies upon which the acceptance is based.
      b. A statement from the facility indicating if additional soil quality testing is required to meet the facility's acceptance criteria. If additional testing is required, the facility shall indicate types, numbers, and locations of tests. The Environmental Consultant and Owner will evaluate the requested additional testing and determine the reasonableness of the request. If the Owner considers the request reasonable, the Contractor shall provide the equipment to obtain the samples at

no additional cost to the Owner. The Environmental Consultant will conduct the additional testing.

c. A copy of the facility's permit, consent order(s), and other applicable documentation under which the facility is operating that indicate the facility's testing requirements and acceptance criteria.

d. A statement from the facility indicating the following:

   1) That the facility is operating in accordance with its permit, consent order(s), and other applicable documents.

   2) If any previous violations or complaints have been filed against the facility; and, if so, provide a brief statement describing the violation(s), how it was addressed, and its current status.

   3) Proposed use of soil or material (i.e., reuse, recycle, treatment, disposal, or other) at the facility.

   4) Description of facility-mandated quality assurance/quality control chemical sampling (QA/QC) that may be conducted on materials proposed for transport to the facility.

   5) Any limitations on soils or materials proposed for transport to the facility based on material consistency (i.e., granular soil, organic soil, or cohesive soil, debris content, slurry excavate, etc.).

   6) Whether the facility is an EPA Superfund site or part of one.

   7) Remedial treatment systems that are in operation at the facility, if any.

   8) If any releases have occurred at or adjacent to the site, if they have been reported to the CTDEEP, MADEP, or other applicable agencies and the status of the release.

e. For Group I facilities as defined herein other than regulated landfills, a statement from the facility and/or the Contractor indicating if local municipal ordinances require filing of applications for any permits relative to reuse, stockpiling, or transport of soils within the municipality of the receiving site.

f. For receiving facilities in Massachusetts, provide facility information necessary to complete Section E of MADEP Bureau of Waste Prevention Material Shipping Record and Log or Uniform Hazardous Waste Manifest for each facility.

g. For facilities in states other than Massachusetts, provide a trucking manifest form acceptable to the Owner unless otherwise directed by the Owner. The manifest shall include the following information, at a minimum:

   1) Generator ID number and manifest tracking number (as applicable).

   2) Name, address(es), contact person, and phone of the site generating the soil/material.

   3) Transporter name(s), contact person, phone, and ID number(s).

   4) Name, address, contact person, and phone of the site receiving the soil/material.

   5) Truck, and trailer if applicable, license plate number(s).

   6) Soil/material description, container number(s)/type(s), container volume, and waste codes (as applicable).

   7) Printed name and signature of generator and date (if applicable).

   8) Printed name and signature of transporter and date that load left site.

   9) Printed name and signature of the receiving facility representative and date the load was received.

3. The Owner and the Environmental Consultant will review the information submitted by the Contractor. Review of the information may take up to 14 days. The Owner may reject a facility if the submittal process is incomplete, or if the Owner deems the proposed facility unacceptable. Reasons that a facility may be deemed unacceptable include, but are not limited to, the following: if the facility is not operated in accordance with state guidelines or a state granted permit applicable to or issued to the facility, if the facility is or is part of an EPA Superfund Site, if the facility is located on or adjacent to an aquifer or aquifer protection area, if there are unreported or outstanding releases at the site, if previous releases have not been dealt with to the satisfaction of the Owner, if the facility controls for accepting and monitoring waste are not adequate, if existing material at the site does not meet the permit or site guidelines, or any reason that may put the Owner at risk.
4. Once the submittal requirements outlined above are completed to the satisfaction of the Environmental Consultant, the Environmental Consultant will prepare a letter of acceptance for signature by the facility or the facility's authorized representative. This letter, once signed and returned to the Environmental Consultant, will constitute approval of the facility for this project. The Environmental Consultant will prepare this letter within 7 days of acceptance of the facility. The Owner maintains the right to reject any proposed facility at any time in the review and acceptance process.
5. A minimum of 14 days prior to transport of any soils from the site, provide a letter stating the name and address of the transporter for each material group classification and each off-site facility as applicable. The Environmental Consultant will prepare manifests (Material Shipping Record and Logs or Uniform Hazardous Waste Manifests) for each approved Massachusetts facility within 7 days of approval of the facility. The Contractor shall prepare trucking manifests and/or other required shipping records for approved facilities in States other than Massachusetts.
6. Within 30 days of last shipment, submit copies of completed trucking manifests and Material Shipping Record & Log Forms documenting transport of excavated soils and materials from the site to approved off-site disposal, reuse, recycling, and treatment facilities. This information is required for payment of Contractor work.
7. Within 30 days of last shipment, submit copies of weight slips for each load transported from the site to approved off-site disposal, reuse, recycling, and treatment facilities. This information is required for payment of Contractor work.

B. Prepare a Soil Management Plan describing the schedule, sequence, and procedures for excavation, off-site disposal of soil (including cobbles, boulders and bedrock), on/off-site reuse of soils, and on/off-site temporary stockpiling, and other information requested by the Environmental Consultant. The narrative shall include description and accompanying scale drawing indicating the space to be used for various activities and controls (e.g., stockpiling, jersey barriers, space for removal of debris, etc.). Narrative shall include schedule and anticipated volume of soil generation for various activities and destinations, and schedule and anticipated location for reuse. Submit the Soil Management Plan allow adequate time for review and acceptance by the Owner and Environmental Consultant (i.e., a minimum of 14 days prior to any earthwork activities).

C. Unless otherwise indicated by the Environmental Consultant, within 7 days of completion of earthwork activities, the Contractor shall submit a drawing documenting locations and depths (in elevation) where soil Groups (other than Group I-1) are reused on-site and the location and depths of the source material (as applicable). The drawing shall be submitted to the Owner and Environmental Consultant for review and acceptance.

D. Health and Safety

1. Submit qualifications of the QHP and SHSO. The QHP and SHSO shall have a minimum of five years of experience in this work, certification as a safety professional qualified by training and experience to act in this capacity, and certification as having completed the 40 hr. OSHA health and safety training course, with current 8-hr. refresher training and 8-hr. OSHA manager's training. The QHP may assume the role of SHSO.
2. Submit to the Owner a CHASP prepared by the Contractor's QHP and obtain approval by the Owner prior to commencing Work. The CHASP shall apply to all Work to be conducted at the site, taking into consideration all workers on-site, the general public, and the environment. Training will not be provided by the Owner or the Environmental Consultant. The plan shall include the following information:
    a. A list of the Contractor's work tasks that may involve contact, excavation, and/or handling of contaminated soil and/or groundwater.
    b. Compounds of concern that may be encountered during the course of the Work and signs/symptoms of exposure.
    c. Potential for worker exposure to the compounds of concern for each work task.
    d. Requirements for OSHA training for each work task and a record or schedule for training of Contractor and subcontractor workers in the use of personal protective equipment.
    e. Work task specific levels of protection and a description of health and safety equipment including protective clothing, respiratory equipment and monitoring instruments.
    f. Procedures for containing oil and/or hazardous materials such as decontamination of heavy construction equipment and tools.
    g. Procedures for monitoring, controlling, and mitigating fugitive dust, odors, and gases for each work task to protect worker and public health and safety, including descriptions of monitoring instruments and action levels triggering responses by the Contractor (e.g., donning personal protective equipment).
    h. Emergency Response Plan.

The CHASP must be completed for discussion at the Health and Safety coordination meeting scheduled by the Contractor and held at least 3 days prior to commencement of Work relating to possible exposure to contamination at the site. The Contractor shall provide written notice of this meeting to all interested parties at least 5 days before the meeting.



## 1.07 ADDITIONAL TESTING (AS NECESSARY)

A. The Contractor shall incorporate additional testing into the project sequence, logistics, and schedule. The Contractor will not be responsible for the laboratory costs of additional chemical testing.

B. Arrange and pay for additional on-site investigations (e.g., test pits) to support chemical testing required by the Contractor-proposed off-site receiving or stockpiling facilities. Additional testing requested by the Contractor's proposed receiving facilities and approved by the Owner shall be performed by the Environmental Consultant. The Contractor shall coordinate with the Environmental Consultant.

C. Some Contractor-proposed receiving facilities may conduct quality assurance/quality control (QA/QC) chemical testing of soils upon arrival at the receiving facility. The precharacterization data is considered to be representative of the soil to be excavated (unless otherwise during construction as described herein), QA/QC chemical testing results conducted by the receiving facility may differ from the precharacterization data due to the heterogeneous nature of urban fill and naturally-deposited soils. Should the receiving facility's QA/QC chemical testing results differ from the precharacterization data and exceed the receiving facility's acceptance criteria, the receiving facility may reject the material, and require that it be removed from the facility. The Contractor will incur the cost of this additional handling and transport back to the site or other approved facilities.

## PART 2 PRODUCTS

### 2.01 STOCKPILE AND CONTAINMENT MATERIALS

A. Stockpile covers: Polyethylene sheeting with min. 6-mil thickness (ASTM D4397), or thicker as required for stability and tear, puncture, or ultraviolet resistance based on site/weather conditions and methods used to secure the cover.

B. Stockpile liners: High density polyethylene (HDPE) sheeting with min. 30-mil thickness (ASTM D-5199.8) unless otherwise proposed by the Contractor and accepted by the Environmental Consultant.

C. Stockpiling containment/ soil segregation: Jersey barriers, deadmen, hay bales and silt fence, or other barrier/container systems proposed by the Contractor and accepted by the Environmental Consultant.

D. Marker layer between soil types: Geotextile fabric, snow fence, or other material(s) acceptable to the Owner and Environmental Consultant.



## PART 3 EXECUTION

### 3.01 GENERAL

A. Work shall be performed in accordance with the approved CHASP, and any registrations or permits obtained for the project (e.g., Contaminated Soil and/or Sediment Management (Staging and Transfer)).

B. The Contractor will be responsible for excavating, conveying, loading/re-loading, handling/re-handling, screening, stockpiling, and transporting soil and material from the site (except transport of hazardous waste soil) to legal and approved off-site disposition (i.e., reuse, recycling, treatment, and disposal facilities) or temporary off-site stockpiling facilities. If off-site temporary stockpiling facilities are used for storage of soils designated for on-site reuse, the Contractor will be responsible for loading, handling, transporting, conveying, and placing soils on the site.

C. Soil or material shall not be transported to residential settings, schools, playgrounds, or such similar sites unless otherwise approved in writing by the Owner and the Environmental Consultant.

D. The control of odor during all phases of work shall be the sole responsibility of the Contractor. Contractor shall control odors such that odors do not present a nuisance beyond site boundaries.

E. Decontaminate all equipment and tools which have come into contact with contaminated and hazardous waste soil and groundwater in accordance with the approved CHASP prepared by the Contractor to prevent the spread of contamination.

## 3.02 HEALTH AND SAFETY

A. The Contractor shall be solely responsible for exercising reasonable precaution to protect the health and safety of all on-site personnel, the general public, and the environment during the course of the Work. The Contractor shall comply with all applicable provisions of federal, state, local, and Owner health and safety and occupational health and safety statutes, codes, rules, and regulations.

B. Prepare a CHASP that ensures the health and safety of all workers engaged in work at the site and the general public at all times when exposure to contaminated soil, contaminated groundwater, dust, odors, or gases is possible. Implement the plan throughout the execution of the work.

C. The Contractor is required to notify all workers of the history of the site and contaminants that may be present, and to be alert for evidence of contaminated soils and hazardous waste soils and groundwater. The Contractor shall notify the Environmental Consultant of the presence of potentially hazardous conditions immediately, if encountered.

D. The Contractor shall monitor the excavation using the equipment described in the CHASP.

E. Contractor's workers who will be engaged in work at the site that might result in exposure to contaminated and hazardous waste soil or groundwater shall attend the health and safety coordination meeting and any follow-up supplemental briefings.

F. Provide adequate health and safety training for all personnel who may come in contact with or be exposed to contaminated materials during the course of the work.

G. Provide personnel, including personnel for subcontractors that are 40-hr. OSHA trained with an 8-hr. OSHA refresher course completed within the previous calendar year. These personnel and their training shall be provided at no additional cost to the Owner. The Contractor shall provide, at the Owner's request, certificates for each worker to demonstrate compliance with this requirement.

H. As necessary, provide personnel, including personnel for subcontractors, that are confined space entry trained to complete the Work specified herein and in other Sections. These personnel shall be current in all applicable and necessary refresher courses. These personnel and their training shall be provided at no additional cost to the Owner. The Contractor shall provide, at the Owner's request, certificates for each worker to demonstrate compliance with this requirement.

I. Personnel who have not received training, and who are not equipped with the required protective clothing and equipment, shall not be permitted access to the site by the

Contractor during the course of the work that may result in exposure to hazardous waste/contaminated soil or groundwater.

## 3.03 CLASSIFICATION OF SOILS AND MATERIALS

A. Excavated materials shall be classified into four general groups and numerous subgroups for the purposes of on- or off-site stockpiling, or on- or off-site reuse, recycling, treatment, and disposal. The classification system is based on criteria established by applicable federal, state, and local agencies having jurisdiction over the Work.

1. Group I: Soils that contain substances at concentrations below the applicable CTDEEP Residential Direct Exposure Criteria (RDEC).
    a. Group I-1: Naturally-deposited soils or fill soils that contain no detectable substances other than metals at or below background conditions typical for natural soils, and meet the CTDEEP RDEC, Pollutant Mobility Criteria (PMC) for areas with groundwater classified "GA" by the CTDEEP (GA-PMC), and Residential Soil Vapor Criteria (RSVC).
    b. Group I-2a: Naturally-deposited soils (Polluted Soils) or artificially-deposited fill (Polluted Fill) that contain substances at concentrations above laboratory detection limits but below CTDEEP RDEC, GA-PMC, RSVC, and that are not otherwise a hazardous waste, as specified in CTDEEP Regulations.
    c. Group I-2b: Naturally-deposited soils (Polluted Soils and Contaminated Soils) or artificially-deposited fill (Polluted Fill) that contain substances at concentrations above laboratory detection limits but below CTDEEP RDEC, GB-PMC, RSVC, and that are not otherwise a hazardous waste, as specified in CTDEEP Regulations.
    d. Group I-3: Naturally-deposited soils (Polluted Soils and Contaminated Soils) or artificially-deposited fill (Polluted Fill) that contain substances at concentrations above laboratory detection limits but below CTDEEP RDEC and RSVC, above GB-PMC, and that are not otherwise a hazardous waste, as specified in CTDEEP Regulations.
2. Group II: Polluted and Contaminated soils that contain substances at concentrations above the applicable RDEC.
    a. Group II-1: Soils that meet all applicable criteria (i.e., COMM-97-001 and/or facility-specific permit requirements) for reuse as daily cover, intermediate cover, or pre-cap contouring material at Massachusetts unlined landfills; or reused at other facilities proposed by the Contractor and approved by the Owner.
    b. Group II-2: Soils that meet all applicable criteria (i.e., COMM-97-001 and/or facility-specific permit requirements) for reuse as daily cover, intermediate cover, or pre-cap contouring material at Massachusetts lined landfills; or reused at other facilities proposed by the Contractor and approved by the Owner.
    c. Group II-3: Soils that exceed Massachusetts landfill criteria (i.e., COMM-97-001 and/or facility-specific permit requirements), but meet all applicable criteria for asphalt batching at the proposed facility, and are not classified as a RCRA Hazardous Waste. The Contractor may propose to reuse these soils at other facilities. The Owner will review and approve or reject.
    d. Group II-4: Soils that contain concentrations of contaminants that require removal to regional out-of-state recycling or thermal treatment facilities, and that are not classified as a RCRA Hazardous Waste. The Contractor may propose to reuse these soils at other facilities. The Owner will review and approve or reject.

e. Group II-5: Soils that contain concentrations of contaminants that require removal to regional disposal facilities and that are not classified as a RCRA Hazardous Waste. Some of the soil may be appropriate for reuse as “cover” at the facility. The Contractor may propose to reuse these soils at other facilities. The Owner will review and approve or reject.

f. Group II-6: Soils that require removal to regional disposal facilities, and are not classified as a RCRA Hazardous Waste. The Contractor may propose to reuse these soils at other facilities. The Owner will review and approve or reject.

3. Group III: Hazardous Waste

a. Group III-1: Soils determined to contain "listed" or "characteristic" hazardous waste constituents that cannot be readily treated on-site. These soils must be transported to an approved out of state RCRA Subtitle C hazardous waste disposal or treatment facility under Uniform Hazardous Waste Manifest.

b. Group III-2: Soils determined to contain "listed" or "characteristic" hazardous waste constituents that can be readily treated on-site to remove applicable leachable contaminant concentrations. Following treatment, the material will be reclassified depending on other contaminants and disposed of at a Group II-2, II-3, II-4, II-5, or II-6 facility, as applicable.

4. Group IV: Solid Waste. Debris such as paper, glass, wood, metal, piles, and miscellaneous rubble shall be disposed at CTDEEP-approved solid waste landfills or processed and recycled if possible.

B. In the absence of additional chemical test data, commingled soils shall default to the “highest” Group classification of soils that are co-mingled. The Contractor shall bear all additional disposal costs (and related incidental costs) associated with commingling of various soil Groups unless such commingling is directed or approved by the Owner.

C. Bedrock is assumed to contain no detectable substances other than metals at or below background concentrations (i.e., consistent with Group I-1 as defined herein). If there is evidence that a release to the environment has occurred proximate to the bedrock and subsequent bedrock testing indicates contamination, then contaminant levels will be compared to regulatory and disposal facility criteria and classified in accordance with the Group Classifications outlined herein.

D. Group classification shall be based on precharacterization data. Material located within the representative zone of the precharacterization test locations shall be assumed similar in quality to the tested material and classification is based on the test results for the representative sample.

1. Soils may be re-classified by the Environmental Consultant during or after excavation based on field screening, visual and olfactory observations, and/or the results of additional laboratory chemical testing.

## 3.04 EXCAVATION

A. Excavate by methods that will permit observation of soils for the purpose of identifying, screening, testing, and segregating soils as necessary prior to off-site removal.

B. Conduct excavation to prevent commingling of soil Groups and/or soil lithologies (e.g., fill, natural soils).

C. Segregate oversized and/or other deleterious materials from excavated soils prior to off-site removal as necessary to meet disposal facility acceptance criteria (e.g., soils shall not contain more than 20 percent asphalt, brick, concrete, wood or metal, in accordance with 310 CMR 19.017) or as directed by the Environmental Consultant. Segregation may consist of hand labor or mechanical screeners.

## 3.05 MANAGEMENT OF EXCAVATED SOILS AND MATERIALS

A. Soils excavated within the site shall be assumed for bidding purposes representative of the chemical test data collected as part of the Precharacterization Program and shall be managed (environmentally) as follows relative to off-site disposition or on-site reuse:

| | Fill Soils | | Natural Soils | |
|---|---|---|---|---|
| Soil Group Type | Off-Site Disposition | On-Site Reuse | Off-Site Disposition | On-Site Reuse |
| I-1 | "Unrestricted" subject to Owner review[1]. | To underside of landscaping or pavement section. | "Unrestricted" subject to Owner review[1]. | To underside of landscaping or pavement section. |
| I-2a | Direct load and transport to Massachusetts unlined landfills[2]. | To underside of landscaping or pavement section, and above groundwater. | Direct load and transport to Massachusetts unlined landfills[2]. | To underside of landscaping or pavement section, and above groundwater. |
| I-2b | Direct load and transport to Massachusetts unlined landfills[2]. | To underside of landscaping or pavement section, and above groundwater. | Direct load and transport to Massachusetts unlined landfills[2]. | To underside of landscaping or pavement section, and above groundwater. |
| I-3 | Direct load and transport to Massachusetts unlined landfills[2]. | Within building footprint between groundwater level and underside of building slab. | Direct load and transport to Massachusetts unlined landfills[2]. | Within building footprint between groundwater level and underside of building slab. |
| II-1 through II-6 | Direct load and transport to MA lined landfills, asphalt batch and thermal treatment facilities, out-of-state regulated disposal facilities, as applicable for each Group type. No on-site reuse. | | | |
| III-1 | Direct load and transport to approved Hazardous Waste disposal facility. No on-site reuse. | | | |
| III-2 | Not Applicable. | | | |

| | Fill Soils | | Natural Soils | |
|---|---|---|---|---|
| Soil Group Type | Off-Site Disposition | On-Site Reuse | Off-Site Disposition | On-Site Reuse |
| IV | Direct load and transport to approved Solid Waste receiving facilities. No on-site reuse. | | | |
| None Assigned/ Unchar-acterized | Soils excavated beyond the limits to which the Precharacterization Program chemical test data can be applied (as determined by the Environmental Consultant) shall be stockpiled in accordance with the requirements herein (i.e., segregate by soil lithologies and Type, prevent comingling), and reused on-site where indicated by the Environmental Consultant unless additional testing is performed by the Environmental Consultant. | | | |

1. Unrestricted" locations must be submitted at the time of bid by the Contractor and approved by the Owner following review by the Owner and Environmental Consultant.
2. or, if submitted at the time of bid by the Contractor and accepted in writing by Owner following review by the Owner and Environmental Consultant, (a) approved temporary off-site stockpiling facilities for future return to the site, and/or (b) other regulated facilities including non-landfill facilities/projects. Approval of facilities is dependent on Group Type and other factors per Paragraph 1.7A.

B. The Contractor shall perform the work to maximize the reuse of fill soils and Group I-2a and I-2b.

C. The Contractor shall perform the work such that sufficient volume of soil is stockpiled both off-site and on-site for backfilling and new imported materials are not required except for select geotechnical, landscaping, and site civil materials.

D. All disposal/reuse and stockpiling facilities and locations will be proposed by the Contactor and approved (or rejected) by Owner and the Environmental Consultant. Non-regulated facilities and sites may require approval by CT DEEP to accept polluted soils.

E. If necessary, the Contractor shall register for and obtain the CTDEEP General Permit for Contaminated Soil and/or Sediment Management (Staging and Transfer), including all costs and fees associated with securing this permit. Registration for this permit will not be required if soil is direct loaded for removal to accepted off-site disposition facilities and no temporary stockpiling is needed. [Note that this permit is presently not available but could be renewed at any time. However, handling of contaminated soil requires compliance with Section 5 of the above-mentioned General Permit.]

F. At the direction of the Environmental Consultant, the Contractor shall segregate and temporarily stockpile excavated soils on the site if visual, olfactory, or field screening evidence indicates inconsistencies with the Group classification. The Contractor shall coordinate with the Owner and Environmental Consultant to have the soils tested and reclassified as necessary prior to off-site removal.
   1. If the Contractor wishes to temporarily stop earthwork activities at no cost or schedule impact to the Owner in an area requiring reclassification, then the Contractor shall provide the necessary equipment at no cost for the Environmental Consultant to obtain soil samples.

## 3.06 OFF-SITE REUSE, RECYCLING, TREATMENT, DISPOSAL

A. Determine appropriate off-site reuse, recycling, treatment, and disposal destination facility/facilities using the precharacterization data. Contract directly with each facility that is approved by the Owner and Environmental Consultant.

B. For Group I disposal facilities, other than regulated landfills, the Contractor shall determine if municipal ordinances require filing of applications for any permits relative to reuse, stockpiling, or transport of soils within the municipality of the receiving site. The Contractor shall incorporate the time to file and obtain such permits in the planning and execution of its work. The Contractor will be responsible for the costs for obtaining the permit(s) as required by municipal ordinances.

## 3.07 TRANSPORTATION OF EXCAVATED MATERIAL

A. The Contractor shall, with the assistance of the Environmental Consultant, complete all paperwork necessary to transport excavated soils and materials from the site to approved off-site facilities. The process to prepare the required paperwork and achieve approval at an off-site facility may require 20 to 30 (or more) business days plus any time for additional chemical testing required by the Contractor-proposed facility.

B. The Owner or Environmental Consultant will provide interaction with the CTDEEP, MADEP or other agencies, if required.

C. The Contractor shall take measures to prevent debris from being spilled from trucks or tracked from the site onto local streets. Soil material on the truck outside of the container (i.e., tires, tailgate) shall be removed within a designated decontamination area prior to leaving the site. All trucks leaving the site shall be covered and cleaned of debris that may fall from the trucks during transport. The Contractor shall sweep streets adjacent to the site as necessary or as directed by the Owner.

D. Excavated soils and materials removed from the site shall be loaded into trucks with secure containers within the site or designated areas as approved by the Owner and Environmental Consultant. Trucks shall not be loaded until the receiving facility is approved.



## 3.08 TEMPORARY STOCKPILING OF EXCAVATED MATERIAL

A. The Contractor will be responsible for the cost of obtaining all required permits for any approved off-site stockpiling facility.

B. The Contractor shall provide access to all temporary stockpile locations to the Owner and the Environmental Consultant for the purpose of observing site activities and collecting environmental samples to document site conditions, as needed.

C. Unless otherwise approved by the Owner and Environmental Consultant, soils representative of the precharacterization data that are to be stockpiled shall be segregated and stockpiled by Group classification (i.e., a separate stockpile for each soil Group classification) AND soil lithologies (e.g., fill, natural soils).

1. Soils that are not representative of precharacterization data or uncharacterized soils that require additional testing shall be segregated on-site in separate stockpile(s) according to direction by the Environmental Consultant and located in areas proposed by the Contractor and approved by the Owner and Environmental Consultant.
2. Soils temporarily stockpiled off-site for later on-site reuse or off-site disposition shall be segregated by Group classification or as otherwise directed by the Environmental Consultant.

D. Install Jersey barriers, deadmen, or other acceptable and suitable barriers around stockpiles to provide confinement and segregation. Haybales and other siltation control measures are required to prevent erosion and washing of stockpiled soils from their temporary storage locations.

E. Subgrades of proposed soil stockpiles shall be covered with stockpile liners prior to stockpiling unless an impermeable surface acceptable to the Environmental Consultant is present. Excavated soils may be stockpiled on soils of the same Group classification if accepted by the Environmental Consultant.

F. Stockpiles shall be covered with stockpile covers at the end of each workday to prevent erosion or the emission of fugitive dust, odors, and gases. Covers shall be secured to prevent cover removal by weather conditions. Stockpiles shall be shaped and graded in accordance with the approved Contractor's Soil Management Plan.

G. At the direction of the Owner or Environmental Consultant, materials can also be stored in containers ranging in size from 55-gallon drums to covered "roll-off" trailers lined with polyethylene sheeting. Storage in containers located on the site may be required if visual, olfactory, field screening evidence or testing indicates inconsistencies with the Group classification or contamination.

H. The balance of the soils remaining following on-site reuse may require testing by the Environmental Consultant to determine off-site disposition requirements and shall be transported to approved facilities from on-site or off-site temporary stockpile locations by the Contractor.

## 3.09 ON-SITE REUSE OF EXCAVATED SOILS

A. Backfill material will be required to construct the site improvements. Site logistics and on- and off-site stockpiling availability will determine the feasibility of reusing select excavated soils as backfill material. The Contractor shall coordinate, sequence, and schedule work as required to enable reuse of specified soils on-site.

B. Soils designated for on-site reuse shall be processed (i.e., screened), as necessary, to remove oversize cobbles or boulders, and shall be protected from the elements (covered) at all times while stockpiled. Soil that becomes unusable due to the Contractor's activities shall be disposed off-site in accordance with this Section at the sole cost of the Contractor. Such activities are considered those that the Contractor undertakes (or does

not undertake) which result in excavated soils not being able to be reused as fill at the time the soils are required for reuse (e.g., trafficking over prepared surfaces, failure to cover stockpiles, comingling, etc.).

C. Based on environmental aspects only, the various soil groups may be reused as specified in Section 3.5A and as proposed by the Contractor and accepted in writing by the Owner and Environmental Consultant. Suitability of the Contractor's proposed on-site reuse of excavated soils will be subject to complying with the requirements of Section 31 23 00 unless otherwise indicated by the Owner's Geotechnical Engineer.

## 3.10 CONTINGENCIES

A. If potentially hazardous conditions develop during the course of the Work, the Work in that specific area shall be terminated until the hazardous condition has been addressed to the Environmental Consultant and Owner's satisfaction. Potentially hazardous conditions include, but are not limited to, encountering buried containers, tanks, or drums.

1. In the event that buried containers, drums or tanks (i.e., USTs) are encountered or if a release of oil or potentially hazardous materials has occurred, the Contractor shall notify the Environmental Consultant and Owner immediately. The Contractor shall secure the area to prevent health risks to workers or the public and releases into the environment. The sources of the event causing the material to be considered suspect will be evaluated by the Environmental Consultant and Owner.
2. If encountered, USTs, associated piping and any associated contaminated soil will be excavated and disposed of off-site in accordance with this Section. The Contractor shall notify the local Fire Department or CTDEEP, as required, upon discovery of the UST. The Contractor shall obtain permission for removal of USTs. Confirmatory soil samples will be collected by the Environmental Consultant from the sidewalls and bottom of the UST excavation to confirm that all soil in excess of RSR criteria has been removed. There is reportedly one 10,000-gallon UST that will require removal as part of this project.

B. Pursuant to CTDEEP's Solid Waste Regulations, if greater than ten cubic yards of Solid Waste are disposed at a location, it constitutes a Solid Waste Disposal Area. It may be necessary to obtain a Disruption Permit from CTDEEP for managing and disposing of solid waste (e.g., some types of buried demolition debris). The need for this permit is determined by the amount and type of solid waste, and will be assessed during excavation and upon consultation with CTDEEP. If required, this permit will be obtained by the Owner. The Contractor will not be responsible for costs for this permit.

C. Excavation beyond the limits of proposed improvements and excavation areas may be required to remove soil or material presenting visual, olfactory, or field screening evidence of contamination. The Owner and Environmental Consultant will direct the Contractor to perform this Work when necessary.

D. The impact on the Work should be evaluated and, if necessary, the CHASP should be revised in response to contingencies.

END OF SECTION

# DIVISION 03
# CONCRETE

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SECTION 03 11 00

CONCRETE FORMING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Formwork requirements for concrete construction.

### 1.02 QUALITY ASSURANCE

A. References:

1. The references listed below are part of this section. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ACI 117 | Tolerances for Concrete Construction and Materials |
| ACI 301 | Specifications for Structural Concrete |
| ACI 318 | Building Code Requirements for Structural Concrete |
| National Institute of Standards - PS1 | Construction and Industrial Plywood |



B. Design – General:

1. Provide design of formwork, shoring and reshoring systems by the Contractor's Professional Engineer currently registered in the State of Connecticut.
2. Design, engineering, and construction of formwork, shoring, and reshoring systems is the responsibility of the Contractor.
3. Develop a procedure and schedule for removal of shores (and installation of reshores).
4. Structural record calculations, signed and sealed by the Contractor's Engineer, are required to prove that all portions of the structure, in combination with the remaining forming and shoring systems, have sufficient strength to safely support their own weight plus the loads placed thereon.
5. When developing procedures, schedules, and structural calculations; consider the structural system that exists, effects of imposed loads, and the strength of concrete at each stage of construction.

C. Design Criteria:

1. Design formwork in accordance with ACI 301 and ACI 318 for building structures and ACI 350 and 350.5 for environmental structures to provide concrete finishes as specified in Section 033000.
2. Design systems for full height of wet concrete pressure.
3. Design formwork to limit maximum deflection of form facing materials, as reflected in concrete surfaces exposed to view, to 1/240 of span.

## 1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturer's product data with installation instructions:
      a. Form materials.
      b. Form ties (with waterstops).
      c. Form release compound.
      d. Void forms.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Letter of certification:
      a. Stating that formwork has been designed in accordance with this specification and referenced documents, sealed and stamped by the Contractor's registered design Engineer.



# PART 2 PRODUCTS

## 2.01 FORMS

A. Wood Forms:
   1. Provide new and unused exterior grade plywood panels manufactured in accordance with American Plywood Association (APA) and bearing the trademark of that group.
      a. Forms for concrete surfaces exposed to view: use APA High Density Overlay (HDO) Plyform Class I Exterior 48" X 96" X 3/4".
      b. Forms for other concrete surfaces: use APA Douglas Fir B-B Plyform Class I Exterior 48" X 96" X 3/4-inch.
      c. When approved, plywood may be reused.

B. Metal Forms:
   1. Do not use aluminum. Provide forms free of rust and straight without dents to provide members of uniform thickness.

## 2.02 FORM TIES

A. Commercially fabricated for use in form construction. Fabricated so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete. Cone on ends shall be 3/4 inch to 1 inch diameter. Provide embedded portion of tie not less than 1 1/2 inch from face of concrete after cone ends have been removed. Provide ties with integral waterstops at water-retaining and below grade structures.

B. Tapered through-bolts may be used when approved. Use 1-inch minimum diameter at the smallest end. Fill tapered tie holes after cleaning to produce watertight construction. Use a mechanical waterstop plug near the center of the wall and fill each side with non-shrink cement grout. Mechanical waterstop plug shall be Greenstreak Group, Inc. "X-Plug"; or equal.

## 2.03 FORM RELEASE COMPOUND

A. Coat form surfaces in contact with concrete using a non-staining, non-residual, water based, bond-breaking form coating.

## PART 3 EXECUTION

## 3.01 PREPARATION

A. Cover surface of forms with form release compound prior to form installation in accordance with manufacturer's recommendations.

B. Do not permit excess form coating material to stand in puddles on forms or hardened concrete surfaces against which fresh concrete is to be placed.

C. Clean surfaces of forms, reinforcing steel and other embedded items of accumulated mortar, grout, or other foreign materials from previous concreting or construction activities before concrete is placed.

## 3.02 FORMWORK CONSTRUCTION

A. Form vertical surfaces of cast-in-place concrete including sides of footings.

B. Construct and place forms so that the resulting concrete will be of the shape, lines, dimensions, and appearance indicated on the Drawings. Brace or tie forms together to maintain position and shape under the load of freshly-placed concrete.

C. Tighten forms to prevent leakage.

D. Provide temporary openings (windows) at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.

E. Provide temporary openings to limit height of free fall of concrete and to limit the lateral movement of concrete during placement. Openings are required in wall placements greater than 20 feet in height, spaced no more than 8 feet on center measured horizontally and vertically.

F. Place a 3/4-inch chamfer strip at exposed to view corners of formed surfaces.

G. At construction joints, overlap hardened concrete surface by at least 1 inch. Brace forms against hardened concrete to prevent movement, offsets, or loss of mortar at construction joint and to maintain a true surface. Where possible, locate juncture of built-in-place forms at architectural lines, control joints, or at other inconspicuous lines.

H. Where circular sections are formed using flat faced materials, use flat form lengths not exceeding 2 feet wide and the resulting deflection angles at the joints is not greater than 3-1/2 degrees.

I. Construct wood forms for openings to facilitate loosening. Anchor forms so that movement of any part of the formwork system is prevented during concrete placement.

J. At platforms constructed to move equipment over in-place reinforcement, provide beams, struts, and/or legs, supported directly on formwork or other structural members without resting on reinforcing steel.

K. Provide a positive means of adjustment (wedges or jacks) at shores and struts to take up settlement during concrete placement. Brace forms against lateral deflection. Fasten in-place wedges and shims used for final adjustment of forms prior to concrete placement.

L. Place tapered through-bolt form ties with the larger end on the side of the structure in contact with liquid.

## 3.03 TOLERANCES

A. Install formwork with tolerances in accordance with ACI 117 and the following (the more stringent requirement controls):

1. Install formwork in accordance with manufacturer's written instructions.
2. Vertical surface tolerance from plumb; walls, columns, piers, and risers:
   ± 1/2 inch for entire height
   ± 1/4 inch in any 10 feet of height
3. Vertical surface tolerance from plumb; exposed wall corners, end columns, control-joint grooves, and other exposed to view vertical lines:
   ± 1/2 inch for entire height
   ± 1/4 inch in any 20 feet of height
4. Horizontal variation from level or from grade; top of slabs, slab soffits, ceilings, and beam soffits, measured before removal of supporting shores:
   ± 3/4 inch for entire length
   ± 3/8 inch for any bay or 20 foot length
   ± 1/4 inch in any 10 feet of length
5. Horizontal variation from level or from grade; exposed lintels, sills, parapets, horizontal grooves, and other exposed-to-view horizontal lines:
   ± 1/2 inch for entire length
   ± 1/4 inch in any 20 feet of length.
6. Plan position variation; columns, walls, and partitions:
   ± 3/4 inch for entire length
   ± 3/8 inch for any bay or 20 foot length
7. Plan location and size; sleeves, floor openings, walls, wall openings, beams, and columns:
   ± 1/2 inch
8. Cross sectional dimensions; columns and beams and thickness of slabs and walls:
   ± 3/8 inch
9. Plan dimensions; footings and foundations:
   minus 1/2 inch
   + 2 inches
10. Misplacement or eccentricity; footings and foundations:
    2 percent of footing width in direction of misplacement
    not more than 2 inches
11. Thickness; footings and foundations:
    minus 5 percent

no limit on the maximum increase except that which may interfere with other construction.

12. Step variance in flight of stairs:
    Rise ± 1/16 inch
    Tread from level ± 1/8 inch

B. Use control points and benchmarks for reference purposes to check tolerances. Establish and maintain reference points in an undisturbed condition until final completion and acceptance of the work.

C. Regardless of tolerances listed, no portion of a structure shall extend beyond the legal boundary of work site.

D. Camber formwork to compensate for anticipated deflections in formwork under wet load of concrete. Adjust camber to maintain above specified tolerances in hardened concrete after forms and shoring are removed.

## 3.04 REMOVAL OF FORMS

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure in combination with remaining forming and shoring systems has sufficient strength to safely support its weight and loads placed thereon.

B. If forms are loosened and not removed, proceed same day with wet curing operations to soak surfaces of concrete where forms are loosened. When wet curing is not practical or not planned, loosen, remove, and start approved curing procedures on the same day.

C. When required for concrete curing in hotweather, required for repair of surface defects, or when required for finishing at an early age; remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

D. Remove top forms on sloping surfaces as soon as concrete has attained sufficient stiffness to prevent sagging. Make repairs or finishing treatment on such sloping surfaces immediately after form removal.

E. Remove wood forms for wall openings as soon as this can be accomplished without damage to concrete.

F. Remove formwork from columns, walls, sides of beams, and other parts not supporting weight of concrete as soon as concrete has hardened sufficiently to resist damage from removal.

G. When shores and supports are so arranged such that non-load-carrying form facing material can be removed without loosening or disturbing other shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

H. In all cases, proceed with curing same day as form removal.

I. Where no reshoring is planned, forms and shoring used to support weight of concrete shall be left in place until concrete has attained its specified 28-day compressive strength.

## 3.05 RESHORING

A. Do not impose construction loads or remove shoring from any part of the structure until that portion of the structure, in combination with remaining forming and shoring systems, has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads are permitted on the new construction.

C. During reshoring, do not subject concrete in structural members to combined dead and construction loads in excess of loads that the structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete, but in no case later than the end of working day on which stripping occurs.

E. Place reshores to carry their required loads without overstressing.

F. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength specified by the formwork engineer's structural calculations and verified by field cured test cylinders or other approved method.



**END OF SECTION**

SECTION 03 20 00

CONCRETE REINFORCING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Section includes: Reinforcing steel for use in reinforced concrete.

### 1.02 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ACI 117 | Specification for Tolerances for Concrete Construction and Materials |
| ACI 315 | Details and Detailing of Concrete Reinforcement |
| ACI 318 | Building Code Requirements For Structural Concrete |
| ACI SP-66 | ACI Detailing Manual |
| ASTM A615 | Deformed and Plain Carbon Steel Bars for Concrete Reinforcement |
| ASTM A706 | Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |
| ASTM A775 | Epoxy-Coated Steel Reinforcing Bars |
| ASTM A884 | Epoxy-Coated Steel Wire and Welded Wire Reinforcement |
| ASTM A1064 | Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| AWS D1.4 | Structural Welding Code - Reinforcing Steel |
| CRSI-PRB | Placing Reinforcing Bars |
| CRSI-MSP | Manual of Standard Practice |
| FEDSPEC QQ-W-461H | Wire, Steel, Carbon (Round, Bare, and Coated) |



### 1.03 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Mill certificates of mill analysis, tensile, and bend tests for all reinforcing.

5. Manufacturer and type of proprietary reinforcing steel splices. Submit a current ICC Report and manufacturer's literature that contains instructions and recommendations for each type of coupler used.
6. Qualifications of welding operators, welding processes and procedures.
7. Reinforcing steel shop drawings showing reinforcing steel bar quantities, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing steel supports. Reinforcing steel shop drawings shall be of sufficient detail to permit installation of reinforcing steel without reference to the contract drawings. Shop drawings shall not be prepared by reproducing the plans and details indicated on the contract drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of reinforcing steel, including large scale drawings at joints detailing bar placement in congested areas. Placement drawings shall be in accordance with ACI 315. Reinforcing details shall be in accordance with ACI SP-66.

## 1.04 DELIVERY, STORAGE AND HANDLING

A. Ship reinforcing steel to the jobsite with attached plastic or metal tags having permanent mark numbers which match the shop drawing mark numbers. All reinforcing shall be supported and stored above ground. Use only plastic tags secured to the reinforcing steel bars with nylon or plastic tags for epoxy coated reinforcing steel bars.



# PART 2 PRODUCTS

## 2.01 BAR REINFORCEMENT

A. Reinforcing steel bars shall be deformed billet steel in conformance with ASTM A615, Grade 60. Bars to be welded shall be deformed billet steel conforming to ASTM A706. Where specified, reinforcing steel shall be epoxy-coated in conformance with ASTM A775.

## 2.02 WIRE FABRIC

A. Wire fabric shall be welded steel mesh conforming to ASTM A1064.

## 2.03 WIRE AND PLAIN BARS

A. Wire used as reinforcement and bars used as spiral reinforcement in structures shall be cold drawn steel conforming to ASTM A1064.

## 2.04 SMOOTH DOWEL BARS

A. Smooth dowel bars shall conform to ASTM A615, Grade 60, with a metal end cap at the greased or sliding end to allow longitudinal movement.

## 2.05 TIE WIRE

A. The wire shall be minimum 16 gage annealed steel conforming to FEDSPEC QQ-W-461H.

## 2.06 BAR SUPPORTS

A. Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI-MSP and placed in accordance with CRSI-PRB. Plastic coating on legs shall extend at least 0.5 inch upward from form surface.

B. Provide precast concrete blocks, four inches square in plan, with embedded tie wires (wire dobies) as specified by CRSI 1 MSP for footing and slabs on grade. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel. Precast concrete blocks shall have same or higher compressive strength as specified for concrete in which they are located.

C. Provide stainless steel or plastic protected plain steel supports for other work.

## 2.07 FABRICATION:

A. Fabricate reinforcing steel bars in accordance with ACI 315 and the following tolerances:
   1. Sheared lengths: +/-1 inch.
   2. Overall dimensions of stirrups, ties, and spirals +/-1/2 inch.
   3. All other bends: +0 inch, -1/2 inch
   4. Minimum diameter of bends of reinforcing steel bars: Per ACI 318.



# PART 3 EXECUTION

## 3.01 PLACEMENT TOLERANCE

A. Reinforcing steel placement tolerance shall conform to the requirements of ACI 117, ACI 318, and the following:
   1. Reinforcing steel bar clear distance to formed surfaces shall be within +/-1/4 inch of specified clearance and minimum spacing between bars shall be a maximum of 1/4 inch less than specified.
   2. Reinforcing steel top bars in slabs and beams shall be placed +/-1/4 inch of specified depth in members 8 inches deep or less and -1/4", +1/2 inch of specified depth in members greater than 8 inches deep.
   3. Reinforcing steel spacing shall be placed within +/- one bar diameter or +/- 1 inch, whichever is greater.
   4. The minimum clear distance between reinforcing steel bars shall be equal to the greater of 1 inch or the reinforcing steel bar diameter for beams, walls and slabs, and the greater of 1 1/2 inches or 1.5 times the reinforcing steel bar diameter for columns.
   5. Beam and slab reinforcing steel bars shall be threaded through column vertical reinforcing steel bars without displacing the column reinforcing steel bars and still maintain clear distances for beam and slab reinforcing steel bars.

## 3.02 CONCRETE COVER

A. Unless specified otherwise on the Drawings, reinforcing steel bar cover shall conform to the following:
   1. Reinforcing steel bar cover shall be 3 inches for concrete cast against earth.
   2. Reinforcing steel bar cover shall be 2 inches for reinforcing steel bars for formed concrete surfaces exposed to earth and weather.
   3. Reinforcing steel bar cover shall be 2 inches for any formed surfaces exposed to or above any liquid.
   4. Reinforcing steel bar cover shall be 1 ½ inches for reinforcing not in the above categories unless noted otherwise on the design drawings.

## 3.03 SPLICING

A. Reinforcing steel splicing shall conform to the following:
   1. Use Class B splice lengths in accordance with ACI 318 for all reinforcing steel bars unless shown otherwise on the drawings.
   2. For welded wire fabric the splice lap length measured between the outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 inches, nor less than 1.5 times the development length nor less than 6 inches.
   3. Splices of reinforcement steel bars not specifically indicated or specified shall be subject to the approval of the Authority's Representative. Mechanical proprietary splice connections may be used when approved by the Authority's Representative or as indicated on the drawings.
   4. Welding of reinforcing steel bars is not allowed unless approved by the Authority's Representative.



## 3.04 CLEANING

A. Reinforcing steel bars at time of concrete placement shall be free of mud, oil, loose rust, or other materials that may affect or reduce bond. Reinforcing steel bars with rust, mill scale or a combination of both may be accepted without cleaning or brushing provided dimensions and weights including heights of deformation on a cleaned sample are not less than required by applicable ASTM standards.

## 3.05 PLACEMENT

A. Reinforcing steel bar placement shall conform to the following:
   1. Uncoated reinforcing steel bars shall be supported and fastened together to prevent displacement by construction loads or concrete placement. For concrete placed on ground, furnish concrete block supports or metal bar supports with non-metallic bottom plates. For concrete placed against forms furnish plastic or plastic coated metal chairs, runners, bolsters, spacers and hangers for the reinforcing steel bar support. Only tips in contact with the forms require a plastic coating.
   2. Fasten coated reinforcing steel bars together to prevent displacement. Use plastic or nylon ties to hold the coated reinforcing steel bars rigidly in place. Support coated reinforcing steel bars with plastic or plastic coated chairs, runners, bolsters, spacers and supports as required.

3. Support reinforcing steel bars over cardboard void forms by means of concrete supports which will not puncture or damage the void forms nor impair the strength of the concrete member.
4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, reinforcing steel bars in the upper layers shall be placed directly over the reinforcing steel bars in the bottom layer with the clear distance between each layer to be 2 inches unless otherwise noted on the Drawings. Place spacer reinforcing steel bars at a maximum of 3'-0" on center to maintain the minimum clear spacing between layers.
5. Extend reinforcement to within 2 inches of formed edges and 3 inches of the concrete perimeter when concrete is placed against earth.
6. Reinforcing steel bars shall not be bent after embedding in hardened concrete unless approved by the Authority's Representative.
7. Tack welding or bending reinforcing steel bars by means of heat is prohibited.
8. Where required by the contract documents, reinforcing steel bars shall be embedded into the hardened concrete utilizing an adhesive anchoring system specifically manufactured for that application. Installation shall be per the manufacturer's written instructions.
9. Bars with kinks or with bends not shown shall not be used.
10. Heating or welding bars shall be performed in accordance with AWS D1.4 and shall only be permitted where specified or approved by the Authroity's Representative. Bars shall not be welded at the bend.



## 3.06 FIELD QUALITY CONTROL

A. Field quality control shall include the following:
   1. Notify the Authority's Representative whenever the specified clearances between the reinforcing steel bars cannot be met. The concrete shall not be placed until the Contractor submits a solution to the congestion problem and it has been approved by the Authority's Representative.
   2. The reinforcing steel bars may be moved as necessary to avoid other reinforcing steel bars, conduits or other embedded items provided the tolerance does not exceed that specified in this section. The Engineer's approval of the modified reinforcing steel arrangement is required where the specified tolerance is exceeded. No cutting of the reinforcing steel bars shall be done without written approval of the Authroity's Representative.
   3. Coated reinforcing steel bars will be inspected on the jobsite for handling defects, coating abrasion, coating thickness and continuity of coating. The Authority's Representative may defer final inspection of the coated reinforcing steel bars until bar erection and handling is complete. Repair coated areas as directed by the Authroity's Representative and completed prior to concrete placement.
   4. An independent laboratory shall be employed to review and approve Contractor welding procedures and qualify welders in accordance with AWS D1.4. The laboratory shall visually inspect each weld for visible defects and conduct non-destructive field testing (radiographic or magnetic particle) on not less than one sample for each 10 welds. If a defective weld is found, the previous 5 welds by the same welder shall also be tested.

**END OF SECTION**

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SECTION 03 30 00

CAST-IN-PLACE CONCRETE

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Cast-in-place concrete, which consists of providing material, mixing, transporting equipment, and labor for the proportioning, mixing, transporting, placing, consolidating, finishing, curing, and protection of concrete in the structure.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related specification sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 60 00 Grouting
   2. Section 07 91 26 Joint Fillers
   3. Section 07 92 00 Joint Sealants
   4. Section 09 90 00 Painting and Coating



### 1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ACI 117 | Specification for Tolerances for Concrete Construction and Materials |
| ACI 211.1 | Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete |
| ACI 214R | Guide to Evaluation of Strength Test Results in Concrete |
| ACI 301 | Specifications for Structural Concrete |
| ACI 305.1 | Specification for Hot Weather Concreting |
| ACI 306.1 | Standard Specification for Cold Weather Concreting |
| ACI 318 | Building Code Requirements for Structural Concrete |
| ACI 350 | Code Requirements for Environmental Engineering Concrete Structures |
| ACI 350.1 | Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures |
| ACI 503.7 | Specification for Crack Repair by Epoxy Injection |
| ASTM A126 | Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM C31 | Making and Curing Concrete Test Specimens in the Field |
| ASTM C33 | Concrete Aggregates |
| ASTM C39 | Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C42 | Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| ASTM C94 | Ready-Mixed Concrete |
| ASTM C117 | Materials Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C131 | Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |

| Reference | Title |
|---|---|
| ASTM C136 | Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C143 | Slump of Hydraulic Cement Concrete |
| ASTM C150 | Portland Cement |
| ASTM C157 | Length Change of Hardened Hyraulic-Cement Mortar and Concrete |
| ASTM C172 | Sampling Freshly Mixed Concrete |
| ASTM C192 | Making and Curing Concrete Test Specimens in the Laboratory |
| ASTM C231 | Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C260 | Air-Entraining Admixtures for Concrete |
| ASTM C309 | Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C494 | Chemical Admixtures for Concrete |
| ASTM C511 | Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes |
| ASTM C595 | Blended Hydraulic Cements |
| ASTM C618 | Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C881 | Epoxy-Resin-Base Bonding Systems for Concrete |
| ASTM C989 | Slag Cement for use in Concrete and Mortars |
| ASTM C1059 | Latex Agents for Bonding Fresh to Hardened Concrete |
| ASTM C1077 | Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation |
| ASTM C1240 | Silica Fume Used in Cementitious Mixtures |
| ASTM C1260 | Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) |
| ASTM C1293 | Determination of Length Change of Concrete Due to Alkali-Silica Reaction |
| ASTM C1315 | Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete |
| ASTM C1567 | Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method) |
| ASTM C1602 | Mixing Water Used in the Production of Hydraulic Cement Concrete |
| ASTM D75 | Sampling Aggregates |
| ASTM D2419 | Sand Equivalent Value of Soils and Fine Aggregate |
| ASTM E329 | Agencies Engaged in Construction Inspection, Testing, or Special Inspection |
| CRD-C572 | U.S. Corps of Engineer's Specifications for Polyvinylchloride Waterstop |
| IBC | International Building Code with local amendments |



## 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance with the specification. Include a detailed, written justification for each deviation. Failure to include a copy of this marked-up specification section, along with justification(s) for requested deviations, with the submittal, is cause for rejection of the entire submittal with no further consideration.

4. Each proposed mix design showing:
    a. Expected strength at 7 and 28-days
    b. Slump, before and after introduction of high-range water-reducing admixture
    c. Water/cement ratio
    d. Weights and test results, certifications, and mill reports of the ingredients
    e. Chemical analysis report and report of other specified test analyses for supplementary cementitious material
    f. Aggregate gradation and documentation of test results classifying aggregate as non-potentially reactive
    g. Test results of mix design prepared by an independent testing laboratory
    h. Shrinkage test results for liquid containing structures
    i. Other physical properties necessary to review each mix design for conformance with these specifications
5. Mix designs proposed shall be sealed by a Professional Engineer registered in the state where the project is located
6. Product literature and technical data for aggregates, cement, and pozzolan.
7. Product literature, technical data, and dosage of proposed admixtures including, but not limited to, air entraining, water reducing, retarding, shrinkage reducing, etc.
8. Anticipated average delivery time from batch plant to site. If this time exceeds the limit specified in Part 3, include proposed method to extend set time without deleterious effects on final product. Authority's Representative reserves the right to accept or reject such proposed methods.
9. Lift Drawings: Submit shop drawings for concrete placements on the project before on-site construction begins. The drawings shall be organized by structure and submitted as a complete set for the Engineer's review. The drawings shall be drawn to scale and show dimensions, forming details, and placement volumes. Show location of construction joints, details of surface preparation, scheduled finish, embedments (including conduits, inserts, and anchor bolts), penetrations (including pipe sleeves), openings, keyways, blockouts, bulkheads, etc. The drawings shall clearly show the placement sequence and will be accompanied by a schedule that shows the schedule dates for forming, placement, and stripping for each section of concrete placed within each structure.
10. Curing program description in sufficient detail to demonstrate that the Contractor will provide acceptable strength, finish, and crack control within the completed structure. Detailed plan for curing and protection of concrete in cold and hot weather.
11. Product literature and technical data for waterstops, curing and sealing compounds, bonding compounds, epoxy and chemical grout for crack injection.
12. Sample panels at least 12-inches by 12-inches by three inches thick to demonstrate formed wall surface finishes as specified in Part 3.
13. Samples of concrete floor and slab for each finish specified in Part 3 approximately four feet square and a minimum of four inches thick, with one construction joint and one expansion joint, if used.
14. Concrete delivery truck tickets showing the information listed in ASTM C94, section 14.

## 1.05 QUALITY ASSURANCE

A. Quality Control By Authority:
   1. Special Inspection of concrete work shall be performed by the Special Inspector under contract with the Authority and in conformance with the IBC Chapter 17. Special Inspection of concrete is in addition to, not replacing, other inspections and quality control requirements specified herein. Where sampling and testing specified herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.
   2. All structural concrete work shall receive Special Inspection in accordance with IBC Chapter 17. Structural concrete includes elements which resist code-defined loads and whose failure would impact life safety. Non-structural site work concrete does not require Special Inspection. Anchor bolts and anchors installed in hardened concrete require Special Inspection.
   3. Refer to Section 01 45 23 Testing and Inspection Services for Authority provided testing.

B. Quality Control By Contractor:
   1. Where required to demonstrate conformance with the specified requirements for cast-in-place concrete, the Contractor shall provide the services of an independent testing laboratory which complies with the requirements of ASTM E329 and ASTM C1077. The testing laboratory shall sample and test concrete materials as specified in this section. Costs of testing laboratory services shall be borne by the Contractor.
   2. Concrete testing laboratory personnel shall be certified in accordance with the ACI Concrete Laboratory Testing Technician - Level 1 Certification Program or the ACI Concrete Strength Testing Technician Certification Program, or an equivalent program.
   3. Refer to Section 01 45 00 Contractor Quality Control.

C. Basis For Quality:
   1. Cast-in-place concrete shall conform to the requirements of ACI 301, except as modified herein.



## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Cement:
   1. Store cement bags immediately upon receipt in a weatherproof structure as airtight as practicable. Elevate floor above ground to prevent absorption of moisture. Stack bags close together to reduce circulation of air but do not stack against outside walls. Stack to permit easy access for inspection and identification of each shipment.
   2. Transfer bulk cement to elevated airtight and weatherproof bins. At the time of use, cement shall be free flowing and free of lumps. Do not use cement which has been in storage longer than 6 months.

B. Aggregates:
   1. Store aggregates on areas covered with tightly laid wood planks, sheet metal, or other hard and clean surfaces in a manner that will preclude the inclusion of foreign material. Store aggregates of different sizes in separate piles. Build stock piles of

coarse aggregate in horizontal layers exceeding 4 feet in depth to minimize segregation. Remix segregated aggregates to conform to the grading requirements.

C. Admixtures:
   1. Store admixtures to prevent damage. Do not use air-entraining admixture which has been in storage for longer than 6 months or has been frozen.

D. Pozzolan:
   1. Deliver and store pozzolan in the same manner as cement.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Cement:
   1. Portland cement shall be ASTM C150, Type II or Type V, low alkali, containing less than 0.60 percent alkalis. In addition to standard requirements, cement shall satisfy optional chemical and physical requirements of ASTM C150, Tables 2 and 4, respectively.
   2. Portland-pozzolan cement shall be ASTM C595, Type IP(MS), interground, low alkali.
   3. Portland blast-furnace slag cement shall be ASTM C595, Type IS (<70) (MS), interground, low alkali.
   4. Hydraulic cements meeting the performance specifications of ASTM C1157 are not permitted.
   5. Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures. See Change of Materials paragraph below.

B. Ground granulated blast-furnace slag (GGBFS), if used in conjunction with portland cement, shall be per ASTM C989, Grade 100 or Grade 120, limited to 50 percent of the weight of cementitious materials. If GGBFS is combined with pozzolans and/or silica fume, the total weight of GGBFS, pozzolans, and silica fume shall not exceed 50 percent of the weight of cementitious materials.

C. Silica fume, if used in conjunction with portland cement, shall be per ASTM C1240, limited to 10 percent of the weight of cementitious materials. Silica fume shall be used with a high-range water-reducing admixture.

D. Aggregates:
   1. General:
      a. Except as modified herein, fine and coarse aggregates shall conform to ASTM C33. Fine and coarse aggregates are regarded as separate ingredients. Aggregates shall be non-reactive and washed before use.
      b. Check aggregates for alkali-silica reactivity to meet the following criteria. Aggregates or combinations of cementitious materials and aggregates shall have less than 0.10% expansion at 16 days when tested in accordance with ASTM C1260 or ASTM C1567. Alternatively, aggregate tested independently in accordance with ASTM C1293 shall have less than 0.04% expansion at one-year,

or combinations of aggregate and cementitious materials tested in accordance with ASTM C1293 shall have less than 0.04% expansion at two years. Test results shall be no older than two years.

c. Tests for size and grading of fine and coarse aggregates shall be in accordance with ASTM C136. Combined aggregates shall be well and uniformly graded from coarse to fine sizes to produce a concrete that has optimum workability and consolidation characteristics. Establish the final combined aggregate gradation during mix design.

d. Aggregates used in the project production concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by the submitted historical data or trial mixtures. See Change of Materials paragraph below.

2. Fine Aggregate:

a. Fine aggregate shall be hard, dense, durable particles of either sand or crushed stone regularly graded from coarse to fine. Gradation shall conform to ASTM C33. For classes of concrete which will be used in liquid-retaining structures, fine aggregate shall not exceed 40 percent by weight of combined aggregate total, except for concrete with coarse aggregate of less than maximum size 1/2 inch.

b. Variations from the specified gradations in individual tests will be acceptable if the average of three consecutive tests is within the specified limits and the variation is within the permissible variation listed below:

| U.S. standard sieve size | Permissible variation in individual tests, percent |
|---|---|
| 30 and coarser | 2 |
| 50 and finer | 0.5 |

c. Other tests shall be in accordance with the following specifications:

| Test | Test method | Requirements |
|---|---|---|
| Amount of material | ASTM C117 | 3 percent passing No. 200 sieve maximum by weight |
| Sand equivalent | ASTM D2419 | Minimum 70 percent |

3. Coarse Aggregate:

a. Coarse aggregate shall be hard, dense and durable gravel or crushed rock free from injurious amounts of soft and friable particles, alkali, and organic matter. Other deleterious substances shall not exceed the limits listed in ASTM C33, Table 4 for Class Designation 4S. Gradation of each coarse aggregate size specified shall conform to ASTM C33, Table 3.

b. Variations from the specified gradations will be acceptable in individual tests if the average of three consecutive tests is within the specified limits.

E. Pozzolan:

1. Pozzolan shall be Class F fly ash conforming to ASTM C618. Class C fly ash is not allowed. Pozzolan supplied during the life of the project shall have been formed at the same single source. See Change of Materials paragraph below.

2. The pozzolan color shall not substantially alter the resulting concrete from the normal gray color and appearance.

3. Use pozzolan materials that are of the same brand and type and from the same plant of manufacture as the materials used in the concrete represented by the submitted field test records or used in the trial mixtures.
4. The loss on ingnitition shall be a maximum of four percent.
5. The maximum percent of sulfur trioxide (SO3) shall be 4.0

F. Admixtures:
1. General:
a. Admixtures shall be compatible with the concrete and with each other. Calcium chloride or admixtures containing calcium chloride are not acceptable. Use admixtures in accordance with the manufacturer's recommendations and add separately to the concrete mix. Water reducing retarders and admixtures shall reduce the water required by at least 11 percent for a given concrete consistency and shall comply with the water/cement ratio standards of ACI 211.1. Retarder dosage shall result in set time consistent with requirements specified in Part 3.
2. Water Reducing Admixtures:
a. Conform to ASTM C494, Type A. Acceptable products include: BASF Corporation “MasterPozzolith Series”; SIKA Chemical Corp. “Plastocrete 161”; Euclid Chemical Co. “Eucon WR 91”; or approved equal.
3. Water Reducing and Retarding Admixtures:
a. Conform to ASTM C494, Type D. Acceptable products include: BASF Corporation “MasterSet R Series”; Sika Chemical Corp. “Plastiment”; Euclid Chemical Co. “Eucon Retarder 75”; or approved equal.
4. High Range Water Reducing (Superplasticizing) Admixtures:
a. Conform to ASTM C494, Type F. Acceptable products include: BASF Corporation “MasterGlenium” Series; Sika Chemical Corp. “Viscocrete 2100” or “Viscocrete 2110” (Hot Weather) or “Viscocrete 6100” (Cold Weather); Euclid Chemical Co. “Eucon 37”; GCP Applied Technologies “ADVA 195”; or approved equal.
5. High Range Water Reducing And Retarding Admixtures:
a. Conform to ASTM C494, Type G. Acceptable products include: GCP Applied Technologies “Daracem 100”; Sika Chemical Corp. “Sikaplast 200” ; Euclid Chemical Co. “Eucon 537”; or approved equal.
6. Air Entraining Agent:
a. Conform to ASTM C260 and produce air entrained concrete as specified in the Mix Proportioning table below. Acceptable products include: BASF Corporation “MasterAir Series”; Sika Chemical Corp. “Sika AEA-14” or “Sika AIR” ; Euclid Chemical Co. “Eucon AEA-92”; or approved equal.

G. Water:
1. For washing aggregate, mixing, and for curing shall be free from oil and deleterious amounts of acids, alkalis, and organic materials; comply with the requirements of ASTM C1602. Additionally, water used for curing shall not contain an amount of impurities sufficient to discolor the concrete.

H. Change of Materials:
1. After each concrete mix design is approved, no changes of any sort or source will be allowed without prior written approval from the Engineer. When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed

to be changed, new field data, data from new trial mixtures, or evidence that indicates that the change will not affect adversely the relevant properties of the concrete shall be submitted for approval by the Engineer before use in concrete.

## 2.02 CONCRETE CHARACTERISTICS

A. Mix Proportioning:

1. Concrete shall be normal weight concrete composed of cement, pozzolan, admixtures, aggregates, and water; proportioned and mixed to produce a workable, strong, dense, and impermeable concrete. It is acceptable to substitute interground Portland-pozzolan cement conforming to ASTM C595, containing the specified amount of pozzolan in lieu of Portland cement and pozzolan. Water-cementitious material (w/cm) ratio is based on the combined contents of cement and pozzolan.
2. Provide concrete mix designs in accordance with the following guidlines:

| Concrete class | Minimum[a] 28-day compressive strength, psi | ASTM coarse aggregate size | Maximum water-cementitious materials (w/cm) ratio | Minimum cementitious materials content (pounds/CY) | Pozzolan, percent by weight of cementitious materials | Air content (percent) | Slump range[f] (inches) |
|---|---|---|---|---|---|---|---|
| A | 4000[b] | 467 | 0.42 | 515 | 20-35 | 4-6 | 3-5 |
| B | 3000 | 57 or 67 | 0.45 | 560 | 15-25[d] | 4-6 | 3-5 |
| C-1 | 4500 | 57 or 67 | 0.40 | 560 | 25-25 | 4-6 | 3-5 |

[a] *Determine compressive strength at the end of 28 days based on test cylinders made and tested in accordance with ASTM C39.*

[b] *Compressive strength of Class A concrete may be determined at 56 days.*

[c] *Concrete encasement for electrical conduit shall contain 3 pounds of red oxide per sack of cement.*

[d] *Pozzolan use is optional for this class of concrete.*

[e] *Minimum 28-day compressive strength shall be 500 psi and maximum 28-day compressive strength shall be 1,000 psi.*

[f] *Slump before addition of high range water reducing admixture (superplasticizer). Maximum slump after addition of high range water reducing admixture shall be 8".*



B. Use:

1. Provide concrete by class for the uses listed below.

| Concrete class | Type of use |
|---|---|
| A | Concrete greater than 36 inches thick |
| B | Non-structural concrete (sidewalks, curbs, pavers, etc.), electrical conduit encasement (duct banks). |
| C-1 | Typical cast-in-place structural concrete |

[a] *Contractor's option to use the same concrete mix for pipe encasement as the concrete slab above.*

C. Control Tests:

1. General:
   a. Select and adjust proportions of ingredients in accordance with ACI 211.1. Verification of mix characteristics for submittal may be achieved using either the

Trial Mix Design method or Field Experience Data method. Do not place concrete prior to submittal and acceptance of proposed mix.

2. Trial Mix Design:
    a. Mixes verified by this method shall have the samples produced for testing, manufactured at the batch plant which will supply concrete to the project, using materials proposed for the Work and material combinations listed above. Testing, data, and reporting shall conform to ACI 318 and the following:
        1) Required compressive strength used as the basis for selecting concrete proportions (f'cr) shall be the specified concrete strength (f'c) + 1000 psi for specified concrete strengths less than 3,000 psi and f'c + 1200 psi for specified concrete strengths between 3000 psi and 5000 psi.
        2) Make at least three different trial mixtures for each class of concrete qualified by the Trial Mix Design. Each trial mixture shall have a different w/cm ratio or different cementitious materials content that will produce a range of compressive strengths encompassing f'cr.
        3) Design trial mixtures to produce a slump within ¾ inch of the maximum specified and an air content within 0.5 percent of the maximum specified.
        4) For each w/cm ratio or cementitious materials content, cast and cure at least twelve standard test cylinders in accordance with ASTM C192. Four cylinders from each batch tested at age 7-days, 14-days, and 28-days or as required to comply with ACI 318.
        5) From results of the cylinder tests, plot a curve showing the relationship between w/cm ratio and compressive strength.
        6) From the curve of w/cm ratio versus compressive strength, select the w/cm ratio that will produce f'cr. This is the maximum w/cm ratio to be used unless a lower w/cm ratio is specified above.
3. Field Experience Data:
    a. When sufficient test data for a particular mix design is available which is identical or substantially similar to that proposed for use, Contractor may substitute use of this data in lieu of a trial mix design. Field data, reports, and analysis shall conform to ACI 318, except as modified herein.
        1) Historical mix design proportions for which data are submitted may vary from the specified mix within the following limits:
        2) f'c as specified or up to 500 psi above
        3) w/cm ratio as specified or lower
        4) pozzolan content within 5 percent of that specified
        5) maximum coarse aggregate size may not vary smaller, but gradation of coarse aggregate may vary
        6) slump after introduction of admixtures +0/-1 inch.
    b. Use of historical Field Experience Data does not allow modification of the project mix specifications herein without review and acceptance by the Engineer.

4. Shrinkage:
    a. Liquid containing structures using Class C-1 concrete mix are intended to be watertight. Provide test results for Class C-1 concrete mix meeting the following requirement: drying shrinkage limit of 0.038 percent in the laboratory at 35-days (7-days moist cure and 28-days drying) as tested in accordance with ASTM C157 and the following modifications:
        1) Wet cure specimens for a period of 7-days (including the period of time the specimens are in the mold). Wet cure may be achieved either through storage in a moist cabinet or room in accordance with ASTM C 511, or through storage in lime saturated water.
        2) Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C 157 section 8.4.
        3) Report results in accordance with ASTM C 157 at 0, 7, 14 & 28-days of drying.
    b. Concrete shall not be placed in the field prior to acceptance of the concrete mix. To meet the drying shrinkage limit, it is recommended that a shrinkage reducing admixture be considered for use in concrete for liquid containing structures.

## 2.03 WATERSTOPS

A. Polyvinyl Chloride (PVC):
    1. Manufacture PVC waterstops from virgin polyvinyl chloride conforming to the Corps of Engineers Specification No. CRD-C572.
    2. Use 6-inch by 3/8-inch ribbed flat waterstop in construction joints. Acceptable products include: Greenstreak Group, Inc. "Model 679"; Vinylex Waterstops and Accessories "Model R638"; or approved equal.
    3. Use 9 inch by 3/8-inch ribbed with center bulb waterstop in expansion joints. Acceptable products include: Greenstreak Group, Inc. "Model 696"; Vinylex Waterstops and Accessories Model "RLB9-38"; or approved equal.
    4. Use molded crosses, tees, and other shapes for changes of direction, intersections, and transitions as recommended by manufacturer.



## 2.04 SEALANTS AND JOINT FILLERS

A. Sealants and preformed joint fillers are specified in Sections 07 92 00 and 07 91 26.

## 2.05 BONDING COMPOUNDS

A. Epoxy resin bonding compounds for use in wet areas shall conform to ASTM C881 Types IV or V, Class A, B, or C depending on temperature at use. Acceptable products include: BASF Corporation "MasterEmaco ADH 327RS"; Sika Chemical Corporation "Sikadur 32"; or approved equal.

B. Non-epoxy bonding compounds for use in dry areas for non-structural bonding or as noted on the drawings shall conform to ASTM C1059 Type II. Acceptable products include: Penetron Specialty Products "Acrylic Bondcrete"; ChemMasters "Cretelox"; or approved equal.

C. Apply bonding compounds in accordance with the manufacturer's instructions.

## 2.06 EPOXY FOR CRACK INJECTION

A. Use a two-component, moisture insensitive, high modulus, injection grade, 100 percent solids, epoxy-resin blend. Consistency as required to achieve complete penetration into cracks. Material shall conform to ASTM C881 Type 1 Grade 1. Acceptable products include: Sika Corporation “Sikadur 52”; Adhesives Technology Corporation “Crackbond SLV302”; or approved equal.

B. Use epoxy injection for structural crack repairs except as noted below for non-structural cracks in liquid-containing concrete structures. The Engineer shall determine whether a crack is classified as structural or non-structural.

## 2.07 CHEMICAL GROUT FOR CRACK INJECTION

A. Use hydrophobic polyurethane grout at the Engineer's discretion as an alternative for sealing non-structural cracks in concrete structures intended to be watertight. Acceptable products for sealing hairline cracks include: GCP Applied Technologies "DE NEEF Flex SLV PURe” (must be used with DE NEEF Flex Cat PURe); or Sika Corporation “SikaFix HH LV” as appropriate for crack width; or approved equal. Coordinate with product supplier to verify and select appropriate product for crack widths to be injected.

## 2.08 CURING AND SEALING COMPOUNDS

A. Acceptable products include: BASF Corporation “MasterKure CC 250SB”; Dayton Superior “Cure & Seal 25% J22UV”; or approved equal, conforming to ASTM C1315.

B. Compound shall be clear and applied in accordance with the manufacturer’s instructions.

C. Curing and sealing compounds shall be certified compliant with final finish system if applicable, including compatibility with floor hardeners in areas where floor hardeners are specified to be used.



# PART 3 EXECUTION

## 3.01 GENERAL

A. Use only truck-mixed, ready-mixed concrete conforming to ASTM C94. Proportion materials by weighing.

B. Introduce pozzolan into the mixer with cement and other components of the concrete mix; do not introduce pozzolan into a wet mixer ahead of other materials or with mixing water.

C. Introduce water at the time of charging the mixer; additional water may be introduced within 45 minutes from charging the mixer, provided the specified w/c ration and slump is not exceeded and the maximum total water per the approved mix design is not exceeded.

D. Arrange with the testing laboratory for inspection as required to comply with these specifications.

E. Deliver concrete to the site and complete discharge within 90 minutes after introduction of water to the mixture. Extension of allowable time beyond this limit requires a Contractor proposed remedial action plan to be reviewed and accepted by the Authority's Representative.

## 3.02 BATCHING:

A. General:
   1. Batch concrete only from equipment with a current National Ready Mix Concrete Association Certificate of Compliance. Provide and maintain such means and equipment as are required to accurately determine and control the relative amounts of the various materials, including water, cement, pozzolan, admixtures, sand and each size of coarse aggregate used in the concrete.
   2. Proportion concrete batches on the basis of integral sacks of cement unless the cement is weighed. Introduce pozzolan into the mixture only with cement and other dry components of the concrete mix. Do not introduce pozzolan into wet mixer ahead of other materials or with mixing water. Determine amounts of sand and coarse aggregate required for each batch of concrete by weighing, and the required water by either weighing or metering.
   3. Deposit aggregates in the batch bins directly over the discharge gates. Deposit coarse aggregate in the batch bins through rock ladders when the free drop of the aggregate exceeds 4 feet. Convey batch materials from the weighing and batching hoppers so that there will be no spillage of the batched materials or overlapping of batches.
   4. Provide sufficient trucks to continuously deliver batched material. Each truck shall carry a delivery ticket showing the mix number, size of batch, and time water was added to the batch.

B. Weighing And Metering Equipment:
   1. Equipment shall be sealed by the state agency having authority over weights and measures and shall be capable of adjustment for compensating for the varying weights and moisture changes which affect the concrete mix proportions and concrete consistencies.
   2. Batching equipment shall be constructed and operated so that when the entire plant is running, the combined inaccuracies in feeding and measuring materials will not exceed 1 percent for water or cement and pozzolan, 2 percent for any size of aggregate, and 1 1/2 percent for the total aggregate in any batch.
   3. Design equipment for convenient confirmation of the accuracy required for each batch. The equipment for measuring water shall not leak when the valves are closed.
   4. Provide standard test weights and other auxiliary equipment required for checking the operating performance of each scale or meter and make tests at intervals of not more than 6 months in the presence of the state inspector. Provide copies of the complete results of check tests made, and make such adjustments, repairs, or replacements as necessary to secure satisfactory performance.
   5. Where the batch plant involves the use of storage bins and weighing hoppers, each weighing unit shall include a visible springless dial or equally suitable device which will register the scale load at any stage of the weighing operation from zero to full capacity. Construct weighing hoppers to permit the convenient removal of overweight material in excess of the prescribed tolerances. Each dial and water-measuring

device shall be in view of the operator and, if practicable, arrange the weighing equipment so that the operator may conveniently observe the operation of the bin gates and also the materials discharged into the mixer hopper.

6. Batching equipment in automatic plants shall be interlocked so that:
   a. A new weighing cycle cannot be started until the batchers are emptied and the dispatcher discharge gates and valves are closed.
   b. The batcher discharge gate cannot be opened until the correct weights of the materials are in the batching hoppers and the scales in balance.
   c. The discharge gates cannot be closed until materials are entirely discharged from the hopper and are back in balance.
   d. The water batcher discharge valve cannot be opened until the filling valve is closed. The admixture dispenser shall be interlocked to operate with the water batcher.
7. Dispensers for admixtures shall have sufficient capacity to measure at one time the full quantity of solution required for each batch. Add admixtures to premeasured water for the batch, or arrange their discharge into the batch to flow uniformly into the water stream for the batch from beginning to end of its flow into the mixer. Dosages of admixtures shall not vary from the required dosage by more than 5 percent.



## 3.03 MIXING:

A. Mix the concrete ingredients in batch mixers until the mixture is homogeneous and uniform in consistency. Mix each batch for at least 1 1/2 minutes for concrete not containing pozzolan and for at least 2 minutes for concrete containing pozzolan after all the ingredients, except the full amount of water, are in the mixer. The minimum mixing period specified is predicated on control of the speed of rotation of the mixer and the introduction of materials, including water, into the mixer.

B. Add water prior to, during, and following the mixer charging operations. Excessive mixing time requiring the addition of water (retempering) to preserve and secure the required concrete consistency is not acceptable.

C. Mixers shall not be loaded in excess of their rated capacity. Equip each mixer with a satisfactory mechanically operated timing, signaling (or locking), and metering device for indicating and assuring the completion of the required mixing period and for counting the batches.

## 3.04 CONVEYING AND PLACING CONCRETE

A. Convey concrete from the mixer to the forms in accordance with ACI 301. Remove concrete that has segregated in conveying from the site of the work.

B. Placing Concrete:
   1. General:
      a. Place concrete in accordance with ACI 301. Do not permit concrete to drop freely more than 4-ft (6-ft when superplasticizer is used).

2. Placing Concrete By Pumping:
    a. Concrete placed by pumping is at Contractor's discretion and shall not be the cause to change or relax specified mix design characteristics. Concrete shall possess the specified characteristics at the point of placement.
    b. Measure slump at the hose discharge, except as follows: Initial slump testing in each placement shall occur at both the pumping unit inlet hopper and hose discharge. Slump loss in pumping, measured between the inlet hopper and the hose discharge, shall not exceed 1 inch. After these criteria have been satisfied, slump may be measured at the inlet hopper with allowable slump increased by the earlier measured difference, not to exceed 1 inch.
    c. Before starting each pumping operation, prime the pump and line with a cement slurry to lubricate the system. Waste cement slurry outside the forms. Equip hose tip with a safety chain for recovery in case of hose blowout during pumping. Hose or accessories shall not remain in the freshly placed concrete.
    d. Use tremie placing techniques and equipment for pump placed concrete. Pump discharge system shall remain full of concrete from pump to discharge point at all times. Concrete pumping shall not occur until Authority's Representative has verified equipment including the tremie plug. Should the discharge line become open, with zones empty of concrete, cease pumping and re-primed with tremie plug installed before continuing.
3. Placing Concrete In Hot Weather:
    a. In temperatures above 80 degrees F, place concrete in accordance with ACI 305.1.
4. Placing Concrete In Cold Weather:
    a. In temperatures below 40 degrees F, place concrete in accordance with ACI 306.1.



## 3.05 CONSOLIDATING CONCRETE

A. Consolidate concrete in accordance with ACI 301. If evidence of inadequate consolidation is observed, concrete placement will be suspended until Contractor provides a revised plan to achieve proper consolidation.

## 3.06 CURING AND SEALING

A. General:
    1. Cure concrete using water (including form curing and use of moister retaining covers), a clear membrane curing compound, or by a combination of both methods. Coordinate repairs or treatment of concrete surfaces so that interruption of curing will not be necessary.
    2. Maintain concrete surface temperature between 50 degrees F and 80 degrees F for at least 5 days. Cure concrete in hot weather (above 80 degrees F) in accordance with ACI 305.1. Cure concrete in cold weather (below 45 degrees F) in accordance with ACI 306.1.

B. Water Curing:
    1. Keep concrete continuously wet for a minimum of 10-days after placement (14 days after placement for sections over 3-feet thick). Absorptive mats or fabric may be used

to retain moisture during the curing period. Absorptive covers shall comply with AASHTO M182, Class 3, and moisture retaining covers shall comply with ASTM C171.

2. Use water curing in hot weather for liquid containment structures. Cover forms and keep moist. Loosen forms as soon as possible without damage to the concrete, and make provisions for curing water to run down inside them. During form removal, take care to provide continuously wet cover to newly exposed surfaces.

C. Curing Compound:

1. When curing compound is allowed, apply it as soon as the concrete has set sufficiently so as not to be marred by the application or apply it immediately following form removal for vertical and other formed surfaces. Preparation of surfaces, application procedures, and installation precautions shall follow manufacturer's instructions. For liquid containing structures, apply curing compound at twice the manufacturer's recommended dosage rate, applied in two coats perpendicular to each other.
2. Do not use curing compound on concrete surfaces to be coated, waterproofed, moisture-proofed, tiled, roofed, or where other coverings are to be bonded. In these cases, use water curing unless the curing compound is first removed or is compatible with the final finish covering.



## 3.07 PROTECTION

A. Protect concrete from injurious action by sun, rain, wind, flowing water, frost, excessive vibration and mechanical means.

B. Loading green concrete is not permitted. Green concrete is defined as concrete with less than 100 percent of the specified strength.

C. Backfill shall not be placed against concrete walls until the concrete has reached the specified strength, connecting slabs and beams have been cast and have also reached the specified strength, and watertightness testing and repairs have been completed for liquid containing strutures to the satisfaction of the Authority's Representative.

D. Arrangements for covering, insulating, heating, and protecting concrete in cold weather shall be in accordance with ACI 306.1.

## 3.08 CONSTRUCTION JOINTS

A. General:

1. Place concrete in each unit of construction continuously. Before new concrete is placed on or against concrete which has set, retighten forms and clean foreign matter from the surface of the set concrete. Provide waterstops as specified.

B. Construction:

1. Form construction joints by producing a rough surface of exposed aggregates using a surface retardant; include joints between the slab and topping concrete. The limit of the treated surfaces shall be 1 inch away from the joint edges. Within 24 hours after placing, remove retarded surface mortar either by high pressure water jetting or stiff brushing or combination of both so as to expose coarse aggregate. A rough surface of exposed aggregate may also be produced by sandblasting followed by high pressure water jetting. Sandblasting, if used, shall remove 1/4 inch of laitance film and expose

coarse aggregate to ensure adequate bond and watertightness at the construction joints.

C. Locations:

1. Provide construction joint locations as follows:
   a. Cast walls exceeding 50 feet in length in panels not to exceed 30 feet in length. Cast adjoining panels only after 5-days have elapsed. Joints are not allowed within the lesser of 10 feet or 25 percent of the wall length from a corner unless specifically detailed thus on the drawings.
   b. Locate joints in beams or girders at or near the quarter point between supports.
   c. Make joints in the members of a floor system at or near the quarterpoint of the span.
   d. Make joints in walls and columns at the underside of floors, slabs, beams or girders and at the tops of footings or floor slabs.
   e. Cast slab panels in checkerboard patterns not to exceed 40 feet in length and not to exceed 900 square feet in area, with maximum 1 ½ to 1 ratio of side lengths. Minimum lapsed time between placing adjacent panels shall be 3 days. The requirements for size of slab panel is waived if joints are located on the Drawings.
2. Vertical construction joints shall have edges grooved or beveled at faces exposed to view including interior faces of basins and tanks. Seal grooves subjected to wetting or weather with joint sealant.
3. Continue reinforcing steel through construction joints. Beams, girders, and floor slabs shall not be constructed over columns or walls until at least one day has elapsed to allow for initial shrinkage in the column or wall. No joint will be allowed between a slab and a beam or girder, unless otherwise shown. Joints shall be perpendicular to the main reinforcement. Provide waterstops in construction joints as specified.



## 3.09 INSERTS AND EMBEDMENTS

A. Inserts:

1. Where pipes, castings, or conduits are to pass through structures, position in forms before placing concrete; or where shown on Drawings or approved by the Authority's Representative, provide openings in the concrete for subsequent insertion of such pipes, castings, or conduits. Provide waterstops and a slight flare in the form to facilitate grouting and permit the escape of entrained air during grouting.
2. Provide additional reinforcement around openings. Use non-shrink grout to infill around inserts.
3. Place horizontal conduits and pipes, in slabs and beams, between the top and bottom layers of reinforcement. Spacing and size limitations shall conform to ACI 318.
4. Conduits and pipes shall not run directly beneath a column.
5. Position conduit, pipe, and other ferrous items such that there will be a minimum of 2-inches clearance between said item and concrete reinforcement. Welding inserts to reinforcement is not permitted.
6. The outside diameter of conduit or pipe shall not exceed one-fourth the slab or beam thickness.

B. Embedments:
   1. Gate frames, gate thimbles, special castings, channels, grating frames, or other miscellaneous metal parts to be embedded in concrete shall be secured in the forms prior to concrete placement.
   2. Embed anchor bolts and inserts in concrete as shown. Provide inserts, anchors, or other bolts necessary for the attachment of piping, valves, metal parts, and equipment.
   3. Provide nailing blocks, plugs, strips, and the like necessary for the attachment of trim, finish, and similar work. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent entry of concrete. Do not use continuouse anchor slots or strips in concrete intended to be watertight.
   4. Positon operators or sleeves for gate or valve stems to clear reinforcing steel, conduit, and other embedments, and to align accurately with equipment.

## 3.10 EXPANSION JOINTS

A. Expansion joints shall be as shown. Do not extend reinforcement or other embedded metal items through expansion joints. Provide waterstops where indicated.

## 3.11 WATERSTOPS

A. Waterstops shall conform to ACI 301. Tie waterstops in position prior to placement of concrete to prevent movement and deformation.

B. Provide waterstops in construction and expansion joints as follows:
   1. Joints in parts of structures exposed to ground or water on one side and occupied by non-submerged equipment or by personnel on the other.
   2. Wall and slab joints of tanks and channels subject to water pressure.
   3. Waterstops shall be provided for the full height of the walls.
   4. Provide at other locations shown on the Drawings.

C. Field splices shall be at straight sections using heat fused welded, butt splices only. Lapping of splices or joining by means other than heat fused welding is not allowed.

D. Install hydrophilic waterstops according to manuacturer's recommendations. Surfaces of concrete shall be prepared level/plumb and to the smoothness required by manufacturer. Grind surface as necessary. Provide bonding adhesive and concrete nails with fender washers to hold waterstop in position during concrete placment.

## 3.12 MODIFICATION OF EXISTING CONCRETE

A. General:
   1. Verify structural dimensions related to or controlled by previously constructed or existing structures prior to concrete work.

B. Cutting or Coring Concrete:
   1. Saw cut concrete to a depth of 1 inch to form straight outlines of concrete areas to be removed. Where reinforcement is exposed due to saw cutting or core drilling and

no new material is to be placed on the cut surface, provide a protective epoxy coating to the entire cut surface.

2. Coat surfaces of oversized openings with an epoxy bonding compound prior to re-finishing with profiling mortar to the required opening size.
3. Grind existing joint edges to create a chamfer matching those used on adjacent construction.
4. Investigate concrete to be drilled, cored, or sawcut to determine location of reinforcing steel. Locate penetrations to clear existing reinforcing steel. Where not possible to avoid reinforcing steel, consult the Engineer as to acceptability of cutting reinforcing steel and provide new reinforcing systems as directed.
5. Locating methods include chipping to expose reinforcing steel, ground penetrating radar, X-ray, or magnetic flux devices. Locates of existing reinforcing shall be by the Contractor.

C. Joining New Concrete To Existing:

1. Existing concrete surfaces to be joined with new concrete shall be cleaned and roughened by abrasive blasting, bush hammering, or other method to achieve ¼-inch amplitude surface. Remove existing metalwork, embeds, or other interfering items. Coat existing surface with epoxy bonding compound prior to placement of new concrete.

D. Post-Installed Anchors and Dowels:

1. Use non-destructive methods for locating reinforcement prior to drilling operations. For anchor and dowel locations that interfere with reinforcement, attempt to relocate to avoid drilling through the reinforcement if possible.
2. For situations that do not allow relocation, cutting of reinforcement for installation is subject to the following:
   a. Prior to drilling through reinforcement, the Contractor shall consult the Authority's Representative or Engineer.
   b. Drill holes with a hammer drill and carbide bit (core drilled holes are not allowed), followed by brushing and air-cleaning with oil-free compressed air.
   c. Holes drilled through reinforcement must be in compliance with adhesive anchor assumptions for roughened hole surface typical of a hammer drill and carbide bit. No smooth hole surfaces are allowed.
   d. Do not cut slab rebar within 24 inches of a supporting wall, column, or an opening in the slab.
   e. No cutting of rebar is allowed in the middle third of slab spans for anchors with diameters equal to or greater than 3/4 inch.
   f. Maximum of two rebar may be cut in any 10 foot width of slab.
   g. Maximum of two rebar may be cut within any 10 foot width of concrete wall.
   h. Maximum of one rebar may be cut within any 8 foot width of CMU wall.
3. For anchors that cannot be moved and that conflict with the above requirements, consult Engineer for direction. It is not acceptable to cut reinforcement in beams, columns, precast members, or stairs.
4. Use a pre-manufactured, self-mixing, injectable, two-component, epoxy adhesive, as per Section 03 60 00. Follow manufacturer's recommendations and ICC Evaluation Report for installation.

E. Waterstops:
   1. Where a waterstop between new and existing concrete is required, install a hydrophilic waterstop, or a retrofit waterstop where indicated on the design drawings for the specific location.

## 3.13 FORMED SURFACE FINISHES

A. Repair Of Surface Defects:
   1. Repair surface defects, including tie holes, minor honeycombing, or otherwise defective concrete in accordance with ACI 301. Clean areas to be repaired. Cut and chip out honeycombed or otherwise defective areas to solid concrete, to a depth of at least 1-inch. If defective area includes exposed reinforcing steel, correct by removing concrete a minimum of 1-inch beyond the reinforcing. Make edges of the cut perpendicular to the surface of the concrete in a neat rectangular patern.
   2. Joints shall be grooved to a radius or bevel of ¾-inch depth.
   3. Finish patches on exposed surfaces to match and blend with adjoining work. Cure patches as specified for the concrete. Protect finished surfaces from stains and abrasions.

B. Formed Surface Finishes:
   1. Finish A - Grout Rubbed Finish
      a. After repair of surface defects, apply a grout rubbed finish in accordance with ACI 301 except that all form fins and other protrusions shall be completely removed. Lightly sandblast surfaces prior to sacking. Sandblasting shall occur after the specified curing period.
      b. Add a PVA bonding compound to the mix water used in sacking mortar; as recommended by the manufacturer.
      c. Provide Finish A at uncoated surfaces of stair wells, at interior surfaces of equipment rooms, galleries, tunnels, operations areas, exposed channels and tanks from 1 foot below minimum water surfaces and up, at exposed exterior surfaces to 1 foot below grade, and at permanently exposed vertical and sloped surfaces such as pipe chases.
      d. Do not provide Finish A at concrete surfaces receiving a coating.
   2. Finish B - Smooth Surface Finish
      a. Initial surface preparation is the same as Finish A; repair surface defects and remove all form fins.
      b. Provide Finish B at surfaces to be coated, at interior surfaces of exposed channels and tanks from 1 foot below minimum water surfaces and down (Finish A applied above this level), and full height at surfaces of wet wells, tanks, and channels not exposed to view. See Section 09 90 00 for additional concrete surface preparation, including filling of bug holes, and coating requirements.
   3. Finish C - Rough Form Finish
      a. Repair surface defects and imperfections greater than 3/8 inch in any dimension. Remove form fins and protrusions down to less than 3/8 inch projection.
      b. Provide Finish C or smoother at exterior surfaces from 1 foot below grade and down, at other vertical surfaces not exposed to view and not specified above to receive Finish A or B.

c. Also apply Finish C to unoccupied interior areas not otherwise specified.

4. Finish D – Unfinished Surface
   a. Repair surface defects and otherwise leave the surfaces as they come from the forms, except plug tie holes and repair or remove defects greater than 1/2 inch in any dimension.

C. Sample Of Formed Surface Finish A:
   1. Provide a sample concrete panel, minimum 4 feet by 4 feet; representative of formed surface Finish A. The panel shall be representative of the workmanship and finish required, including repair of defects, filling of tie holes, sandblasting, and rubbing.
   2. The sample shall be approved by the Authority's Representative prior to the start of production work. The sample shall be on display at the job site, and finished surfaces shall match sample.

## 3.14 SLAB FINISHES

A. General:
   1. The finishes specified herein include surface finishes, treatments and toppings for floors and slabs. Do not use dry cement on new concrete surfaces to absorb excess moisture. Round edges to a radius of 1/2 inch.
   2. Slope floors to drain uniformly within a room or space. Unless otherwise specified, slope shall be a minimum of 1/8 inch per foot toward nearest drain. Restrict use of floor drains with only locally depressed slabs to locations specifically noted.
   3. Immediately after final finish is applied, the surface shall be cured and protected as specified in Curing, Sealing, and Protection paragraphs above.
   4. Where finish is not specified, floor slabs shall receive a Steel Trowel Finish.

B. Float Finish:
   1. Perform floating with a hand or power-driven float in accordance with ACI 301. Begin floating when the bleed water sheen has disappeared and the surface has stiffened sufficiently. Float as required to meet tolerance requirements of ACI 117 for a conventional surface.
   2. Floating shall close cracks and checks plus compact and smooth the surface. Refloat the slab to a uniform texture.
   3. Applly float finish to surfaces of channels, tank bottom slabs, exterior below grade horizontal surfaces, incuding tops of footings, and surfaces to receive insulation or roofing.

C. Steel Trowel Finish:
   1. Float the concrete surface as indicated above and then trowel in accordance with ACI 301.
   2. Provide Steel Trowel Finish on interior exposed floors and slabs that will receive resilient fooring, carpet or ceramic tile, unless specified otherwise.

D. Broom Finish:
   1. Float the concrete surface as indicated above, then immediately give the concrete a coarse transverse scored texture by drawing a broom or burlap belt across the surface in accordance with ACI 301.

2. Provide a Broom Finish for steps and ramps, exterior exposed horizontal surfaces, and where otherwise indicated.

E. Samples Of Concrete Slab Finishes:
1. Provide a sample concrete slab, minimum 4 feet by 4 feet, representative of workmanship and each specified finish.
2. Samples shall be approved by the Authority's Representative prior to the start of production work. The samples shall be on display at the job site, and finished surfaces shall match samples.

## 3.15 TOPPING CONCRETE

A. Subfloor Finish:
1. Slabs to receive a topping concrete, topping grout, or tile; shall be float finished to required elevations. Immediately following the final finishing, either:
a. treat slab with a retardant and abrasive blast to create expose aggregate with 1/4-inch amplitude, or
b. create the ¼ inch amplitude roughened surface by raking the freshly floated surface using a standard garden rake.
2. Immediately after finishing, proceed with required curing and protection of the slab as stated above.

B. Topping Concrete or Grout:
1. Remove dirt, laitance, and loose aggregate. Keep cleaned base slab saturated surface dry for a period of 24 hours prior to the application of topping. Remove excess water.
2. Apply and scrub a neat cement grout into the surface of the base slab using a stiff broom. The cement grout shall not be allowed to dry and shall be spread within 15 minutes ahead of the topping placement.
3. The topping shall then be placed, compacted, and floated. Test surface with a straight edge to detect and correct high and low spots to a tolerance of 1/8 inch in 10 feet.
4. Incorporate float finish, surface hardener, steel trowel finish, etc as specified.



## 3.16 RELATED SURFACES

A. Stair Treads:
1. Construct stair treads with a nonskid nosing as specified in Section 05 50 00.
2. Treads shall have a Float Finish followed by a Steel Trowel Finish with a slope of 1/8 inch toward the front.

B. Finishing of Unformed Surfaces:
   1. Adjacent Unformed Surfaces:
      a. Tops of walls, buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be Float Finished to a texture reasonably consistent with that of the adjacent formed surface.
      b. Continue final treatment of formed surface uniformly across the top of the unformed surface.
   2. Pavements and Sidewalks:
      a. The surface of the concrete shall be screeded to grade and sloped to drain. After screeding, the surface shall be Float Finished followed by a Broom Finish.
      b. Round edges and expansion joints to a radius of 1/2 inch. Control joints shall be grooved or sawcut to a minimum depth of 1/4 the slab thickness.

## 3.17 FIELD SAMPLING AND TESTS

A. General:
   1. Field sampling and tests shall be performed by an independent testing laboratory. Samples of aggregates and concrete will be obtained at such times to represent the quality of the materials and work throughout the project.
   2. The laboratory shall provide necessary labor, materials and facilities for sampling aggregate and for casting, handling and initially storing the concrete samples at the work site.
   3. The minimum number of samples and tests are specified in Testing paragraph below.

B. Sampling:
   1. Aggregates:
      a. General:
         1) Sample fine and coarse aggregates in accordance with ASTM D75 not less than 30 days prior to the use of such aggregates in the work.
         2) Take samples at the discharge gates of the bins feeding the weigh hopper. Repeat sampling when the source of material is changed or when unacceptable deficiencies or variations from the specified requirements of materials are found.
         3) Aggregate samples shall be tagged and their sources idenified.
      b. Coarse Aggregate:
         1) Take a sample weighing between 50 and 60 pounds after the batch plant is brought up to full operation.
         2) Take samples to obtain a uniform cross section, accurately representing the materials on the belt or in the bins for sieve analysis.
      c. Fine Aggregate:
         1) Take samples as specified for coarse aggregate.
         2) Take samples of sand when the sand is moist for sieve analysis and specific gravity tests.
   2. Concrete:
      a. Take samples of plastic concrete in accordance with ASTM C172.

b. Take samples at the hopper of mixing equipment or transit mix truck, except as noted in the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

C. Testing:

1. Aggregate:
   a. A minimum of one test of coarse aggregate per 400 cubic yards of concrete used and a minimum of one test of fine aggregate per 200 cubic yards of concrete used shall be made to confirm continuing conformance with specifications for gradation, cleanliness and sand equivalent.
   b. A maximum of one test per day of each aggregate is required.
   c. Repeat of the entire concrete mix design test program is required before source changes will be accepted.
2. Concrete:
   a. Strength Tests:
      1) The strengths specified for the design mix shall be verified by the independent testing laboratory during placement of the concrete. Verification shall be accomplished by testing standard cylinders of concrete samples taken at the job site. Cylinders shall be 4 by 8 inch or 6 x 12 inch.
      2) Concrete samples shall represent the concrete placed in the forms. One set of six standard 6 x 12 inch (or nine 4 x 8 inch) cylinders shall be cast of each class of concrete for each 100 cubic yards or less, or for each 5,000 square feet of slab or wall surface area placed per day. Provide additional cylinders when an error in batching is suspected. Each set of cylinders are cast from material taken from a single load of concrete.
      3) Casting, handling and curing of cylinders shall be in accordance with ASTM C31. For the first 24 hours after casting, keep cylinders moist in a storage box constructed and located so that its interior air temperature will be between 60 and 80 degrees F. At the end of 24 hours, the testing laboratory will transport the cylinders to their laboratory.
      4) Testing of specimens for compressive strength shall be in accordance with ASTM C39. Each test shall consist of two 6 x 12 inch (or three 4 x 8 inch) test cylinders from each group of six (or nine) specimens. Test at the end of 7 days and at the end of 28 days. The remaining cylinders shall be tested at the end of 56 days if the 28-day strength reports below specification.
      5) A strength test shall consist of the average strength of two 6 x 12 inch (or three 4 x 8). If one cylinder shows evidence of low strength due to improper sampling, casting, handling, or curing, the result of the remaining cylinders may be used if approved by the Authority's Representative.
      6) The average of any three consecutive 28-day strength test results of the cylinders representing each class of concrete for each structure shall be equal to or greater than the specified strength. Not more than 10 percent of the individual strength test results shall have values less than the specified 28-day strength for the total job concrete. No individual strength test result shall be less than the specified strength by more than 500 pounds per square inch.
      7) Provide certified reports of the test results directly to the Authority's Representative and the Engineer. Test reports shall include sufficient

information to identify the mix used, the stationing or location of the concrete placement, and the quantity placed. Slump, water/cement ratio, air content, temperature of concrete, and ambient temperature shall be noted.

8) The 28-day strength test results shall be evaluated in accordance with ACI 214R. Quality control charts showing field test results shall be included with the test results for each class of concrete in each major structure. Charts shall be prepared in accordance with ACI 214R. Quality control charts shall be maintained throughout the entire project and shall be available for the Authority's Representative's inspection at any time.

9) If the 28-day test results fall below the specified compressive strength for the class of concrete required for any portion of the work, adjustment in the proportions, water content, or both, shall be made as necessary at the Contractor's expense. Report changes and adjustments in writing to the Authority's Representative.

10) If compressive test results indicate concrete in place may not meet structural requirements, tests shall be made to determine if the structure or portion thereof is structurally sound. Tests may include, but not be limited to, cores in accordance with ASTM C42 and any other analyses or load tests acceptable to the Engineer. Costs of such tests and/or anlysis shall be borne by the Contractor.

b. Tests for Consistency of Concrete:

1) Measure slump in accordance with ASTM C143. Take samples for slump determination from concrete during placement. Tests shall be made at the beginning of concrete placement operation, whenever test cylinders are cast, and at subsequent intervals to ensure that the specification requirements are met.

2) For pumped concrete, measure slump in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

3) When high range water reducer is added at the site, slump tests shall be taken before and after addition of the admixture.

c. Tests for Temperature and Air Content:

1) Temperature tests shall be made at frequent intervals during hot or cold weather conditions until satisfactory temperature control is established. Perform temperature tests whenever test cylinders are cast.

2) Measure air content in accordance with ASTM C231 whenever test cylinders are cast. For pumped concrete, measure air content in accordance with the Placing Concrete by Pumping subparagraph of the Conveying and Placing article above.

D. Final Laboratory Report:

1. The testing laboratory shall provid a final report at the completion of all concreting. This report shall summarize the findings concerning concrete used in the project and provide totals of concrete used by class and structure.

2. Include final quality control charts for compressive strength tests for classes of concrete specified in each major structure. Also include the concrete batch plant's coefficient of variation and standard deviation results for each class of concrete.

## 3.18 REPAIR OF DAMAGED AND CRACKED CONCRETE:

A. Acceptance Of Concrete:
   1. Completed cast-in-place concrete work shall conform to the applicable requirements of ACI 301 and the Contract Documents. Concrete work that fails to meet these requirements shall be repaired, as approved by the Engineer, to bring the concrete into compliance. Repair methods shall be in accordance with ACI standards, including ACI 503.7, and are subject to the approval of the Engineer.
   2. Concrete that cannot be brought into compliance by approved repair methods will be rejected. Remove and replace rejected concrete work.
   3. The cost of repairs and replacement of defective concrete shall be borne by the Contractor.

B. Repair Methods:
   1. Damaged/defective concrete or concrete with crack widths exceeding 0.004 inches at liquid-containing and conveying structures or crack widths exceeding 0.006 inches for other structures shall be repaired by one of the following methods (only the Engineer may determine that a defect or crack does not require repair):
      a. Perform watertightness testing and repair as needed to meet leakage criteria in this specification even when liquid-containing and conveying structures meet the crack width criteria defined above.
      b. Damaged or defective concrete includes surface defects, honeycomb, rock pockets, indentations greater than 3/16 inch, spalls, chips, air bubbles greater than 1/2 inch diameter, pinholes, bugholes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins, projections, form popouts, texture irregularities, and stains or other color variation that cannot be removed by cleaning.
         1) Damaged or defective concrete is repaired according to procedures outlined above under finish requirements, Repair of Surface Defects.
   2. Crack Repair Method 1:
      a. Fill the joint or crack by drilling holes to the affected area (following the product manufacturer's details), install injection ports, and force epoxy or chemical grout (expanding urethane) into the joint under pressure.
      b. Material type and repair proceedures shall be approved by Engineer.
      c. After injection and curing; ports, sealing mix, and surface shall be cleaned and worked to match the adjacent specified finish.
   3. Crack Repair Method 2:
      a. Fill cracks with low viscosity epoxy, applied by pouring/flooding crack zone until cracks are filled. Prepare surface, install, and cure according to manufacturer's recommendations.
      b. At a minimum, prepare surface to be clean and dry with no visible detrimental material in cracks to be filled. Conform to temperature limitations of epoxy. Clean and refinish to match adjacent surfaces.
   4. Crack Repair Method 3:
      a. Cut a bevel groove 3/8 to 1/2 inch in width and depth, use backer rod or tape, and fill with sealant in accordance with manufacturer's instructions.
      b. This repair method is only used where approved by Engineer.

c. Groove and sealant shall be applied on wet or hydrostatic pressure side of surface.

C. Repair Method Use:

1. Repair Method 1: For cracks in walls, surfaces sloped 1:1 or greater, beams, columns, structural slabs, overhead surfaces, and liquid retaining surfaces. Need for repair depends upon crack width, location, and leakage.
2. Epoxy grout is used for repair of structural cracks and chemical grout (expanding urethane) for repair of non-structural cracks at liquid-containing structures. The Engineer shall determine whether a crack is classified as structural or non-structural.
3. Repair Method 2: Utilized in lieu of Method 1 for slabs when approved by Authority's Representative. Final finish shall match adjacent surfaces.
4. Repair Method 3: Limited to dry-surface slabs, walls subject to less than three feet of liquid pressure, or as approved by Engineer. Repair Method 3 is not an equivalent repair method to Repair Methods 1 or 2, which shall be considered the standards.

## 3.19 WATERTIGHTNESS TESTING AND REPAIR

A. Liquid Containing Concrete Tanks And Channels:

1. Watertightness testing shall comply with ACI 350.1 and the following requirements.
2. Concrete tanks, basins, reservoirs and channels which have walls or slabs subjected to hydrostatic pressure shall be tested for watertightness. The tests shall be made after the structure is complete and the concrete has achieved its specified 28-day strength, but prior to application of waterproof coating or backfill.
3. Filling of the tank for watertightness testing shall not exceed a rate of 4 feet/hour. Fill with water to the maximum operating water surface. Keep water at this level for at least 72 hours prior to start of test.
4. Testing includes visual inspection of the dry sides of all walls, wall base construction joint at top of the slab, and the soffit of elevated slabs for evidence of leakage. Damp spots, leakage, or seepage revealed by the test, including those caused by shrinkage of concrete, honeycombed areas, construction joints, or other sources shall be repaired by Repair Method 1 (see Repair Methods paragraph in the Repair of Damaged Concrete and Cracking article above).
5. Damp spots are defined as areas from which water that can be picked up on dry hand and smeared across the dry concrete surface.
6. Re-test tanks or channels which have been repaired to check the suitability of repairs.
7. Provide water required for testing and re-testing and dispose of in an approved manner.
8. After repair of visual leakage, liquid containing or conveying concrete structures supported on soil must also meet maximum leakage criteria into the soil through their base slab or mat foundation as follows:

| Structure Type | Tightness Criterion |
|---|---|
| Containment structures fully lined prior to hydrostatic test | No measurable loss |
| Cylindrical water and wastewater storage tanks and reservoirs other than digesters | 0.050 percent per day |

| Structure Type | Tightness Criterion |
|---|---|
| Digesters | 0.050 percent per day (surcharged hydrostatic test) |
| Rectangular basins and tanks | 0.050 percent per day |
| Concrete paved reservoirs and channels | 0.10 percent per day |

*Note: All damp spots and/or leakage through walls, wall-to-slab joints, and elevated slabs shall first be repaired as described above.*

9. Record volume loss by measuring the vertical distance from the water surface to a fixed point on the tank above the water surface. Account for evaporation from open surfaces.
10. If the drop in water surface during the test period exceeds the values given in the table above, exclusive of evaporation, the leakage is considered excessive and shall be remedied. The test period shall be per ACI 350.1.

## 3.20 CLEANUP

A. Upon completion of the work and prior to final inspection, clean all concrete surfaces as follows: Sweep with a broom to remove loose dirt, then mop and/or flush with clean water. Scrub by hand or machine as required to remove and blend stains or discolored areas .

B. Clean floors that have curing and sealing compound as stated above, followed by the final application of curing and sealing compound.

**END OF SECTION**

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SECTION 03 60 00

GROUTING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Section includes: Grout for column base plates, other structural supports, equipment bases, reinforcing bar dowels, surface repair, grout toppings, patching of fresh concrete, and uses other than masonry. Grout for masonry is specified in Section 04 22 00. Adhesive anchor bolt grouting is specified in Section 05 05 20. Topping concrete over precast elements and clarifier topping concrete is specified in Section 03 30 00.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-In-Place Concrete
   2. Section 04 22 00 Concrete Unit Masonry
   3. Section 05 05 20 Anchor Bolts
   4. Section 43 05 13 Rigid Equipment Mounts

### 1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ASTM C109 | Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50 mm Cube Specimens) |
| ASTM C230 | Flow Table for Use in Tests of Hydraulic Cement |
| ASTM C307 | Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings |
| ASTM C939 | Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method) |
| ASTM C531 | Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes |
| ASTM C579 | Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes |
| ASTM C882 | Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear |
| ASTM C942 | Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory |
| ASTM C1107 | Packaged Dry, Hydraulic-Cement Grout (Non-shrink) |

| Reference | Title |
|---|---|
| ASTM C1181 | Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts |
| ASTM E329 | Agencies Engaged in Construction Inspection, Testing, or Special Inspection |
| COE CRD-C611 | Flow of Grout for Preplaced Aggregate Concrete |
| COE CRD-C621 | Non-shrink Grout |
| IBC | International Building Code |

## 1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Complete product literature, including mixing, handling and placement instructions for the following: Cementitious non-shrink grout, epoxy grout, adhesive for reinforcing bar dowel grouting, concrete repair mortar, and prepackaged cement grout products to be used on the project.
   5. Mix design for cement grout that is not prepackaged, including product data for aggregates and cement in accordance with Section 03 30 00.
   6. Current ICC Evaluation Service reports for adhesives used for reinforcing dowels.
   7. Installer certification in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.
   8. Certified test results verifying the compressive strength, shrinkage and expansion requirements specified herein.



## 1.05 QUALITY ASSURANCE

A. Quality Control by Authority
   1. The Authority will provide the services of a qualified Special Inspector in accordance with Section 01 45 29.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
      a. The Special Inspector shall furnish a report to the Engineer, Authority's Representative and Building Official that the work covered by the report has been

performed and that the materials used and the installation procedures used conform with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Quality Control by Contractor

1. Provide the services of an independent testing laboratory which complies with the requirements of ASTM E329 if a product other than those listed below is proposed and test data is not available from the supplier to demonstrate equivalence to the specified grout. The testing laboratory shall sample and test the proposed grout materials. Costs of testing laboratory services shall be borne by the Contractor.

C. Certifications

1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined reinforcing bar dowels grouted using adhesive.

D. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications.

1. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.
2. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.

E. Manufacturer Qualifications

1. Manufacturer shall have a minimum of five years' experience of producing products substantially similar to that required and shall be able to submit documentation of at least five satisfactory installations that have been in successful operation for at least five years each.
2. When required, provide services of manufacturer's full-time employee, factory-trained in handling, use, and installing the products required, with at least five years of experience in field applications of the products required.



## PART 2 PRODUCTS

### 2.01 CEMENTITIOUS NON-SHRINK GROUT

A. The grout material shall be an approved ready to use mixture requiring only water for use at the job site. The 2-inch cubes shall have a minimum compressive strength of 3,000 psi at 7 days and 7,000 psi at 28 days.

B. Cementitious non-shrink non-metallic aggregate grout shall be:

1. BASF, Masterflow 928
2. Euclid Chemical Company, Hi-Flow Grout
3. Five Star Products, Inc., Five Star Grout

4. Sika Corporation, SikaGrout 212
5. Approved Equal

C. Non-shrink grout shall conform to CRD-C 621 and ASTM C1107, Grade B or C when tested at a maximum fluid consistency of 30 seconds per ASTM C939 at temperature extremes of 45 degrees Fahrenheit and 90 degrees Fahrenheit and an extended working time of 15 minutes.

D. Fluid grout shall pass through the flow cone, with continuous flow, one hour after mixing.

## 2.02 EPOXY GROUT FOR EQUIPMENT MOUNTING:

A. Epoxy grout shall be a pourable, non-shrink, 100-percent solids system.

B. Epoxy grout for equipment mounting shall be a non-cementitious, resin based, multi-component formulation. Epoxy grout shall be flowable, with shrinkage minimized to achieve minimum 98% effective bearing area. Epoxy grout shall be:
1. BASF, Masterflow 648
2. Euclid Chemical Company, E3-G
3. Sika Corporation, Sikadur 42
4. Approved Equal.

C. The following properties shall be attained with the minimum quantity of aggregate allowed by epoxy grout manufacturer:
1. Length change after hardening shall be less than 0.0006-inch per inch and coefficient of thermal expansion shall be less than 0.00003-inch per inch per degree F when tested in accordance with ASTM C531.
2. Compressive creep at one year shall be less than 0.001-inch per inch when tested under a 400-psi constant load at 140 degrees F in accordance with ASTM C1181.
3. Minimum seven day compressive strength shall be 14,000 psi when tested in accordance with ASTM C579
4. Grout shall be capable of maintaining at least a flowable consistency for minimum of 30 minutes at 70 degrees F.
5. Shear bond strength to portland cement concrete shall be greater than shear strength of concrete when tested in accordance with ASTM C882/C882M.



## 2.03 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Adhesive for setting dowels in concrete shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report. Adhesive shall be:
1. Hilti, HIT-RE 500v3
2. Simpson Strong Tie, SET XP
3. Approved Equal (equivalent product must have ICC approval for use in cracked concrete in areas with high seismic risk).

B. Adhesive for setting dowels in concrete masonry shall be an injectable two-component epoxy adhesive. Adhesive shall be approved for the intended use per the product ICC Report or IAPMO Report. Adhesive shall be:
   1. Hilti, HIT-HY 70
   2. Simpson Strong Tie, SET XP
   3. Approved Equal

## 2.04 CONCRETE REPAIR MORTAR

A. Horizontal Applications: Repair mortars shall be:
   1. BASF, MasterEmaco S 466CI
   2. Sika Corporation, SikaTop 111 Plus
   3. Approved Equal

B. Vertical and Overhead Applications: Repair mortars shall be:
   1. BASF, MasterEmaco 1500HCR Vertical Overhead
   2. Sika Corporation, SikaTop 123 Plus
   3. Approved Equal

## 2.05 CEMENT GROUT

A. Cement grout shall be comprised of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed in accordance with this Section.
   1. Minimum Compressive Strength: 4,500 psi at 28 days.
   2. Maximum Water Cement Ratio: 0.42 by weight.
   3. Coarse Aggregate: ASTM C33/C33M, No. 8 size.
   4. Fine Aggregate: ASTM C33/C33M, approximately 60 percent by weight of total aggregate.
   5. Air Content: Five percent (plus or minus one percent).
   6. Minimum Cement Content: 564 pounds per cubic yard.
   7. Slump for grout fill shall be adjusted to match placing and finishing conditions, and shall not exceed four inches.



# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

## 3.02 CEMENTITIOUS NONSHRINK GROUT

A. Non-shrink, cementitious, nonmetallic aggregate grout shall be used for column base plates, structural bearing plates, and all locations where the general term “non-shrink grout” is indicated on the Drawings. Use of this grout to support the bearing surfaces of machinery shall be as specified in Section 43 05 13 or as detailed on the Drawings for specific locations or pieces of equipment. If guidance is not provided in locations noted above, use of non-shrink grout for equipment mounting shall be limited to equipment

less than 25 horsepower or 750 pounds. Grout shall be placed and cured in accordance with the manufacturer's instructions.

B. Non-shrink cementitious grout shall not be used as a surface patch or topping. Non-shrink cementitious grout must be used in confined applications only.

## 3.03 EPOXY GROUT FOR EQUIPMENT MOUNTING

A. Prepare concrete surfaces of equipment pads as indicated in details on the Drawings and as required by the epoxy grout manufacturer. Epoxy grout for equipment mounting shall be placed and cured in accordance with the requirements of Section 43 05 13, details on the Drawings, and in conformance with manufacturer's recommendations.

## 3.04 ADHESIVE FOR GROUTING REINFORCING BAR DOWELS

A. Follow manufacturer's instructions.

## 3.05 CONCRETE REPAIR MORTAR

A. Concrete repair materials and procedures shall be submitted for review to the Authority's Representative and shall be accepted prior to commencement of the repair work.

B. Follow all manufacturer's instructions, including those for minimum and maximum application thickness, surface preparation and curing. Add aggregate as required per manufacturer's recommendations. Any deviations from the manufacturer's instructions shall be submitted for review to the Authority's Representative and shall be accepted prior to commencement of the work.

## 3.06 CEMENT GROUT

A. Cement grout shall be used for grout toppings less than four inches thick and for patching of fresh concrete.

B. Grouting shall comply with temperature and weather limitations in Section 03 30 00, Cast-In-Place Concrete.

C. Cure grout in accordance with grout manufacturer's instructions for prepackaged grout and Section 03 30 00, Cast-In-Place Concrete, for non-prepackaged cement grout.

**END OF SECTION**

# DIVISION 04
# MASONRY

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SECTION 04 20 00

UNIT MASONRY

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This section specifies masonry work consisting of brick, concrete masonry units, general unreinforced and reinforced masonry construction.

B. Type:
   1. Masonry work shall be constructed from units of concrete or clay in combination with reinforcing, mortar, and grout as specified.

### 1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.



| Reference | Title |
|---|---|
| ASTM A82 | Steel Wire, Plain, for Concrete Reinforcement |
| ASTM A90 | Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles |
| ASTM A153 | Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM C27 | Classification of Fireclay and High-Alumina Refractory Brick |
| ASTM C55 | Concrete Building Brick |
| ASTM C62 | Building Brick (Solid Masonry Units Made from Clay or Shale) |
| ASTM C67 | Sampling and Testing Brick and Structural Clay Tile |
| ASTM C90 | Loadbearing Concrete Masonry Units |
| ASTM C91 | Masonry Cement |
| ASTM C129 | Non-Load-Bearing Concrete Masonry Units |
| ASTM C144 | Aggregate for Masonry Mortar |
| ASTM C150 | Portland Cement |
| ASTM C207 | Hydrated Lime for Masonry Purposes |

| Reference | Title |
|---|---|
| ASTM C216 | Facing Brick (Solid Masonry Units Made from Clay or Shale) |
| ASTM C270 | Mortar for Unit Masonry |
| ASTM C404 | Aggregates for Masonry Grout |
| ASTM C476 | Grout for Masonry |
| ASTM C666 | Resistance of Concrete to Rapid Freezing and Thawing |
| ASTM E514 | Water Penetration and Leakage Through Masonry |

B. Sample Panel:
   1. A sample masonry panel for each type of masonry, approximately 6 feet long by 4 feet high shall be constructed on site for approval by the Construction Manager. Each panel shall show the workmanship, coursing, bond, anchors, joint reinforcing wall ties, tooling of joints, range of color, texture of masonry, and mortar color. Finished work shall match the approved sample panel.

C. Appearance:
   1. Source or supply of materials shall not be changed after the work has started if the appearance of the finished work would be affected.

D. Efflorescence Testing:
   1. Certified efflorescence test reports shall be provided on masonry units that are to be exposed to weathering. Schedule tests far enough in advance of starting masonry work to permit retesting if necessary. Test three pairs of specimens of each type of masonry unit for efflorescence in accordance with ASTM C67. If any pair is rated "effloresced," the units represented by the samples will be rejected.



## 1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Shop drawings showing details of bond beams and lintels.
   3. Three representative full-size sample masonry units showing full range of color, texture, finish, and dimensions.

## 1.04 DELIVERY, STORAGE, AND HANDLING:

A. Cementitious materials shall be delivered to the site in unbroken containers, plainly marked and labeled with manufacturers' names and brands, stored in dry, weathertight enclosures to prevent entry of foreign materials and damage by water or dampness. Masonry units shall be stored off the ground and handled with care to avoid chipping and breakage. Materials shall be protected from damage and, except for sand, kept dry until used. Sand shall be covered to prevent intrusion of water and foreign materials and to prevent drying. Materials containing frost or ice shall not be used.

# PART 2 PRODUCTS

## 2.01 MASONRY UNITS

A. Concrete Masonry Units:
   1. General:
      a. Concrete masonry units shall be of modular dimensions and air, water, or steam cured. Unless otherwise specified, exposed surfaces of units shall be comparatively smooth and of uniform texture. Special surface texture or, architectural faces shall be provided where specified.
   2. Hollow Load-Bearing Units:
      a. Hollow load-bearing units shall conform to ASTM C90, Grade N, Type I, made with lightweight or normal weight aggregate. Load-bearing units shall be provided, unless otherwise specified.
   3. Hollow Non-Load-Bearing Units:
      a. Hollow non-load-bearing units, where specified, shall conform to ASTM C129, Type I, made with lightweight or normal weight aggregate. Load-bearing units may be provided in lieu of non-load-bearing units.
   4. Solid Load-Bearing Units:
      a. Solid load-bearing units shall conform to ASTM C145, Grade N, Type I, and made with lightweight or normal weight aggregates. Solid load-bearing units shall be provided where specified.
   5. Special Shapes:
      a. Special shapes such as closures, header units, and jamb units shall be provided as necessary to complete the work. Special shapes shall conform to the requirements for the units with which they are used.

B. Precast Concrete Lintels:
   1. Precast concrete lintels shall be of the same materials and surface texture as adjacent masonry units, with a 28-day compressive strength of not less than 2000 psi. Reinforcing shall be provided as specified. Lintels shall be of sizes specified, straight and true, with at least 8 inches of bearing at each end.

C. Facing Brick:
   1. Unless building brick is specified, facing brick shall be provided for all brickwork. Facing brick shall conform to ASTM C216, Grade SW, Type FBX, 3-5/8 inches thick, 2-1/4 inches high, and 7-5/8 inches long. Facing brick shall be of uniform color, size, style, and texture to match existing buildings on site, coordinate final selection with owner.

## 2.02 MORTAR

A. Cement:
   1. Cement shall be Portland cement conforming to ASTM C150, Type II, low alkali containing less than 0.60 percent alkalies.

B. Hydrated Lime:
   1. Hydrated lime shall conform to ASTM C207, Type S.

C. Masonry Cement:
   1. Masonry cement shall conform to ASTM C91, except that for masonry cement used in mortar for exterior walls, the air content of the mortar specimen shall be not more than 16 percent by volume in lieu of 22 percent. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar.

D. Sand:
   1. Aggregate for mortar shall be sand conforming to ASTM C144.

E. Water:
   1. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

F. Waterproofing Compound:
   1. Mortar shall contain an admixture of Master Builders Rheomix 235, Sonneborn Hydrocide Powder, or equal.

G. Mortar Types:
   1. Unless otherwise specified, mortar shall be ASTM C270, Type M for foundation and exterior walls and other load bearing or shear-wall masonry, and Type S for non-load-bearing, non-shear-wall interior masonry. Waterproofing compound shall be added in accordance with manufacturer's recommendations. Air content shall not be less than 11 percent. Provide colored mortar to match existing on site. Add colorant to obtain the color indicated. Colorant shall be alkali-resistant iron oxide based and shall be Sonneborn "Sonobrite," Solomon Grind-Chem Service, Inc., "Concentrated Cement Color," or equal, coordinate final color section with owner.

H. Premixed Mortar:
   1. Premixed mortar shall be ASTM C270, Type M or S for use as specified in paragraph 2.02 Mortar Types. Water proofing compound shall be added in accordance with manufacturer's recommendation. Air content shall not be less than 11 percent.

I. Admixtures:
   1. Admixtures may be used in mortar to retard curing and provide up to 36 hours of workability, provided that the admixture does not adversely affect bonding or compressive strength.

## 2.03 ACCESSORIES

A. Horizontal Joint Reinforcement:
   1. Horizontal joint reinforcement shall be fabricated from cold drawn steel wire, ASTM A82. Wire shall be hot-dipped galvanized after fabrication in accordance with ASTM A153. Reinforcement shall be truss type with two or more longitudinal wires welded to a continuous diagonal cross wire, or ladder type with perpendicular cross wires not more than 16 inches o.c. Reinforcement shall be provided in flat sections 10 feet long, and preformed corners and tees approximately 30 inches long. Overall width shall be approximately 2-inches less than nominal thickness of wall.
   2. For single-wythe walls and partitions, two 9-gage longitudinal wires and 9-gage cross wires shall be provided.
   3. For brick-faced or composition walls, unless otherwise specified, three 9-gage longitudinal wires (one for each face shell of concrete masonry units and one for the brick wythe) and 9-gage cross wires shall be provided.

B. Reinforcing Bars:
   1. Reinforcing steel shall be as specified in Section 03 20 00.

C. Anchors And Ties:
   1. General:
      a. Anchors and ties shall be approved designs of stainless steel, zinc-coated steel, or noncorrosive metal having the equivalent total strength of steel types. Zinc-coated steel shall be coated by the hot-dip process after fabrication to a minimum of 1.25 ounces of zinc per square foot of surface when tested in accordance with ASTM A90.
   2. Dovetail Flat Bar Or Wire Anchors:
      a. Flat bar anchors shall be sheet steel, not lighter than 16 gage, and 7/8-inch wide, with end turned up 1/4 inch. Wire anchors shall be not lighter than 6 gage, 7/8-inch wide with wire looped and closed.
   3. Dovetail Anchor Slots:
      a. Unless otherwise specified, Dovetail slots shall be made of galvanized steel with minimum dimensions of 1 inch wide back by 1 inch deep by 5/8-inch throat.

D. Through-Wall Flashing:
   1. Flashing, where specified, shall be 5-ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, elastic bituminous compound. Factory applied coating shall weigh not less than 6 ounces per square foot (approximately 3 ounces per square foot on each side).



## 2.04 GROUT

A. General:
   1. Grout shall comply with ASTM C476, shall use Type II cement, and shall be proportioned by volume to achieve a minimum 28-day compressive strength of 2,000 psi. Grout shall have sufficient water added to produce a consistency for pouring without segregation.

B. Aggregate:
   1. Aggregate shall comply with ASTM C404.

C. Fine Grout:
   1. Fine grout shall be composed of one part cement, not more than 1/10 part lime, and 2-1/4 to 3 parts fine aggregate.

D. Coarse Grout:
   1. Coarse grout shall be composed of one part cement, not more than 1/10 part lime, 2 to 3 parts fine aggregate, and not more than 2 parts coarse aggregate.

## 2.05 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00. Information shall be received by the Construction Manager at least 14 days prior to the beginning of masonry work.
   1. Masonry unit certificates showing compliance to the specifications shall be submitted for each type of masonry unit.
   2. Reinforcing certificates showing compliance to the specifications shall be submitted for reinforcing steel, including reinforcing steel wire and joint reinforcing, as specified herein and in Section 03 20 00.
   3. Certified efflorescence test reports specified in paragraph 1.02 Efflorescence Testing.
   4. Shop drawings showing details of anchors, adjustable wall ties, positioning devices, and other accessories.
   5. Manufacturer's data and descriptive literature for each type of masonry accessory, premixed mortar, masonry cement, grout admixtures, and flashing. Clearly mark the data to indicate which type, size, or item the Contractor intends to provide. Data shall show conformance to specified requirements and Contractor's proposed usage details.



# PART 3 EXECUTION

## 3.01 PREPARATION

A. General:
   1. Foundations for masonry work shall be straight, on-line, and level. All surfaces to be bonded with masonry shall be clean and free from laitance or foreign materials. Reinforcing dowels shall be in the correct location as specified. The placement and location of anchor ties, inserts, and other embedded items in concrete or other adjoining work shall be coordinated by the Contractor to suit the masonry work.

B. Protection:
   1. Exposed surfaces shall be protected from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Base of walls shall be protected from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.
   2. Uniform loads shall not be applied for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed.

3. Temporary bracing shall be provided as required to prevent damage during construction.
4. Protective boards for polyester film shall be provided during job installation to ensure no damage from building debris.

## 3.02 WORKMANSHIP

A. Masonry shall be level and plumb. Story poles or gage rods shall be used throughout the work. Changes in coursing or bonding after the work is started will not be permitted; neither will carrying one section of the walls up in advance of the others be permitted. Unfinished work shall be stepped back for joining with new work; toothing will not be permitted. Heights of masonry at each floor and at sills and heads of openings shall be checked with an instrument to maintain the level of the walls. Door and window frames, louvered openings, anchors, pipes, ducts, and conduits shall be built in as the masonry work progresses. Spaces around metal door frames shall be filled solidly with mortar. Drilling, cutting, fitting, and patching to accommodate the work of others shall be performed by masonry mechanics. Masonry shall be cut with masonry saws for exposed work. Structural steelwork, bolts, anchors, inserts, plugs, ties, lintels, and miscellaneous metalwork shall be placed in position as the work progresses. Chases of approved dimensions for pipes and other purposes shall be provided where specified and necessary. Tops of exposed walls and partitions not being worked on shall be covered with a waterproof membrane secured in place and extended down at least 2 feet on both sides.

## 3.03 MORTAR MIXING

A. Mortar materials shall be measured in 1 cubic foot containers to maintain control and accuracy of proportions; measuring materials with shovels is not permitted. Mortar shall be mixed in a mechanical batch mixer for not less than 3 nor more than 5 minutes after all ingredients are in so as to produce a uniform mixture. Water shall be added gradually as required to produce a workable consistency. Mortar not formulated to include retarding admixtures, which has not been placed in final position within 2-1/2 hours after the initial mixing, shall not be retempered and used. Use of antifreeze compounds, salts, or other substances to lower the freezing point of mortar is prohibited.

B. Mortar shall be mixed in accordance with ASTM C270 to obtain type mortar required. Where colored mortars are required, pigments may be added at the site or provided as part of prepackaged mortar mix. When masonry cement is used, mixing shall conform to printed instructions of the masonry cement manufacturer.

## 3.04 MORTAR JOINTS

A. Mortar joints shall be a uniform thickness of 3/8-inch unless otherwise specified. Exposed joints shall be tooled slightly concave with a round or other suitable jointer when the mortar is thumbprint hard except where otherwise required to match existing construction. For horizontal joints, jointers shall be at least 12 inches long for brickwork and 16 inches long for concrete masonry. Jointers shall be slightly larger than the width of the joint so that complete contact is made along the edges of the units, compressing and sealing the surface of the joint. Joints that will not be exposed shall be struck flush. Vertical joints shall be tooled first. Horizontal joints shall be level; vertical joints shall be

plumb and in alignment from top to bottom of wall within a tolerance of plus or minus 1/2 inch in 40 feet.

B. Weep holes shall be placed at a maximum spacing of 24 inches at the base of cavity walls or veneer walls and in the course bearing on through-wall flashing.

## 3.05 TOLERANCES

A. Masonry work shall be within the following limits:
   1. Pilasters and Columns: 1/4 inch from true line.
   2. Face of Brick: 1/32 inch from face of adjacent brick.
   3. Face of Concrete Masonry Unit: 1/16 inch from face of adjacent unit.
   4. Variation from True Plane: 1/4 inch in 10 feet and 1/2 inch maximum in 20 feet or more.
   5. Variation from Plumb: 1/4 inch in each story, noncumulative and 1/2 inch maximum in two stories or more.
   6. Variation from Level: 1/8 inch in 3 feet, 1/4 inch in 10 feet, and 1/2 inch maximum.
   7. Variation in Wall Thickness: Plus or minus 1/4 inch.



## 3.06 BRICKWORK

A. General:
   1. Brickwork shall conform to requirements of paragraph 3.05. Brick shall be selected and placed so that the better face of stretchers and headers are exposed.

B. Testing:
   1. Except during cold weather, as defined under paragraph 3.16, clay or shale brick shall be tested daily on the job, prior to laying. Testing shall be done using a wax pencil to draw a circle the size of a quarter on five randomly selected bricks and applying 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely absorbed in the five bricks is less than 1 1/2 minutes, bricks represented by the five bricks tested shall be wetted. Each brick shall be nearly saturated, but surface dry when laid. During cold weather, masonry units shall be kept dry until laid.

C. Application:
   1. Unless otherwise specified, brick shall be laid in running bond. Joints between bricks shall be filled completely with mortar. The practice of slushing head joints will not be permitted. Closure bricks shall be laid with mortar on all bedding surfaces of unit to be laid and units in place. Dry or butt joints will not be permitted. Grouting shall be provided where specified.

D. Brick-Faced Walls:
   1. Two wythes in every sixth brick course shall be bonded with continuous horizontal joint reinforcement. Additional bonding ties shall be provided spaced not more than 3 feet apart around the perimeter of and within 12 inches of all openings.
   2. For brick sills, brick shall be laid on edge, sloped, and projected not less than 1/2 inch beyond the face of the wall to form a wash and drip. All joints shall be filled solidly with mortar and tool.

## 3.07 CONCRETE MASONRY UNIT WORK

A. General:

1. The first course shall be laid in a full bed of mortar for the full width of the unit. Succeeding courses shall be laid in running bond unless otherwise specified. Bed-joints shall be formed by applying the mortar to the entire top surfaces of the inner and outer face shells and to head joints by applying the mortar for a width of about 1 inch to the ends of the adjoining units. The mortar shall be of such thickness that it will be forced out of the joints as the units are placed in position. Where anchors, bolts, and ties occur within the cells of the units, metal lath shall be placed in the joint at the bottom of such cells and the cells filled with mortar or grout as the work progresses. Except at grouted or reinforced masonry, concrete brick shall be used for bonding walls, working out the coursing, topping out walls under sloping slabs, distributing concentrated loads, backing brick headers, and elsewhere as required. Concrete masonry units shall not be dampened before or during laying.

B. Special Concrete Masonry Unit Work:

1. Where exposed concrete masonry unit walls and partitions are specified, special concrete masonry unit work shall be provided. Units shall be selected for uniformity of size, texture, true plane, and undamaged edges and ends of exposed surfaces. Units shall be placed plumb, parallel, and with properly tooled joints of maximum 3/8-inch thickness, and exposed surfaces kept clean and free from blemishes or defects.

C. Reinforced Concrete Masonry Unit Walls:

1. Where vertical reinforcement occurs, cores shall be filled solid with grout, and units laid in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Adjacent webs shall be embedded in mortar to prevent leakage of grout, and mortar fins protruding from joints removed before grout is placed. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Reinforcing shall be positioned and held accurately before placing grout by tying or by using bar positioners at maximum 8-foot intervals. Vibrator shall be used to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be 1/2 inch. Unless otherwise specified, splices shall be formed by lapping bars not less than 40 bar diameters.



## 3.08 BONDING AND ANCHORING

A. Unless otherwise specified, partitions shall extend from the floor to the bottom of the construction above. Walls and partitions shall be structurally bonded and anchored to each other and to concrete walls and beams. Unless otherwise specified, non-load-bearing partitions and interior walls shall be securely anchored to the construction above in a manner that provides lateral stability while permitting unrestricted deflection of construction above. Anchors shall be completely embedded in mortar joints.

B. In addition, bonding and anchoring shall comply with the following procedures unless otherwise specified.

1. At corners of load-bearing walls, provide a true masonry bond in each course.

2. At intersections of load-bearing walls, provide a true masonry bond in each course, or anchor with rigid steel anchors not more than 2 feet apart vertically.
3. At intersections of non-load-bearing partitions with other walls or partitions, tie with wire mesh ties at vertical intervals of not more than 2 feet or with masonry bonding in alternate courses.
4. At masonry walls facing or abutting new concrete members, anchor masonry to the concrete with dovetail or wire-type anchors inserted in slots or inserts built into the concrete. To anchor masonry walls to existing concrete members, use corrugated metal ties anchored by drive pins to the concrete. Locate anchors not more than 18 inches o.c. vertically and not more than 24 inches o.c. horizontally.

## 3.09 HORIZONTAL JOINT REINFORCEMENT

A. Unless otherwise specified, reinforcement shall be provided at 16-inch spacing in all masonry walls. Reinforcement shall be continuous except at control joints and expansion joints. Reinforcement above and below openings shall extend not less than 24 inches beyond each side of openings. Reinforcement shall be provided in the longest available lengths, utilizing the minimum number of splices. Welded L-shaped assemblies and welded T-shaped assemblies to match the straight reinforcement shall be provided at corners and intersections of walls and partitions.

## 3.10 CONCRETE MASONRY UNIT LINTELS AND BOND BEAMS

A. Special units, lintels, and bond beams shall have cells filled solidly with grout or concrete, and provided with not less than two No. 5 reinforcing bars, unless otherwise specified. Reinforcing shall overlap a minimum of 40 bar diameters at splices. Bond beams and reinforcing shall terminate on each side of expansion joints. Concrete masonry units used for lintels and bond beams shall have exposed surfaces of the same material and texture as the adjoining masonry units. Bond beam units shall be produced from standard vertically-voided units with precut knock-out cross walls. Lintels shall be straight and true and shall have at least 8 inches of bearing at each end. Lintels shall set at least 6 days before shoring is removed.



## 3.11 THROUGH-WALL FLASHING

A. Unless otherwise specified, flashing shall be installed at bottom of cavity wall, above all masonry openings and where indicated on the Contract Drawings.

## 3.12 GROUT

A. General:
   1. Fine grout shall be provided in grout spaces which are less than 2 inches in any horizontal dimension after deducting the thickness of horizontal reinforcing or in which clearance between reinforcing and masonry is less than 3/4 inch. Coarse grout shall be provided in grout spaces which are 2 inches or greater in all horizontal dimensions after deducting the thickness of horizontal reinforcing provided the clearance between reinforcing and masonry is not less than 3/4 inch. For a coarse grout pour over 6 feet high, increase grout space minimum horizontal dimension to 3 inches.

B. Placement:

1. Grout shall be placed from the interior side of walls, except as approved otherwise. Sills, ledges, offsets, and other surfaces shall be protected from grout droppings. Prior to grouting, the grout space shall be clean so that all spaces to be filled with grout do not contain mortar projections greater than 1/2 inch, mortar droppings, or other foreign material. Grout shall be well mixed to prevent segregation, shall be sufficiently fluid to flow into joints and around reinforcing without leaving voids, and shall be placed by pumping or pouring from buckets equipped with spouts. Grout shall be placed in a continuous pour in grout lifts not exceeding 6 feet. At grout pours exceeding 6 feet, cleanouts shall be provided in the bottom course at every vertical bar but shall not be spaced more than 32 inches on center for solidly grouted masonry. Pours shall be 1-1/2 inches below the top of masonry units in top course, except at the finish course. Grout shall be agitated thoroughly to eliminate voids. Masonry displaced by grouting operation shall be removed and relaid in alignment with fresh mortar.

## 3.13 FORMS AND SHORING

A. Contractor shall construct forms to the shape, lines, and dimensions of members indicated and make sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry. Forms shall not be removed until members have cured.

## 3.14 PARGING

A. Contractor shall parge the outside of masonry basement walls in contact with the earth with two coats of Type M mortar as specified in paragraph 2.02 Mortar Types, each 3/8 inch thick. The first coat shall be cross-scratched and allowed to cure at least 24 hours. The second coat shall be troweled smooth, beveled at top, and coved out to edge of footing. Parging shall extend not more than 4 inches above grade, unless otherwise specified, and kept damp for at least 3 days.

## 3.15 CLEANING

A. Contractor shall protect work which may be damaged, stained, or discolored during cleaning operations.

B. Exposed masonry surfaces shall be cleaned with clear water and stiff fiber brushes and rinsed with clear water. Where stains, mortar, or other soil remain, scrubbing shall continue with warm water and detergent. Immediately after cleaning, each area shall be rinsed thoroughly with clear water. Damaged, stained, and discolored work shall be restored to original condition or replaced with new work.

## 3.16 COLD WEATHER CONDITIONS

A. Construction:

1. During cold weather, that is, when the air temperature is below 40 degrees F and falling, or when it appears that the air temperature will drop to 40 degrees F or below within 24 hours, Contractor shall not lay masonry unless the work is protected from freezing as specified below. Surfaces receiving mortar shall be free of ice and frost. The following requirements shall be adhered to:
    a. Air Temperature 40 to 32 Degrees F:
        1) Heat sand or mixing water to produce mortar temperature between 40 and 120 degrees F.
    b. Air Temperature 32 to 25 Degrees F:
        1) Heat sand and mixing water to produce mortar temperature between 40 and 120 degrees F.
    c. Air Temperature 25 to 20 Degrees F:
        1) Heat sand and mixing water to produce mortar temperature between 40 and 120 degrees F. Use other heat sources on both sides of walls under construction. Use windbreaks when wind is in excess of 15 mph.
    d. Air Temperature 20 Degrees F and Below:
        1) Heat sand and mixing water to produce mortar temperature between 40 and 120 degrees F. Provide enclosures and auxiliary heat to maintain air temperature above 32 degrees F on both sides of walls under construction. Ascertain that temperatures of masonry units are not less than 20 degrees F when units are laid.

B. Protection:

1. Newly laid masonry shall be protected as specified below for the respective mean daily air temperature (MDAT), that is, the average of the daytime high temperature and the forecasted nighttime low temperature.
    a. MDAT 40 to 32 degrees F:
        1) Protect masonry from rain and snow by covering the top 4 feet with weather-resistive membrane for 24 hours after laying.
    b. MDAT 32 to 25 degrees F:
        1) Completely cover newly-laid masonry with weather-resistive membrane for 24 hours.
    c. MDAT 25 to 20 degrees F:
        1) Completely cover newly-laid masonry with insulating blankets and weather-resistive membrane for 24 hours.
    d. MDAT 20 degrees F and Below:
        1) Maintain temperature of masonry above 32 degrees F for 24 hours by providing enclosures and supplementary heat or other approved means.



**END OF SECTION**

# DIVISION 05
# METALS

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SECTION 05 05 14

HOT-DIP GALVANIZING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Section includes: Hot-dip galvanizing of steel materials.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 09 90 00 Painting and Coating

### 1.03 REFERENCES:

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ASTM A123 | Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A143 | Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement |
| ASTM A153 | Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A384 | Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies |
| ASTM A385 | Providing High-Quality Zinc Coatings (Hot-Dip) |
| ASTM A780 | Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM B6 | Zinc |
| ASTM D6386 | Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting |
| ASTM E536 | Test Methods for Chemical Analysis of Zinc and Zinc Alloys |
| DOD-P-21035A | Paint, High Zinc Dust Content, Galvanizing Repair |



### 1.04 SUBMITTALS

A. Action Submittals
   1. Procedure: Section 01 33 00:
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the

marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

4. Coating applicator's Certificate of Compliance that the hot-dip galvanized coating meets or exceeds the specified requirements of ASTM A123 or A153, as applicable.
5. Evidence that the galvanized coating applicator is a member of the American Galvanizing Association.

## 1.05 QUALITY ASSURANCE

A. Hot-dip galvanized coating applicator shall be a member of the American Galvanizing Association.

# PART 2 PRODUCTS

## 2.01 MATERIALS

A. Zinc used for galvanizing shall conform to ASTM B6, and shall be at least equal to the grade designated as Prime Western.

B. Maximum amount of aluminum added to a galvanizing bath shall not exceed 0.01 percent.

C. Hot-Dip Galvanized Coating: Conform to ASTM A123 and A153, as applicable.

D. Repair: Zinc dust-zinc oxide coating conforming to DOD-P-21035A and containing 95 percent zinc in the dry film. Acceptable product is ZRC Cold Galvanizing Compound by ZRC Worldwide, or approved equal.



## 2.02 FABRICATION REQUIREMENTS

A. Fabrication practices for products to be galvanized: In accordance with applicable portions of ASTM A143, A384 and A385. Avoid fabrication techniques that could cause steel distortion or embrittlement.

B. Coordinate with steel detailer to provide vent and drain holes of sufficient size and quantity to achieve specified galvanized coating.

# PART 3 EXECUTION

## 3.01 PREPARATION

A. Casting surfaces to be galvanized shall be sand blasted or ground smooth. When a smooth cast is required, castings shall be tumbled and all high spots ground flush. Castings shall be normalized to prevent cracking. Malleable iron shall be safeguarded against embrittlement by pre-annealing.

B. Steel work shall be precleaned utilizing a caustic bath, acid pickle and flux or shall be blast cleaned and fluxed to obtain an acceptable surface for quality hot dip galvanizing.

## 3.02 APPLICATION

A. Steel Members, Fabrications, and Assemblies: Hot-dip galvanize after fabrication in accordance with ASTM A123.

B. Steel Bolts, Screws, Nuts, Washers and Hardware Components: Hot-dip galvanize in accordance with ASTM A153.

## 3.03 COATING REQUIREMENTS

A. Hot-dip Coating Thickness: Conform to ASTM A123 or ASTM A153, as applicable.

## 3.04 TESTING

A. Chemical analysis for impurities in the bath shall be made in conformity with ASTM E536.

B. Test Requirements and Methods: In accordance with ASTM A123 or ASTMA153, as applicable.

## 3.05 GALVANIZED SURFACES TO BE PAINTED

A. Where galvanized surfaces are specified to be painted in Section 09 90 00 or elsewhere in the Project Manual, conform to ASTM D6386.

## 3.06 REPAIR OF DEFECTIVE GALVANIZED COATING

A. Where zinc coating has been damaged after installation, clean substrate surface and repair with zinc dust-zinc oxide coating in accordance with ASTM A780. Apply zinc dust-zinc oxide coating in accordance with manufacturer's recommendation. Apply multiple coats to achieve a minimum film thickness of 8 mils.

B. Remove items not physically damaged, but which have insufficient or deteriorating zinc coatings, and items damaged in shipment or prior to installation, from the project site for repair by the hot-dip zinc coating method.

**END OF SECTION**

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SECTION 05 05 20

ANCHOR BOLTS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Bolts and all-thread rods used to attach structural elements and equipment to concrete and concrete masonry. Included are cast-in-place and post-installed anchors (adhesive systems and wedge type expansion anchors), nuts and washers.

B. Cast-in-place and post-installed anchors shall be Type 316 stainless steel unless noted otherwise.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
2. Section 03 30 00 Cast-In-Place Concrete
3. Section 03 60 00 Grouting
4. Section 43 05 13 Rigid Equipment Mounts



### 1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ACI 318 | Building Code Requirements for Structural Concrete |
| ASTM A193 | Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications |
| ASTM A194 | Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both |
| ASTM A320 | Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service |
| ASTM A563 | Carbon and Alloy Steel Nuts |
| ASTM F593 | Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594 | Stainless Steel Nuts |
| ASTM F844 | Washers, Steel, Plain (Flat), Unhardened for General Use |
| ASTM F1554 | Anchor Bolts, Steel, 36, 55, 105-ksi Yield Strength |
| IBC | International Building Code with local amendments |
| Connecticut State Building Code | Building Code with local amendments |

## 1.04 SUBMITTALS

A. Action Submittals
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Anchor bolt placement plans.
   5. Anchor bolt, nut, and washer material information, including material certifications.
   6. Record copy of design calculations and details showing the required diameter, length, embedment, edge distance, confinement, anchor reinforcement, anchor bolt sleeves, connection redesign, and other conditions, stamped and signed by a Professional Engineer currently registered in the state of Connecticut. Calculations shall comply with the provisions of ACI 318-14, Chapter 17. Base anchor capacity determination on cracked concrete condition and compressive strength of new concrete per Section 03 30 00. Assume compressive strength of existing concrete is 3,000 psi unless otherwise noted.
   7. Product Data:
      a. ICC Evaluation Service Reports for post-installed adhesive type anchors and expansion (wedge type) anchors when allowed. Products shall be ICC approved for use in cracked concrete in high seismic areas (Seismic Design Category D, E and F).
      b. Product data indicating load capacity charts/calculations.
      c. Chemical resistance.
      d. Temperature limitations.
      e. Manufacturers written installation instructions.
   8. Installer certification for horizontal or upwardly inclined adhesive anchors in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program.



## 1.05 QUALITY ASSURANCE

A. Quality Assurance By Authority
   1. Special inspection of anchor bolts shall be performed by the Special Inspector under contract with the Authority and in accordance with IBC Chapter 17.
   2. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by a Special Inspector.
   3. The Special Inspector shall furnish a report to the Engineer, Authority's Representative, and Building Official that the work covered by the report has been performed and that the materials used and the installation procedures used conform

with the approved Project Manual and the Manufacturer's Printed Installation Instructions (MPII).

B. Certifications

1. Installer certification shall be in accordance with ACI/CRSI Adhesive Anchor Installer Certification Program for installers of horizontal or upwardly inclined adhesive anchors.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Anchor bolt holes in equipment support frames shall not exceed the bolt diameters by more than 1/4 inch. Minimum anchor bolt diameter shall be 1/2 inch. Anchor bolts for equipment mounting and vibration isolation systems shall be provided as specified in Sections 43 05 13.

B. Tapered washers shall be provided where mating surface is not square with the nut.

C. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings. Substitution of post-installed anchors will not be permitted unless specifically requested by the Contractor and approved by the Engineer.



### 2.02 PERFORMANCE/DESIGN CRITERIA

A. Anchor bolts for equipment shall be designed by the equipment manufacturer to include equipment operational loads combined with seismic and wind forces when applicable. Design criteria provided in Section 01 73 24.

B. Design anchor bolts for support and bracing of non-structural components and non-building structures for loading specified in Section 01 73 24.

### 2.03 MATERIALS

A. Anchor bolt materials shall be as specified in the following table:

| Material | Specification |
|---|---|
| Stainless Steel Anchor Bolts | ASTM A193 or A320, Type 316 |
| Stainless Steel Threaded Rods | ASTM F593, Type 316 |
| Stainless Steel Nuts | ASTM A194 Heavy Hex Nuts, Type 316<br>ASTM F594 Heavy Hex Nuts at Adhesive Anchors, Type 316 |
| Stainless Steel Washers | Type 316 to match bolt material |
| Carbon Steel Anchor Bolts | ASTM F1554, Grade 36, Hot Dip Galvanized |
| High-Strength Carbon Steel Anchor Bolts | ASTM F1554, Grade 55, Weldable per Supplementary Requirement S1, Hot Dip Galvanized |
| Carbon Steel Nuts and Washers | ASTM A563 and F844, Heavy Hex, Hot-Dip Galvanized |
| Concrete Adhesive Anchors | Hilti "HIT-RE 500v3", Simpson Strong-Tie "SET-XP", or approved equal, with Type 316 Stainless Steel threaded rods |
| Concrete Masonry Adhesive Anchors | Hilti "HIT-HY 70", Simpson Strong-Tie "SET-XP", or approved equal, with Type 316 Stainless Steel threaded rods |

| Material | Specification |
|---|---|
| Concrete Masonry Expansion (wedge) Anchors* | Hilti "KWIK BOLT 3", or approved equal, Type 316 Stainless Steel |
| Concrete Expansion (wedge) Anchors * | Hilti “KWIK BOLT TZ”, or approved equal, Type 316 Stainless Steel |

**Post installed anchors shall always be an adhesive type anchor system except where noted otherwise or when Contractor makes a request for a specific application and Engineer approves.*

## 2.04 STAINLESS STEEL FASTENER LUBRICANT (ANTI-SEIZING)

A. Anti-seizing Lubricant for Stainless Steel Threaded Connections:
   1. Formulated to resist washout.
   2. Acceptable manufacturers are Bostik, Saf-T-Eze, or equal.

## 2.05 ANCHOR BOLT SLEEVES

A. Provide anchor bolt sleeves as shown on design drawings and as required by equipment manufacturer’s design.
   1. Provide high density polyethylene plastic sleeves of single unit construction with deformed sidewalls such that the concrete and grout lock in place.
   2. The top of the sleeve shall be self-threading to provide adjustment of the threaded anchor bolt projection.
   3. Acceptable manufacturers are Contec, Wilson, or equal.



# PART 3 EXECUTION

## 3.01 GENERAL

A. Anchor bolts shall be cast-in-place anchors unless post-installed anchors are specified or shown on the Drawings.

B. Grouting of anchor bolts using plastic sleeves with non-shrink or epoxy grout, where specified, shall be in accordance with Section 03 60 00.

C. The threaded end of anchor bolts and all-thread rods shall be long enough to project through the entire depth of the nut and if too long, shall be cut off at ½-inch beyond top of nut and ground smooth.

## 3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Anchor bolts to be embedded in concrete shall be placed accurately and held in correct position using templates while the concrete is placed.

B. After anchor bolts have been embedded, their threads shall be protected by grease and the nuts run on.

## 3.03 ADHESIVE ANCHOR BOLTS

A. Note that adhesive anchors shall not be substituted for cast-in-place anchor bolts unless the adhesive anchors have been specified or shown on the Drawings, or approval has

been obtained from the Engineer that substitution of adhesive anchors is acceptable for the specific use and location. Use of adhesive anchors shall be subject to the following conditions:

1. Limit to locations where intermittent or continuous exposure to the following is extremely unlikely:
   a. Acid concentrations higher than 10 percent
   b. Chlorine gas
   c. Machine or diesel oils
2. Limit to applications where exposure to the following is extremely unlikely:
   a. Fire
   b. Concrete or rod temperature above 120 degrees F
3. Overhead applications (such as pipe supports) shall not be allowed unless approved by the Engineer and installation is by an Installer specially certified for overhead applications.
4. Approval from Engineer for specific application and from supplier of equipment to be anchored, if applicable.
5. Anchor diameter and material shall be per Contract Documents or equipment manufacturer's specifications. Anchor shall be threaded or deformed the full length of embedment and shall be free of rust, scale, grease, and oils.
6. Embedment depth shall be as specified or as required by the equipment manufacturer.
7. Follow the anchor system manufacturer's installation instructions.
8. Holes shall have rough surfaces created by using a hammer drill with carbide bit. Core drilled holes are not allowed.
9. Holes shall be blown clean with oil-free compressed air and be free of dust or standing water prior to installation. Follow additional requirements of the adhesive manufacturer.
10. Concrete and air temperature shall be compatible with curing requirements of adhesives per adhesive manufacturer's instructions. Anchors shall not be placed in concrete when the temperature is below 25 degrees F.
11. Anchors shall be left undisturbed and unloaded for full adhesive curing period, which is based on temperature of the concrete.



## 3.04 EXPANSION ANCHORS

A. Expansion (wedge type) anchors shall not be substituted for cast-in-place anchor bolts or adhesive anchors unless approved by the Engineer for a specific application. Use of expansion anchors shall be subject to conditions 4 through 9 as specified above for adhesive anchors. Expansion anchors shall not be used in a submerged condition or in mounting of equipment subject to vibration or cyclic motion.

## 3.05 REINFORCING STEEL CONFLICTS WITH POST-INSTALLED ANCHOR INSTALLATION

A. When reinforcing steel is encountered in the drill path, slant drill to clear obstruction and provide beveled washer to match angle of anchor. Drill shall not be slanted more than 10 degrees.

B. Where slanting the drill does not resolve the conflict, notify the Authority's Representative and resolve the conflict to the satisfaction of the Authority's Representative in consultation with the Engineer.

C. Abandoned post-installed anchor holes shall be cleaned and filled with non-shrink grout and struck off flush with adjacent surface.

D. The costs of determining and executing the resolution shall be borne by the Contractor. The determination and execution of the resolution shall not result in additional cost to the Authority.

E. Reinforcing steel in masonry shall not be damaged.

F. In order to avoid or resolve a conflict, locate embedded reinforcing steel using non-destructive methods and/or redesign the attachment.
   1. Redesign shall be done by the Contractor's Professional Engineer currently registered in the state of Connecticut
   2. Calculations and details for redesign shall be submitted.

**END OF SECTION**

SECTION 05 10 00

STRUCTURAL METAL FRAMING

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Structural metals consisting of standard shapes, hollow sections, fasteners, and plates that are used in structural framing and connections.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 Submittal Procedures
   2. Section 05 05 20 Anchor Bolts
   3. Section 05 05 14 Hot Dip Galvanizing
   4. Section 09 90 00 Painting



### 1.03 REFERENCES

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. The references listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version referenced by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. For questions, refer to Engineer.

| Reference | Title |
|---|---|
| Aluminum Association ADM | Aluminum Design Manual |
| AISC 207 | Certification Programs |
| AISC 303 | Code of Standard Practice for Steel Buildings and Bridges |
| AISC 313 | Code of Standard Practice for Structural Stainless Steel Buildings |
| AISC 325 | Steel Construction Manual |
| AISC 360 | Specification for Structural Steel Buildings |
| AISC 370 | Specification for Structural Stainless Steel Buildings |
| AISC DG 10 | Erection Bracing of Low-Rise Structural Steel Buildings |
| AISC DG 27 | Structural Stainless Steel |

| Reference | Title |
|---|---|
| ASTM A6 | General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A36 | Carbon Structural Steel |
| ASTM A53 | Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A193 | Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications |
| ASTM A194 | Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both |
| ASTM A276 | Stainless Steel Bars and Shapes |
| ASTM A312 | Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A320 | Alloy-Steel and Stainless Steel Bolting for Low Temperature Service |
| ASTM A380 | Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems |
| ASTM A384 | Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies |
| ASTM A480 | General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip |
| ASTM A484 | General Requirements for Stainless Steel Bars, Billets, and Forgings |
| ASTM A500 | Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A554 | Welded Stainless Steel Mechanical Tubing |
| ASTM A563 | Carbon and Alloy Steel Nuts |
| ASTM A999 | General Requirement for Alloy and Stainless Steel Pipe |
| ASTM A992 | Structural Steel Shapes |
| ASTM A1069 | Laser and Laser Hybrid Welded Stainless Steel Bars, Plates, and Shapes |
| ASTM B209 | Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B241 | Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube |
| ASTM B308 | Aluminum-Alloy 6061-T6 Standard Structural Profiles |
| ASTM F3125 | High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength |
| ASTM F436 | Hardened Steel Washers Inch and Metric Dimensions |
| ASTM F593 | Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594 | Stainless Steel Nuts |
| AWS-B2.1 | Welding Procedure and Performance Qualification |
| AWS D1.1 | Structural Welding Code – Steel |
| AWS D1.2 | Structural Welding Code – Aluminum |
| AWS D1.6 | Structural Welding Code – Stainless Steel |
| AWS D1.8 | Structural Welding Code – Seismic Supplement |
| RCSC | Structural Joints Using High Strength Bolts |
| IBC | International Building Code with local amendments |
| Local Code | Local building code if differs from IBC |

## 1.04 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. Shop drawings for approval prior to fabrication. Shop drawings shall not be reproductions of the Drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, coatings, connection details, blocks, copes, and cuts. Substitutions of details shown on the Drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the Drawings.
5. Certification that steel Fabricator is approved to perform steel fabrication without special inspection.
6. AISC quality certification: Evidence that steel Fabricator has AISC 207 Certification as a AISC Certified Plant, Category BU (Certified Building Fabricator). Certificate to show name and address of certified firm, effective date, and category of certification.
7. Welding procedures, qualifications, and inspection report.
8. Certified mill test reports for structural steel and high-strength bolts and nuts.
9. In accordance with IBC Chapter 17, Fabricator at the completion of fabrication to submit Certification of Compliance stating that the fabrication was performed in accordance with the design documents.
10. Certified copies of all surveys conducted by a registered professional engineer or surveyor showing elevations and locations of base plates and anchor bolts to receive structural steel or aluminum, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.



## 1.05 QUALITY ASSURANCE

A. Quality Control by Authority:

1. Special Inspection of structural metals work shall be performed by the Special Inspector under contract with the Authority and in conformance with the IBC Chapter 17. Special Inspector(s) and laboratory shall be acceptable to the Owner in their sole discretion. Special Inspection of structural metals is in addition to, but not replacing, other inspections and quality control requirements herein. Where sampling and testing required herein conforms to Special Inspection standards, such sampling and testing need not be duplicated.
2. All structural steel work shall receive Special Inspection in accordance with IBC, Chapter 17. Structural steel includes all steel elements that resist code-defined loads and whose failure would affect life safety. Items to be inspected include, but are not

limited to, mechanical / electrical supports, beams, stringers, columns, access walkways, and stairways.

B. Fabricator Qualifications:
   1. A qualified Fabricator must participate in the AISC 207 Certification program and be designated an AISC Certified Plant, Category BU (Certified Building Fabricator).

## PART 2 PRODUCTSMATERIALS

A. Steel:
   1. Materials for structural steel shall be as specified in Table A.

**Table A - Steel Materials**

| Material | Specification |
|---|---|
| M-shapes | ASTM A36 |
| S-shapes | ASTM A36 |
| Channels | ASTM A36 |
| Angles | ASTM A36 |
| HP-shapes | ASTM A572 Grade 50 |
| Rolled wide-flange sections (W-shapes) and WTs | ASTM A992 |
| Pipe sections | ASTM A53, Type E or S, Grade B (Fy = 35 ksi) |
| Round Hollow Structural Sections (HSS) | ASTM A500, Grade C (Fy=46 ksi min) |
| Square and Rectangular Hollow Structural Sections (HSS) | ASTM A500, Grade C (Fy = 50 ksi min) |
| Stainless steel bolts (used at stainless steel and aluminum framing unless noted otherwise) | ASTM F593, Type 316 |
| Stainless steel nuts and washers (used at stainless steel and aluminum framing unless noted otherwise) | ASTM F594, Type 316 |
| Steel bolts (used at galvanized and painted steel framing) | Galvanized ASTM F3125 Gr. A325 |
| Carbon steel nuts and washers | Galvanized ASTM A563 nuts and galvanized ASTM F436 washers |
| Anchor bolts | Refer to Section 05 05 20 |



B. Stainless Steel:
   1. Materials for structural stainless steel shall be as specified in Table B. All stainless steel shall be passivated per ASTM A380.

**Table B – Stainless Steel Materials**

| Material | Specification |
|---|---|
| Hot-rolled and extruded structural shapes | ASTM A276, Type 316, finish per ASTM A484 |
| Hollow structural sections (HSS) | ASTM A554, Type 316, finish per ASTM A554 |
| Welded round pipe | ASTM A312, Type 316, finish per ASTM A999 |
| Built-up I-shape, channel, angle, tee, & box section shapes (laser & laser hybrid) | ASTM A276, Type 316, finish per ASTM A1069 |
| Bolts | Use stainless steel bolts for stainless steel framing (see Table A above) |

**Table B – Stainless Steel Materials**

| Material | Specification |
|---|---|
| Plates | ASTM A480, Type 316, finish per ASTM A480 |
| Anchor bolts | Refer to Section 05 05 20 |

C. Aluminum:
   1. Materials for structural aluminum shall be as specified in Table C.

**Table C - Aluminum Materials**

| Material | Specification |
|---|---|
| Structural shapes | Alloy 6061-T6 per ASTM B308 |
| Bolts | Use stainless steel bolts for aluminum framing (see Table A above) |
| Guardrail and handrail pipe | Alloy 6061-T6 or 6063-T6 per ASTM B241 |
| Plates | Alloy 6061-T6 per ASTM B209 |
| Anchor bolts | Refer to Section 05 05 20 |



## PART 3 EXECUTION

### 3.01 GOVERNING DOCUMENTS

A. The following paragraphs are primarily written to be applicable to structural steel. Where stainless steel or aluminum are utilized the applicable governing document(s) for that material shall be adhered to as necessary.

### 3.02 EXAMINATION

A. Examine and accept conditions before beginning work.

### 3.03 FABRICATION

A. Fabrication of steel shall be in accordance with the applicable provisions of the AISC Steel Construction Manual and AISC 360. Fabrication of stainless steel shall be in accordance with the applicable provisions of AISC 313 and AISC 370. Fabrication of aluminum shall be in accordance with Aluminum Design Manual. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under AISC 207 for Category BU.

B. Compression joints depending on contact bearing shall have a surface roughness not more than 500 micro-inches and ends shall be square within the tolerances for milled ends specified in ASTM A6.

C. Shop splices of members will be permitted only where indicated on the Drawings. Splices not indicated require the approval of the Authority's Representative.

D. Verify measurements at the job site prior to fabrication. Fabricate to match job site measurements.

E. Provide bolt holes as indicated for securing other work to structural framing. Conform to

AISC 325 and AISC 360 guidelines or contact Authority's Representative for approval for bolt holes not indicated on drawings.

F. Other work shall be routed around structural steel framing members to the extent possible. Where not indicated on the design drawings, additional cuts, alterations, and holes for the passage of other work through steel framing members require the approval of the Authority's Representative and shall be addressed in accordance with AISC 303.

## 3.04 INSTALLATION

A. General:
   1. Erection of structural steel shall be in accordance with the applicable provisions of AISC Steel Construction Manual (AISC 325). Erection plan shall conform to AISC 303. For low-rise structural steel buildings, 60 feet tall or less and a maximum of 2 stories, the structure shall be erected in accordance with AISC Design Guide 10.
   2. Coordinate installation of anchor bolts and other connectors required for securing structural steel in place. Refer to Section 05 05 20 for additional information regarding anchor bolts.
   3. Employ a registered professional engineer or surveyor for accurate erection of the structural framing. Check elevations of concrete and locations of anchor bolts before erection proceeds and report discrepancies to the Authority's Representative.
   4. Placement tolerances shall be in accordance with AISC 303 and AISC 360
   5. After final positioning of members, provide full bearing under base plates and bearing plates using non-shrink grout. Place non-shrink grout in accordance with the Manufacturer's instructions. Grout shall be cured prior to loading of the structure.
   6. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Protect aluminum in contact with concrete or grout with a heavy coat of bituminous paint.
   7. Metalwork to be embedded in concrete shall be placed accurately and held in correct position while the concrete is placed. The surfaces of metalwork in contact with or embedded in concrete shall be thoroughly cleaned without damaging any metalwork coatings (if applied).
   8. Structural steel completely encased in concrete shall not be galvanized or painted and shall have a clean surface for bonding to concrete.
   9. Metalwork which is bent, broken or otherwise damaged shall be repaired or replaced at the Contractor's expense.

B. Welding:
   1. Welding shall be done by welders, welding operators, and tackers who have been qualified by tests as prescribed by AWS to perform the type of work required. The quality of welding shall conform to AWS Codes.
   2. Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures.
   3. Provide continuous seal welds for plates or structural shapes that are exposed to or submerged in water or wastewater.

C. Bolted Connections:
   1. Bolted connections, unless noted otherwise, shall conform to AISC 360 and the RSCS and shall be bearing type connections with bolts snug-tight Punch, subpunch and ream,

or drill bolt holes perpendicular to the surface of the member. Finished holes shall be 1/16 inch larger than the nominal size of the bolts for bolts less than one inch diameter, unless otherwise specified. Finished holes shall be 1/8 inch larger than the nominal size of the bolts for bolts one inch diameter and larger, unless otherwise specified. Bolts, nuts, and washers shall be clean of dirt and rust and lubricated immediately prior to installation. No drifting of bolts or enlargement of holes will be allowed to correct misalignment. Holes shall not be cut or enlarged by burning. Mismatched holes shall be corrected with new material. Bolts may not be re-used. Specifics to bolted connection types are as follows:

a. Snug-tight: Typical bearing type connections per the requirements of the RCSC specification. Note that thru-bolted HSS connections are only allowed to be snug-tight.

## 3.05 CORROSION PROTECTION

A. Unless otherwise specified, carbon structural steel shall be galvanized. If coatings are indicated on the Drawings or elsewhere in the Specifications, coat in accordance with Section 09 90 00. Coating surface preparation shall be as specified in Section 09 90 00 and shall include the following operations:

1. Grind the exterior and interior edges of all flame-cut plates or members to a smooth surface.
2. Grind all sharp edges from sheared plates and punched holes.
3. Grind uneven or rough welds with high beads to a smooth finish.

## 3.06 CLEANING

A. After installation, damaged surfaces of shop primed metals shall be cleaned and touched up with the same material used for the shop coat. Damaged surfaces of galvanized metals shall be repaired as specified in Section 05 05 14.



**END OF SECTION**

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SECTION 05 31 23

STEEL ROOF DECKING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. General:
   1. This section specifies fabrication and erection of steel roof deck.

B. Related Sections:
   1. The work of the following Sections is related to the work of this Section. Other Sections, not referenced below, may also be related to the proper performance of this work.
      a. Section 05 10 00 – Structural Metal Framing

### 1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| AISI SG-673 | Design of Cold-Formed Steel Structural Members |
| ASTM A36 | Carbon Structural Steel |
| ASTM A611 | Steel, Sheet, Carbon, Cold Rolled, Structural Quality |
| ASTM A653 | Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron, Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM 780 | Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings |
| ASTM A924 | Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM D1056 | Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber. |
| AWS D1.3 | Structural Welding Code Sheet Steel |
| Steel Deck Institute (SDI) | Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution |



### 1.03 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Complete shop drawings showing framing and deck layout indicating length, type, cross section, thickness, markings of metal deck units, and size and locations of all openings. Shop drawings shall not be a reproduction of the Contract Drawings.

C. Details and gages of all accessories and miscellaneous items showing sump pans, cant strips, ridge and valley plates, closure strips and insulation supports.

D. Manufacturer's load table including design thickness in inches, section properties, allowable gravity load, allowable diaphragm shear loads.

E. Erection marks. Mark each bundle to correspond to the shop drawings.

F. Certification from SDI that manufacturer is a member of SDI and that the steel roof deck is designed in accordance with SDI standards.

G. Certification for installers of deck fastening systems.

## 1.04 QUALITY ASSURANCE

A. Steel roof deck shall conform to the requirements of the SDI standard for Steel Roof Deck.

B. Deck manufacturer shall be a member of the Steel Deck Institute and design of the deck shall be by a qualified professional engineer.

C. Deck installer shall have minimum three years experience on comparable steel deck projects. Installers shall be trained and certified by manufacturer to install fastening systems.

## 1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials off the ground with one end elevated to provide drainage. Protect from the elements with a waterproof covering, ventilated to avoid condensation. Prevent rust, deterioration and accumulation of foreign materials.



# PART 2 PRODUCTS

## 2.01 MATERIALS

A. Sheet Steel:
   1. ASTM A653, SS, Grade 33, minimum yield 38 ksi, with Designation G60 galvanized coating.

B. Structural Steel:
   1. ASTM A36.

## 2.02 FABRICATION

A. General:
   1. Form deck units in lengths to span three or more support spacings, with minimum two-inch laps and side laps. Configuration shall be appropriate for side lab connection.
   2. Deck profile and gage shall be as shown on the drawings. Acceptable manufacturer is Verco or approved equal.

B. Closure Plates:
   1. Fabricate closure plates of galvanized sheet steel of same quality as deck units. Provide tight-fitting closure with deck units.

C. Fabrication Tolerances:
   1. Maximum variation in unit alignment shall be 1/4 inch in 40 feet.

## PART 3 EXECUTION

### 3.01 INSPECTION

A. Check supporting members for correct layout and alignment. Verify that surfaces to receive steel deck are free of debris. Do not proceed with installation until defects are corrected.

### 3.02 INSTALLATION

A. Install steel roof deck and accessories in accordance with the manufacturer's instructions and in accordance with final approved shop drawings and as specified herein.

B. Fasten steel roof deck to all interior and exterior transverse supports and at side laps and longitudinal supports. Deck fasteners and fastener spacing shall be as shown on the Drawings. End lap of steel roof deck shall be at least 2 inches and shall occur over transverse supporting members.

C. Coordinate size, location, and details of penetrations with the Drawings, other trades, and details of approved equipment. Pipe and conduit openings in the steel roof deck shall be reinforced according to the manufacturer's recommendation.
   1. Cutting and Fittings:
      a. Cut and fit steel roof deck units and accessories around projections through steel roof deck.
      b. Make cuts neat, square, and trim.
      c. Cut openings in steel roof deck true to dimensions using metal saws or drills.
      d. Do not use cutting torches.
      e. Openings greater than 6 in and less than 12 in in greatest dimension shall be reinforced with a 24-in by 24-in flat plate, minimum 20-gauge thickness, centered on the opening.

D. Suspended ceilings, light fixtures, ducts, piping, conduits, or other utilities shall not be attached to steel roof deck.

### 3.03 INSPECTION

A. The Engineer reserves the right to inspect steel roof deck in the field for compliance with the requirements specified herein and the approved shop drawings. The Engineer may reject or require repair or re-fabrication of steel roof deck or accessories not meeting these requirements.

**END OF SECTION**

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SECTION 05 50 00

METAL FABRICATIONS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be provided under work of other specification sections.
   2. Seat angle frames
   3. Fall arrest anchors
   4. Ladders, safety posts, and access control systems
   5. Ladder Rail Fall Protection System
   6. Bollards
   7. Miscellaneous metal fabrications not covered elsewhere

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 05 05 14 Hot-Dip Zinc Coating
   3. Section 05 05 20 Anchor Bolts
   4. Section 05 10 00 Structural Metal Framing
   5. Section 05 53 10 Metal Gratings and Stair Treads
   6. Section 09 90 00 Painting and Coating



### 1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| Aluminum Design Manual | The Aluminum Association, Aluminum Design Manual with Specifications and Guidelines for Aluminum Structures |
| AISC 303 | Code of Standard Practice for Steel Buildings and Bridges |
| AISC 360 | Specification for Structural Steel Buildings |
| AISC Steel Construction Manual | American Institute of Steel Construction, Manual of Steel Construction |
| ANSI A14.3 | Standard for Ladders - Fixed - Safety Requirements |
| ASTM A36 | Carbon Structural Steel |
| ASTM A48 | Gray-Iron Castings |

| Reference | Title |
|---|---|
| ASTM A53 | Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A108 | Steel Bar, Carbon and Alloy, Cold-Finished |
| ASTM A123 | Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153 | Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A193 | Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications |
| ASTM A194 | Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both |
| ASTM A240 | Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM A276 | Stainless Steel Bars and Shapes |
| ASTM A283 | Low and Intermediate Tensile Strength Carbon Steel Plates |
| ASTM A307 | Carbon Steel Bolts, Studs, and Threaded Rod 60000 psi Tensile Strength |
| ASTM A312 | Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes |
| ASTM A320 | Alloy-Steel Bolting Materials for Low Temperature Service |
| ASTM A325 | Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength |
| ASTM A380 | Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems |
| ASTM A384 | Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies |
| ASTM A489 | Carbon Steel Lifting Eyes |
| ASTM A500 | Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A554 | Welded Stainless Steel Mechanical Tubing |
| ASTM A563 | Carbon and Alloy Steel Nuts |
| ASTM A572 | High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM A653 | Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process |
| ASTM A780 | Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings |
| ASTM A786 | Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates |
| ASTM A793 | Rolled Floor Plate, Stainless Steel |
| ASTM A924 | Steel Sheet, Metallic-Coated by Hot-Dip Process |
| ASTM A992 | Structural Steel Shapes |
| ASTM A1011 | Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| ASTM B209 | Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B210 | Aluminum and Aluminum-Alloy Drawn Seamless Tubes |
| ASTM B211 | Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire |
| ASTM B221 | Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM B241 | Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube |
| ASTM B308 | Aluminum-Alloy 6061-T6 Standard Structural Profiles |
| ASTM B429 | Aluminum-Alloy Extruded Structural Pipe and Tube |

| Reference | Title |
|---|---|
| ASTM B632 | Aluminum-Alloy Rolled Tread Plate |
| ASTM D1056 | Flexible Cellular Materials - Sponge or Expanded Rubber |
| ASTM F436 | Hardened Steel Washers |
| ASTM F468 | Nonferrous Bolts, Hex Cap Screws, SocketHead Cap Screws and Studs for General Use |
| ASTM F593 | Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594 | Stainless Steel Nuts |
| AWS D1.1 | Structural Welding Code - Steel |
| AWS D1.2 | Structural Welding Code - Aluminum |
| AWS D1.6 | Structural Welding Code - Stainless Steel |
| OSHA 29 CFR 1910.27 | Fixed Ladders |
| OSHA 29 CFR 1926.502 | Fall Protection Systems Criteria and Practices |
| SSPC SP5 | White Metal Blast Cleaning |
| IBC | International Building Code |

## 1.04 DEFINITIONS

A. Galvanize: Hot-dip galvanize per ASTM A123 or ASTM A153, per Section 05 05 14.

## 1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration
   4. Manufacturer's product data.
   5. Detailed Shop Drawings:
      a. Fabrication drawings showing layouts, connections to structural system, and anchoring details.
      b. Erection and installation drawings indicating thickness, type, grade, class of metal, coating system and dimensions.
      c. Construction details, reinforcement, anchorage, and installation with relation to the building construction.
   6. Welding procedures and welder certificates and qualifications.
   7. U-Channel Concrete Inserts: Manufacturer’s product description and allowable load tables.
   8. Passivation method for stainless steel fabrications.

9. Fall Arrest Anchor Certificate:
    a. Certify fall arrest system is designed to meet OSHA 29 CFR 1926.502 specified performance requirements.
    b. Signed and sealed by a Professional Engineer licensed in the state in which the project is located.

## 1.06 QUALITY ASSURANCE

A. Qualifications
    1. Fabricator shall have a minimum of five years' experience in fabrication of metal specified.

B. Certificates
    1. Certified welding procedures and welding operators in accordance with AWS. Welding operator certificates shall be no more than one-year old and the welder shall have used the welding process to be performed within the last six months.

C. The use of salvaged, reprocessed or scrap materials will not be permitted.

D. Shop Assembly: Items in the shop shall be preassembled to the greatest extent possible, so as to minimize field splicing and assembly of units. Units shall be disassembled only to the extent necessary for shipping and handling limitations. Units shall be clearly marked for reassembly and coordinated installation.

## 1.07 DELIVERY, STORAGE AND HANDLING

A. Avoid damage during delivery and handling of fabrications.

B. Store off the ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.



# PART 2 PRODUCTS

## 2.01 MATERIALS

A. Materials for miscellaneous metalwork are specified in the following table.

| Material | Specification |
|---|---|
| Steel | |
| Sheets, plates and shapes (except W shapes) | ASTM A36 |
| W shapes | ASTM A992 |
| Pipe | ASTM A53, Grade B |
| Square/rectangular tubing | ASTM A500, Grade B |
| Headed Anchor Studs | ASTM A108 |
| Carbon steel bolts | ASTM A307, Grade A |
| High strength bolts | ASTM A325 (Type 1) |
| Nuts | ASTM A563 |

| Material | Specification |
|---|---|
| Washers | ASTM F436 |
| Stainless Steel | |
| Sheet and Plates | ASTM A240, Type 316 or 316L |
| Shapes, bars, and similar items | ASTM A276, Type 316 or 316L |
| Pipe | ASTM A312, Type 316 or 316L |
| Headed Anchor Studs | ASTM A276, Type 316L |
| Bolts | ASTM F593, Type 316 |
| Nuts | ASTM F594, Type 316 |
| Aluminum | |
| Sheets and plates | ASTM B209, Type 6061-T6 |
| Bars, flats and similar items | ASTM B211 or B221, Type 6061-T6 |
| Shapes | ASTM B308, Type 6061-T6 |
| Round tubing and pipe | ASTM B241, Type 6061-T6 |
| Square and rectangular tubing | ASTM B221, Type 6063-T52 |
| Pipe | ASTM B211 or B241, Type 6061-T6 |
| Bolts, Stainless Steel | ASTM F593, Type 316 |
| Nuts, Stainless Steel | ASTM F594, Type 316 |
| Checker Plate | |
| Steel | ASTM A786 |
| Stainless steel | ASTM A793, Type 304 |
| Aluminum | ASTM B632, Type 6061-T6 |
| Other steel items | |
| Iron castings | ASTM A48 |
| Eyebolts | ASTM A489 |
| Threaded rods | ASTM A36 |



## 2.02 FABRICATION

A. General

1. Conform to AISC or Aluminum Association standards as applicable. Where Code defined loads apply, also conform to IBC requirements.
2. Shop and field welding shall conform to the requirements of AISC, the Aluminum Design Manual, and applicable AWS procedures and specifications as required by the material being welded.
3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt, tight, flush, and hairline. Remove burrs and weld splatter. Ease exposed edges to small uniform radius.
4. Holes shall be punched 1/16 inch larger than the nominal size of the bolts, unless otherwise specified. Whenever needed, because of the thickness of the metal, holes shall be subpunched and reamed or shall be drilled.

5. Fabrication, including cutting, drilling, punching, threading and tapping required for fabrications or adjacent work, shall be performed prior to galvanizing.

B. Seat Angle Frames
   1. Provide recessed seat angle frames for grating and floor plates. Miter corners to ensure accurate fit. Match depth of recess with grating or floor plate thickness. Anchor frames in concrete with headed studs. Steel angle support frames shall be stainless steel, ASTM A276, Type 316, unless indicated otherwise.

C. Fall Arrest Anchors
   1. Fall arrest anchors shall meet requirements of OSHA 29 CFR 1926.502. Anchorages attached to personal fall arrest equipment shall be capable of supporting at least 5,000 pounds per employee attached, or shall be designed, installed, and used as part of a complete personal fall arrest system which maintains a safety factor of at least two. Type of anchor shall fit the application and substrate material.
   2. Fall arrest anchors shall be manufactured by:
      a. Thaler Metal Industries
      b. DBI-SALA
      c. Approved Equal

D. Ladders
   1. Aluminum Ladders: Ladders shall be vendor supplied pre-engineered aluminum ladders. Ladders shall be fabricated of alloy 6063-T6. Rungs shall have non-slip grip surface. Finish shall be anodized. Fabricate ladders with rails, rungs, landings and cages to meet applicable requirements of OSHA 29 CFR 1910.27. Rungs shall be a minimum clear length of 16 inches, uniformly spaced at a maximum of 12 inches and plug welded into side rails. Install ladders so that the distance from the centerline of rungs to the finished wall surface is not less than 7 inches nor more than 12 inches. Provide clip angle supports bolted to the side rail at the top. Provide intermediate clip angle lateral supports at a maximum of 10 feet on center.
   2. Ladder Safety Access Control System:
      a. Provide a non-penetrating access control guardrail system with a self-closing safety gate at ladders that extend above, over or through roof parapets.
      b. The ladder safety roof guard rails and safety gate shall be assembled in accordance with manufacturer instructions.
      c. Provide required hardware for proper mounting of the safety gate to the guardrail system and for the guardrail system to the ladder.
      d. All ladder access control system components shall be by one manufacturer.
      e. Performance characteristics:
         1) Guardrail and safety gate shall meet OSHA standards 1910.23, 1910.27, 1910.28 and 1910.29.
         2) Guardrail shall be 42” high with top rail, horizontal mid-rail, and two mount bars.
         3) Guardrail shall be self-supporting and non-penetrating to roofing system below.
         4) Guardrail system shall attach to the ladder rails.

5) Gate shall have self-closing hinges, Coordinate direction of swing with final layout of roof with Engineer and Owner's Representative.
6) Material of construction: Aluminum
7) Color: Powder Coated Yellow

f. Acceptable products include:
1) Ladder Defender by BlueWater Manufacturing
2) Ladder Guard by EDGE Fall Protection
3) Approved equal

3. Ladder Rail Fall Protection System:
a. System shall consist of a vertical rigid track carrier rail securely and permanently attached to ladder, over which travels a sleeve to harness belt can be attached.
b. Rail:
1) Notched at six-inch intervals and constructed of galvanized steel.
2) Provide ladder attachments/rail mounting brackets of same material as rail, and as required by Supplier.
3) For all ladders, include provisions to secure safety sleeve to carrier rail at top of vertical ladder so that sleeve will not slide down rail when safety belt is unsnapped.
4) Ladders Not Below Hatches: Rail for ladder shall extend from bottom of ladder to above horizontal landing or roof at top of ladder. Provide removable extension section at top of ladder. Arrange rail to allow climber to land on landing or roof without unsnapping climber's safety harness.
c. Accessories: Provide with each ladder the following, all furnished by the fall prevention system Supplier:
1) One safety sleeve compatible for use with the rail. Sleeve shall be cast bronze with five zinc plated steel roller bearings. Sleeve shall travel smoothly on straight or curved rail.
2) One safety harness that attaches to sleeve. Harness shall be of woven high-strength nylon, with padded straps and forged steel buckles and rings. Harness shall distribute impact forces of a fall over climber's thighs, buttocks, chest, and shoulders.
3) One shock adsorbing lanyard no longer than six-feet, complying with ANSI Z359.1. Lanyard shall be 5/8-inch diameter nylon rope with double locking hooks at each end.
d. Acceptable ladder rail fall protection systems include:
1) Miller Saf-T-Climb as manufactured by Honeywell
2) Vertical Rigid Track Fall Arrest System as manufactured by Diversified Fall Protection
3) Approved equal

E. Bollards
1. Provide minimum 6 inch galvanized standard weight steel pipe or as indicated on the Drawings. Pipe to be in accordance with ASTM A53. Anchor posts in concrete and fill solidly with concrete of a minimum compressive strength of 2500 psi. Coat galvanized pipe above grade in accordance with Section 09 90 00. Top coat cover color shall be safety yellow.

F. Other Miscellaneous Steel Metalwork

1. Other miscellaneous steel metalwork including embedded and non-embedded steel metalwork, hangers and inserts shall be as specified or shown on the Drawings, and shall be galvanized after fabrication unless otherwise noted.

## 2.03 FINISHES

A. Galvanizing

1. Galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing in accordance with ASTM A123, ASTM A153, ASTM A653 or ASTM A924, Z275 G90, as applicable. Galvanize anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.
2. Repair damaged Zinc-Coated surfaces with galvanizing repair method and paint conforming to ASTM A780 or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Owner's Representative.
3. Safeguard against warpage and distortion during galvanizing of steel in accordance with ASTM A384. Straighten items after galvanizing so that they are straight, free of racking and distortion.

B. Shop Painting

1. Prepare and coat surfaces in accordance with Section 09 90 00.
2. Steel to be embedded in concrete shall be free of dirt and grease.

C. Aluminum Surfaces

1. Surface condition aluminum before finishes are applied. Remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.
2. Aluminum finishes for unexposed sheet, plate and extrusions may have mill finish as fabricated.
3. Provide other aluminum items with a standard mill finish.
4. Provide a coating thickness not less than that specified for protection.
5. Provide decorative type finishes for items used in interior occupied locations or architectural type finish for items used in exterior locations.
6. Provide a polished satin finish on items to be anodized.



# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Verify measurements at the site. Include field dimensions in shop drawings.

B. Examine and accept existing conditions before beginning work.

## 3.02 PREPARATION

A. Make provisions for erection loads with temporary bracing. Keep work in alignment.

B. Supply items required to be cast into concrete or embedded in masonry with setting templates.

## 3.03 INSTALLATION

A. Install items plumb, level and square, accurately fitted, and free from distortion or defects. Install rigid, substantial, and neat in appearance.

B. Allow for erection loads and provide temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Fieldwork shall not be permitted on galvanized items. Drilling of bolts or enlargement of holes to correct misalignment will not be allowed.

D. Protect encased or embedded dissimilar metals (both metals must be encased or embedded) from galvanic corrosion by means of pressure tapes, coatings or isolators.

E. Place metalwork to be embedded in concrete accurately and hold in correct position while the concrete is placed or, if indicated, form recesses or blockouts in the concrete. Thoroughly clean the surfaces of metalwork in contact with or embedded in concrete.

F. Seat angles, supports and guides: Set seat angles for grating and supports for floor plates so that they maintain the grating and floor plates flush with the floor.

G. Ladder Access Control System: Comply with manufacturer's installation instructions.

H. Fastening to Construction-In-Place: Provide anchorage devices and fasteners where necessary for fastening fabricated items to construction-in-place. Design anchorage devices in accordance with Section 01 73 24. Anchor bolts to be in accordance with Section 05 05 20.



## 3.04 REPAIR/RESTORATION

A. Galvanized
   1. Maximum area to be repaired shall not be more than 1/2 of 1 percent of the surface area of 36 sq. in. per ton of piece weight, whichever is less. Damage in excess of this requirement shall be repaired by stripping and recoating entire piece.
   2. Clean damaged areas to SSPC-SP5. Repair with zinc-rich paint in accordance with the manufacturer's instructions and with ASTM A780, Annex A2. Minimum thickness requirements shall be in accordance with ASTM A123.
   3. Use zinc-rich repair paint. Acceptable manufacturers:
      a. LPS, Cold Galvanize
      b. ZRC Worldwide, ZRC Galvilite
      c. Approved Equal

B. Painted
   1. After installation, clean and touch up damaged areas with the same materials used for the shop coat.

## 3.05 FIELD QUALITY CONTROL

A. Electrolytic Protection

B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Aluminum in contact with concrete or grout shall be protected with a heavy coat of bituminous paint.

**END OF SECTION**

SECTION 05 53 10

METAL GRATING AND STAIR TREADS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Aluminum bar grating and stair treads.

### 1.02 RELATED SECTIONS

A. This section contains references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-In-Place Concrete.

### 1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ASTM B221 | Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ANSI/NAAMM | Metal Bar Grating Design Manual |



### 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   1. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   2. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Shop drawings showing placing plans for grating.
      a. Provide layout and fabrication details of support frames.
      b. Provide panel layout with individual panel dimensions.
   4. Manufacturer's product data with load tables.

## PART 2 PRODUCTS

### 2.01 MATERIALS

| Component | Material |
|---|---|
| Aluminum grating bearing and cross bars | ASTM B221, alloy 6061 |

### 2.02 ASSEMBLY/FABRICATION

A. Welds:
   1. Grind smooth rough welds and sharp metal edges. Make welds exposed to view uniform and neat.

B. Clearance: provide ¼" separation between panels and at bearing ends of panel to support frame.

C. Grating:
   1. General
      a. Provide serrated grating for slip resistance.
      b. Bearing bars and cross bars are continuous.
      c. Openings shall be banded with bars having the same dimensions as the bearing bars. Band perimeter edges with bars flush at the top surface of the grating and 1/4 inch clear of the bottom surface.
      d. Bars terminating against edge bars shall be welded to the edge bars when welded construction is used.
      e. When crimped or swaged construction is used, bars at edges shall protrude a maximum of 1/16 inch and be peened or ground to a smooth surface.
      f. Fabrication methods employing bending or notching of bearing or cross bars is not permitted.
      g. Maximum grating panel weigh shall not exceed 80 pounds.
   2. Aluminum Grating
      a. Fabricate grating with a mill finish. Punch bearing bars to receive cross bars. After insertion in the bearing bars, cross bars are deformed by a hydraulic press or similar means to permanently lock the bars into the bearing bar openings.

D. Stair Treads:
   1. Treads shall match the grating material and type furnished for landings. Use serrated surface for slip resistance. Provide abrasive nosings on each tread. Provide carrier angle at each end for attachment to stair stringers. Attach components to support members with Type 316 stainless steel fasteners.



## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

B. Field measure grating for proper cutouts and sizes prior to fabrication.

## 3.02 INSTALLATION

A. Drilling of bolts or enlargement of holes to correct misalignment is not permitted.

B. Protect dissimilar metals from galvanic corrosion by means of pressure tapes, coatings, or isolators. Protect aluminum in contact with concrete with a heavy coat of bituminous paint.

C. Use stainless steel metalwork to be embedded in concrete. Clean surfaces in contact with or embedded in concrete and hold in correct position while concrete is placed. Or, provide formed recesses or blockouts in concrete and then, after concrete has attained design strength, grout metalwork in-place using non-shrink grout.

**END OF SECTION**

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# DIVISION 06
# WOODS, PLASTICS, AND COMPOSITES

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SECTION 06 10 00

ROUGH CARPENTRY

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies all rough carpentry.

### 1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.



| Reference | Title |
|---|---|
| ANSI B18.2.1 | Square and Hex Bolts and Screws, Inch Series Including Hex Cap Screws and Lag Screws |
| ANSI B18.2.2 | Square and Hex Nuts (Inch Series) |
| ANSI B18.5 | Round Head Bolts (Inch Series) |
| ANSI B18.6.1 | Wood Screws (Inch Series) |
| ASTM A687 | High-Strength Nonheaded Steel Bolts and Studs |
| AWPA C1 | All Timber Products--Preservative Treatment by Pressure Process |
| AWPA C2 | Standard for the Preservative Treatment of Lumber, Timber, Bridge Ties, and Mine Ties by Pressure Treatment |
| AWPA C9 | Plywood--Preservative Treatment by Pressure Process |
| AWPA M6 | Brands Used on Forest Products |
| AWPB LP-22 | Standard for Softwood Lumber, Timber, and Plywood Pressure Treated with Waterborne Preservatives for Ground Contact Use |
| FEDSPEC FF-B-588C | Bolt, Toggle, and Expansion Sleeve, Screw |
| FEDSPEC FF-N-105B | Nails, Brads, Staples and Spikes: Wire, Cut and Wrought |
| FEDSPEC FF-S-325 | Shield, Expansion, Nail Expansion, and Nail, Drive Screw (Devices, Anchoring, Masonry) |
| FEDSPEC FF-T-1813 | Tack |
| FEDSPEC MM-T-371E | Ties, Railroad, Wood (Cross and Switch) |

| Reference | Title |
|---|---|
| FEDSPEC UU-B-790A | Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant) |
| MIL-L-19140E | Lumber and Plywood, Fire-Retardant Treated |
| NFP-NDS | National Design Specification for Wood Construction and Supplement 1986, Design Values for Wood Construction |
| PS 1 | U.S. Department of Commerce, Product Standard, Construction/Industrial Plywood |
| PS 20 | U.S. Department of Commerce, Product Standard, American Softwood Lumber Standards |
| TPI 78 | Design Specification for Metal Plate Connected Wood Trusses |
| TPI BWT | Bracing Wood Trusses--Commentary and Recommendations |
| TPI HET | Handling and Erecting Wood Trusses—Commentary and Recommendations |
| TPI QST | Quality Standard for Metal Plate Connected Wood Trusses |
| UBC | Uniform Building Code |

B. Grading and Marking:
   1. Lumber:
      a. Each piece of framing and board lumber and each bundle of small pieces of lumber shall be marked with the grade mark of a recognized association or independent inspection agency. Such association or agency shall be certified by the Board of Review, American Lumber Standards Committee, to grade the species used.
   2. Preservative-Treated Lumber and Plywood:
      a. The Contractor shall be responsible for the quality of treated wood products. Each treated piece shall be permanently marked or branded by the producer in accordance with AWPA M6. The Contractor shall provide the Construction Manager with the inspection report of an independent inspection agency showing that offered products comply with applicable AWPA treatment standards. The AWPB Quality Mark "LP-22" on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

C. Sizes and Surfacing:
   1. Dressed sizes of yard and structural lumber shall comply with PS 20. Unless otherwise specified, lumber shall be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes shall be within manufacturing tolerances allowed by the standard under which the product is produced.

D. Moisture Content:
   1. Lumber shall be air-dried or kiln-dried. Treated lumber shall be kiln-dried after treatment. Maximum moisture content of wood products shall be as follows:
      a. Framing lumber and boards--19 percent maximum.
      b. Timbers 5 inches and thicker--25 percent maximum.

## 1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Detailed list of equipment, joist hangers, and type of fasteners to be used.

## 1.04 STORAGE

A. Materials shall be stored in an area protected from weather, elevated a minimum of 6 inches above the ground on framework and covered with waterproof covering. Materials shall not be stored in wet or damp areas.

## 1.05 PRESERVATIVE TREATMENT

A. Lumber and timber, where specified, shall be treated in accordance with AWPA C1 and C2 and plywood in accordance with AWPA C1 and C9. All wood shall be air- or kiln-dried after treatment. Specific treatments shall be verified by the report of an approved independent inspection agency or the AWPB Quality Mark on each piece. Surfaces of lumber that will be exposed shall not be incised. Areas that are cut or drilled after treatment shall be brush coated with either the same preservative used in the treatment or with a 2 percent copper napthenate solution. Preservatives used shall be acceptable for specific treatment under local codes and regulations pertaining to toxic and hazardous materials. Unless otherwise specified, the following items shall be preservative treated:

## 1.06 FIRE-RETARDANT TREATMENT

A. The following items shall be treated in accordance with MIL-L-19140. Such items which will not be inside a building shall receive exterior fire-retardant treatment.

# PART 2 PRODUCTS

## 2.01 LUMBER

A. Framing Lumber:
   1. Framing lumber such as studs, plates, caps, collar beams, cant strips, bucks, sleepers, nailing strips, and nailers and board lumber such as subflooring and wall

and roof sheathing shall be one of the species listed in the table below. Minimum grade of species shall be as listed.

**Table of Grades for Framing and Board Lumber**

| Grading rules | Species | Exterior and interior trim, finish, and frames |
|---|---|---|
| PS20 | Southern Yellow Pine | Acceptable |

## 2.02 ROUGH HARDWARE

A. Unless otherwise specified, rough hardware shall be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials shall be as recommended by the product manufacturer unless otherwise specified. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs shall be hot-dip galvanized. Nails and fastenings for fire-retardant treated lumber and woodwork exposed to the weather shall be copper alloy.

B. Bolts, nuts, studs, and rivets shall conform to ANSI B18.2.1, ANSI B18.5, ANSI B18.2.2, and ASTM A687.

C. Expansion shields shall conform to FEDSPEC FF-S-325. Unless otherwise specified, maximum size of devices in Groups IV, V, VI, and VII shall be 3/8 inch.

D. Lag screws and lag bolts shall conform to ANSI B18.2.1.

E. Toggle bolts shall conform to FEDSPEC FF-B-588.

F. Wood screws shall conform to ANSI B18.6.1.

G. Wire nails shall conform to FEDSPEC FF-N-105.

H. Unless otherwise specified, joist anchors for joists supported by masonry walls shall be 3/16-inch by 1-1/2-inch steel tee or strap, bent and of length to provide 4 inches of embedment into wall and 12 inches along joist. Unless otherwise specified, anchors for joists parallel to masonry or concrete walls shall be 1/4-inch by 1-1/4-inch minimum cross-sectional area, steel strap, length as necessary to extend over top of first three joists and into wall 8 inches.

I. Door buck anchors, where specified, shall be metal anchors, 1/8-inch by 1 1/4-inch steel, 12 inches long, with ends bent 2 inches. Anchors shall be screwed to the backs of bucks and built into masonry or concrete, and shall be located 8 inches above sills and below heads and not more than 24 inches intermediately between.

## 2.03 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Shop drawings for fabricated wood trusses and other fabricated structural members indicating materials, details of construction, methods of fastening, and erection details.
   2. Inspection report specified in paragraph 1.02 Preservative-Treated Lumber and Plywood.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. General:

1. Framing lumber and other rough carpentry shall be fit and set accurately to the required lines and levels and secured in place in a rigid manner. Framing members between bearing points shall not be spliced. Joists, rafters, and purlins shall be set with their crown edge up. Members shall be framed for the passage of pipes, conduits, and ducts; however, cutting or boring of structural members for the passage of ducts or pipes is not permitted. Unless otherwise specified, all members damaged by such cutting or boring shall be reinforced by means of specially formed and approved sheet metal or bar steel shapes, and spiking and nailing shall be in accordance with the Nailing Schedule contained in UBC. Spikes, nails, and bolts shall be drawn up tight. Timber connections and fastenings shall conform to NFPA-NDS. Slate or steel shims shall be used when leveling joists, beams, and girders on masonry or concrete.

B. Sills:

1. General:
    a. Sills shall be set level and square, wedged with steel or slate shims, and grouted with nonshrinking cement mortar to provide continuous and solid bearing. Sills shall be anchored to the foundations as specified. Unless otherwise specified, minimum 5/8-inch diameter bolts shall be provided at all corners and splices and spaced at a maximum of 6 feet o.c. between corner bolts. At least two bolts shall be provided for each sill member. Bolts shall be provided with plate washers and nuts. Bolts in exterior walls shall be zinc-coated.
2. Anchors in Masonry:
    a. Unless otherwise specified, anchor bolts shall be embedded not less than 15 inches in masonry unit walls and each provided with a nut and a 2-inch diameter washer at bottom end. Bolts shall be fully grouted with mortar.
3. Anchors in Concrete:
    a. Unless otherwise specified, anchor bolts shall be embedded not less than 8 inches in poured concrete walls and each provided with a nut and a 2-inch diameter washer at bottom end. A bent end may be substituted for the nut and washer; bend shall be not less than 90 degrees.



### 3.02 MISCELLANEOUS

A. Wood Bumpers:

1. Wood bumpers shall be dressed to the sizes specified and provided with beveled edges. Bumpers shall be bored and bolted in place using countersunk holes.

**END OF SECTION**

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SECTION 06 71 10

FIBERGLASS REINFORCED PRODUCTS AND FABRICATIONS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Requirements for Contractor designed fiberglass reinforced products and fabrications. Provide labor, materials, and equipment necessary to install glass fiber and resin fabrications including fiberglass reinforced plastic (FRP) structural and miscellaneous framing members and frames.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below:
   1. Section 01 73 24 Design Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 05 05 20 Anchor Bolts
   3. Section 06 74 13 Fiberglass Reinforced Gratings

### 1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ANSI A14.3 | Standard for Ladders - Fixed - Safety Requirements |
| ASTM D570 | Water Absorption of Plastics |
| ASTM D635 | Rate of Burning and/or Extent and Time of Burning Plastics in a Horizontal Position |
| ASTM D638 | Tensile Properties of Plastics |
| ASTM D695 | Compressive Properties of Rigid Plastics |
| ASTM D696 | Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer |
| ASTM D790 | Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| ASTM D792 | Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement |
| ASTM D2344 | Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates |
| ASTM D2583 | Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor |
| ASTM E84 | Surface Burning Characteristics of Building Materials |
| IBC | International Building Code |
| OSHA 29 CFR 1910.23 | Guarding floor and wall openings and holes |
| OSHA 29 CFR 1910.24 | Fixed Industrial Stairs |
| OSHA 29 CFR 1910.27 | Fixed Ladders |

## 1.04 SUBMITTALS:

A. Action Submittals :
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Qualification statements for manufacturer and installer.
   5. Shop drawings of fabricated framing members, connections, anchors into concrete, and accessories showing dimensions, connections, frames, and details of installation.
   6. Shop drawings for manufacturer designed fabrications shall be sealed by a Professional Engineer licensed in the state of Connecticut.
   7. Structural calculations for platforms, support structures, embedments and other fabrications stamped by a Professional Engineer licensed in the state of Connecticut.
   8. Manufacturer's published literature, including structural design data, structural properties data, corrosion resistance tables, certificates of compliance, test reports as applicable, anchor systems and their allowable load tables.



## 1.05 QUALITY ASSURANCE

A. General:
   1. FRP fabrications shall conform to the standards of the Occupational Safety and Health Administration (OSHA).
   2. FRP products and fabrications shall be furnished by a qualified manufacturer who is regularly engaged in the manufacturing and installation of FRP systems.

B. Qualifications
   1. Fiberglass Reinforced Plastic (FRP) manufacturer is required to have a minimum of 10 years' experience in manufacturing FRP products.
   2. The FRP Manufacturer's Professional Engineer is to be currently licensed by the state of Connecticut, and have a minimum of five years' experience as an Engineer for manufacturers of similar FRP systems. Supply the names and locations of five projects of similar size and scope for which the Engineer has provided engineering calculations using the manufacturer's products within the previous three years.

C. Installer
   1. Engage a single installer skilled, trained, and with record of successful experience in installing FRP miscellaneous fabrications systems in accordance with recommendations and requirements of manufacturer (or who can submit written acceptance by manufacturer),

D. Component Supply and Compatibility
   1. Obtain all components for each type of system, such as platforms, and structural shapes and framing and supports, each from a single FRP miscellaneous fabrications manufacturer.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Shipment:
   1. Systems, sub-systems and structures shall be shop fabricated and assembled into the largest practical size suitable for transporting.
   2. Package and clearly tag parts and assemblies, that are of necessity shipped unassembled, in a manner that will protect materials from damage and facilitate identification and final assembly in the field.

B. Storage and Handling: Store and handle in accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.



# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. Candidate manufacturers are listed below. The manufacturer's standard product may require modification to conform to specified requirements:
   1. American Grating, LLC
   2. Fibergrate Composite Structures Inc.
   3. Seasafe, Inc.
   4. Strongwell Corp.
   5. Approved Equal

## 2.02 PERFORMANCE/DESIGN CRITERIA

A. FRP Platforms:
   1. Dead Load: Design for full dead-load plus the following load conditions applied individually or in combination in accordance with IBC.
   2. Live Loads:
      a. Platforms assembly to carry a minimum uniform live load of 100 psf of projected plan area.
      b. An isolated concentrated load of 1000 pounds shall be applied to framing members where it is most critical.
      c. Maximum Clear Span Deflection for Concentrated Live Loads: 1/240 of span, but no greater than 1/4-inch.
   3. Snow Loads: See Section 01 73 24.
   4. Wind Loads: See Section 01 73 24.
   5. Seismic Loads: See Section 01 73 24.
   6. Deflection: Limit dead load plus live load deflection of treads, platforms, and framing members to L/180.

## 2.03 MATERIALS

A. General:

1. FRP systems shall be fabricated using a vinyl ester resin with flame retardant to achieve a flame spread of 25 or less in accordance with ASTM E84. Polyester resin shall not be used.
2. Exterior exposed systems shall be manufactured with a ultra-violet (UV) inhibitor additive and synthetic surface veil as an outermost layer covering the exterior surface.
3. Exposed surfaces shall be smooth and true to form.
4. Surfaces that will receive foot traffic shall have non-skid surface.
5. After fabrication, cuts, drill holes, and abrasions, including field alterations, shall be sealed with a compatible resin coating to prevent intrusion of moisture.
6. Fasteners used for FRP assemblies shall be Type 316 stainless steel.
7. Color pigment shall be dispersed in resin system. Color shall be selected by Owner's Representative.

B. Structural Shapes:

1. Manufacture by the pultrusion process with a glass content minimum of 45 percent, maximum of 55 percent (by weight) for maximum sunlight and chemical resistance. The structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements, and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.
2. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.
3. Resins shall be fire retardant vinyl ester with chemical formulation necessary to provide corrosion resistance and strength.
4. Pultruded structural shapes are to have the minimum mechanical properties listed below:

| Material Properties | Test Method | Value |
|---|---|---|
| Pultruded Fiberglass Structural Shapes | | |
| Ultimate tensile stress in longitudinal direction, psi | ASTM D638 | 30,000 |
| Ultimate compressive stress in longitudinal direction, psi | ASTM D695 | 30,000 |
| Ultimate flexural stress in longitudinal direction, psi | ASTM D790 | 30,000 |
| Ultimate short beam shear in longitudinal direction, psi | ASTM D2344 | 4,500 |
| Ultimate tensile stress in transverse direction, psi | ASTM D638 | 7,000 |
| Ultimate compressive stress in transverse direction, psi | ASTM D695 | 15,000 |
| Ultimate flexural stress in transverse direction, psi | ASTM D790 | 10,000 |
| Modulus of elasticity, full section, psi | N/A | 2,800,000 |
| Density (lb./in.$^3$) | ASTM D792 | 0.060-0.070 |
| Water absorption (25-hr immersion) | ASTM D570 | 0.60 max, percent by weight |
| Barcol hardness | ASTM D2583 | 45 |
| Coefficient of thermal expansion $10^{-6}$ in./in./degrees C | ASTM D696 | 8.0 |

| | | |
|---|---|---|
| Flame-Retardant Properties | | |
| Flammability test | ASTM D635 | Self-extinguishing |
| Surface burning characteristics | ASTM E84 | 25 maximum |
| Flammability class | UL 94 | VO |
| Temperature index | UL 94 | 130 degrees C |

C. FRP Grating: In accordance with Section 06 74 13.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

### 3.02 FABRICATION

A. Member cuts shall be clean, straight, square, and accurate for minimum joint gap. Work shall be done in conformance with the manufacturer's recommendations. Work shall be free from blemishes, defects, and misfits that can affect durability, strength, or appearance. Cuts and drill holes shall be sealed by application of manufacturer provided resin.

B. Thermal Movements:
   1. Provide fabrications that allow for thermal movements resulting from the project site's maximum range in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

C. Field Measurements:
   1. Verify field dimensions after construction of facilities and include in shop drawing submittal.



### 3.03 INSTALLATION

A. General:

B. Install products in accordance with Contract Documents and manufacturer's instructions. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal shop and field cut or drilled surfaces using manufacturer provided resin. Fastening To Construction-In-Place:
   1. Provide anchorage devices and fasteners where necessary for fastening fabricated FRP items to construction-in-place. Design anchorage devices in accordance with Section 01 73 24. Anchor bolts to be in accordance with Section 05 05 20.
   2. Use Type 316 stainless steel anchors for attachment of fabrications to structure.
   3. Attach grating panels in place with Type 316 stainless steel hold-down fasteners spaced at a maximum of four feet apart with a minimum of four per grating panel.

**END OF SECTION**

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SECTION 06 74 13

FIBERGLASS REINFORCED GRATINGS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Fiberglass-reinforced plastic (FRP) grating, hold down attachments and supports.

B. FRP grating shall be molded type grating unless noted otherwise.

### 1.02 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ASTM A276 | Stainless Steel Bars and Shapes |
| ASTM D635 | Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position |
| ASTM E84 | Test Method for Surface Burning Characteristics of Building Materials |
| ASTM F593 | Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ISO 9001 | Quality Management Systems |
| IBC | International Building Code |



### 1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Fabrication and erection drawings and schedules of all materials included under this Section. Include plans, elevations, and details, including connection details. Show anchorage and accessory items. Shop Drawings shall indicate location of planned field cut-outs in grating. Sample: Each type of grating.

5. Product data information and catalog cuts showing materials and allowable loads, spans, and deflections; include manufacturer's specifications.

## 1.04 QUALITY ASSURANCE

A. Qualifications
   1. Items to be provided under this section shall be furnished only by manufacturers having a minimum of 10 years' experience in the design and manufacture of fiberglass reinforced grating.

B. Certifications
   1. Manufacturer shall be certified to the ISO 9001 standard.
   2. Manufacturer shall provide proof of certification from at least two other quality assurance programs for its facilities or products (DNV, ABS, USCG, and AARR).

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. Candidate manufacturers are listed below. The manufacturer's standard product may require modification to conform to specified requirements.
   1. American Grating, LLC
   2. Fibergrate Composite Structures Inc.
   3. Seasafe, Inc.
   4. Strongwell Corp.
   5. Approved Equal



## 2.02 PERFORMANCE/DESIGN CRITERIA

A. Design FRP grating and stair treads in accordance with the following:
   1. Unless otherwise indicated, design live loads for FRP grating shall 100 psf minimum.
   2. Maximum deflection shall be the quotient of the grating span divided by 180 or 1/4 inch, whichever is less.
   3. The minimum thickness of FRP grating shall be 1 1/2 inches.
   4. Grating sheet sizes shall be compatible with the support spans shown on the Drawings and shall require a minimum of field cutting.
   5. Corrosion Resistance:
      a. Exterior surfaces of grating shall have a synthetic surfacing veil.
      b. FRP grating shall be suitable for continuous service under the following conditions:

| Service | Concentration by Weight (percent) | Maximum Temperature (degrees F) |
|---|---|---|
| Chlorine gas[1] | 20 | 100 |
| Chlorine solution | Saturated | 100 |
| Ferrous chloride | 30 | |
| Hydrogen sulfide[1] | 5 | 100 |

| Service | Concentration by Weight (percent) | Maximum Temperature (degrees F) |
|---|---|---|
| Hypochlorite solution | 5 | 100 |
| Hypochlorous acid | 5 | 100 |
| Potassium permanganate | 10 | 100 |
| Sodium hydroxide | 25 | 100 |
| Sodium hypochlorite | 15 | |
| Sulfuric acid | 15 | 100 |

*Note:*

*1. Wet or dry*

## 2.03 MATERIALS

A. Molded Type Grating:

1. Open-molded fiberglass grating made in one piece by interweaving continuous, thoroughly wetted, glass strand with vinyl ester resin with UV inhibitor additives. Polyester resin shall not be used.
2. Square mesh, 1 1/2 inch maximum spacing for 1 1/2 inch thick grating; 2 inch maximum spacing for 2 inch thick grating.
3. Stair treads shall be minimum 1 1/2 inch by 6 inch grid, with anti-slip grit top and integral abrasive bull nosing.
4. Cut ends, holes and abrasions of FRP shapes shall be sealed with resin to prevent moisture wicking.
5. Load bars in both directions with equal stiffness.
6. Color shall be selected by Owner's Representative from manufacturer's standard color selection.
7. Meet self-extinguishing requirements of ASTM D635.
8. Fire Rating: Flame spread of 25 or less as measured by ASTM E84.
9. Skid-Resistant Surface: Grit adhesively bonded, manufacturer's standard.

B. FRP Embedment Angles: Fiberglass reinforced plastic with slate-gray, vinyl ester, fire-retardant resin. Size FRP embed angle as required for the thickness of grating.

C. Hold Down Clips: ASTM A276 Type 316 stainless steel.

D. Bolts and Connectors: Corrosion resistant FRP or ASTM F593 Type 316 stainless steel. Size and strength to meet IBC requirements.

## 2.04 ASSEMBLY/FABRICATION

A. Measurements: Grating supplied shall meet the dimensional requirements and tolerances as shown or specified. Provide and/or verify measurements in field for work fabricated to fit field conditions as required by grating manufacturer. When field dimensions are not required, determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.

B. Layout: Each grating section shall be readily removable (no single piece shall weigh more than 80 pounds), except where indicated on the Drawings. Manufacturer to provide

openings and holes where located on the Drawings. Grating openings that fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so that each section of grating is readily removable.

C. Sealing: Shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. Field fabricated grating cuts shall be coated similarly in accordance with the manufacturer's instructions.

D. Hardware: Hold down clips shall be provided and spaced at maximum of four feet apart with a minimum of four per piece of grating, or as recommended by the manufacturer.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

### 3.02 INSTALLATION

A. Provide FRP grating with hold-down attachments, end panel attachments, and appurtenances to make the work complete and operable.

B. Provide adequate quantities of resin sealing kits comprised of pre-measured quantities of thixotropic resin and catalyst, mixing containers, chip brushes, and stirring sticks.

C. Seal field cut holes, edges, and abrasions.

D. Install plumb or level, rigid and neat, as applicable.

E. Install each grating section such that it is easily removable.

F. Install each grating section in accordance with manufacturer’s assembly drawings.

G. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

H. Clearance (Grating to Vertical Surfaces): 1/4 inch (±1/8 inch tolerance).



**END OF SECTION**

# DIVISION 07
# THERMAL AND MOISTURE PROTECTION

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SECTION 07 10 00

DAMPPROOFING AND WATERPROOFING

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Dampproofing and waterproofing coatings and membranes for concrete surfaces.
   1. Plastic Lining is not covered by this specification.
   2. Refer to Section 09 90 00 for protective concrete coatings.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 03 30 00 Cast-In-Place Concrete.
   2. Section 09 90 00 Painting and Coating.



### 1.03 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ASTM C109 | Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens) |
| ASTM C321 | Bond Strength of Chemical-Resistant Mortars |
| ASTM C348 | Flexural Strength of Hydraulic-Cement Mortar |
| COE CRD-C48 | Handbook for Concrete and Cement Standard Test Method for Water Permeability of Concrete |

### 1.04 DEFINITIONS

A. SM – Coating or Membrane - System Manufacturer

B. TR – Coating or Membrane System Manufacturer's - Technical Representative

### 1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.

3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. System Manufacturer's (SM) current printed recommendations and product data sheets for proposed systems including:
    a. Volatile organic compound (VOC) data.
    b. Surface preparation recommendations.
    c. Allowable substrate moisture content.
    d. Primer type, coverage rate, and drying time; where required.
    e. Maximum dry and wet-mil thickness per coat.
    f. Product(s) shelf life.
    g. Minimum and maximum curing time between coats.
    h. Atmospheric condition requirements during application and curing.
    i. Curing time before submergence in liquid.
    j. Thinner to be used.
    k. Ventilation requirements.
    l. Allowable application methods.
    m. Corner, joint, and wall penetration details.
    n. Protection board requirements.
    o. Backfill procedure recommendations including termination bar if required.
5. Affidavits signed and sealed by an officer of the SM's corporation, attesting to compliance of each system component with federal, state, and local air pollution control regulations and requirements.
6. SM's detailed, written instructions for system installation including graphic details for terminations, pipe penetrations, metal embedments, gate frames, concrete joints, and other terminations as coordinated by Contractor.
7. Schedule of all surfaces where dampproofing, waterproofing coating, and sheet membrane waterproofing will be applied.

B. Informational Submittals:
1. Material Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.
2. List of cleaning and thinner solutions allowed by the SMs.
3. Storage and handling requirements including temperature, humidity, and ventilation for system materials as recommended by the SMs.
4. The Contractor and SM shall each provide five project references with contact name, address, and telephone number where similar coating work has been performed by their companies in the past five years.

## 1.06 QUALITY ASSURANCE

A. General:
   1. Materials in each system shall be the products of a single SM.
   2. Installation of each system shall be by a single installation Contractor, approved by the SM.

B. Quality Control:
   1. The Contractor is responsible for the workmanship and quality of the system installation. Inspections by the Owner's Representative or the System Manufacturer's Technical Representative (TR) will not relieve or limit the Contractor's responsibilities.
   2. Installation methods shall conform to requirements of this specification. Changes in the system installation requirements will be allowed only with the written acceptance of the Owner's Representative before work commences.
   3. Only personnel who are trained by the TR specifically for the system or who are approved by the SM specifically for the system are allowed to perform the system installation specified in this Section.
   4. For repairs, provide the same products, or products recommended by the SM, as used for the original installation.
   5. Identify the points of access for inspection by the Owner's Representative. Provide ventilation, ingress and egress, and other means necessary for the Owner's Representatives to safely access the work areas.
   6. Conduct and inspect the work so that the system is installed as specified. Work that does not conform to the specifications shall be corrected.



## 1.07 SPECIAL WARRANTY

A. Waterproofing coating and sheet membrane waterproofing SM and the installation Contractor agree to repair or replace components of the waterproofing system that fail in materials or workmanship within 5 years from the date of completion.

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS AND PRODUCTS

A. Dampproofing Coating:
   1. W.R. Meadows, Sealtight Sealmastic Emulsion.
   2. ChemMasters, MasterGard 400.
   3. Euclid Chemical Company, Dehydratine 75.

B. Sheet Membrane Waterproofing:
   1. Grace Construction Products, Bituthene 3000, except below base slab use Preprufe 300R.
   2. W.R. Meadows, Sealtight MEL-ROL, except below base slab use Precon.
   3. Tremco, Paraseal, except below base slab use Paraseal LG.

## 2.02 MATERIALS

A. Dampproofing Coating:
   1. Cold applied, asphalt emulsion.

B. Sheet Membrane Waterproofing:
   1. Modified bituminous, self-adhering, cold-applied sheet membrane system consisting of rubberized asphalt laminated on one side to polyethylene-film reinforcement with release liner on the adhesive side, or HDPE/bentonite sheet membrane with expandable granular bentonite.
   2. Use products from the same manufacturer for both vertical and horizontal surfaces. Sealed interface of vertical to horizontal membranes shall be per manufacturer's recommendations.
   3. Protection board shall be 1/2- inch asphalt impregnated fiberboard or protection board.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Examine and accept existing conditions before beginning work.

## 3.02 DAMPPROOFING COATING

A. Location:
   1. Apply to the earth side of concrete walls which are below grade at the following locations or as indicated on the Drawings:
      a. Walls at unoccupied crawl spaces.
      b. Wall areas above the water table and the waterproofing membrane or coating at walls common with rooms, tunnels or galleries to be occupied by equipment, piping or personnel.
      c. Walls of concrete channels, basins and tank walls (above and below ground water table).
   2. Do not apply to walls that are to be provided with waterproofing sheet membrane with protection board or to walls that are placed directly against an excavated surface.
   3. Dampproofing is not a substitute for waterproofing.

B. Surface Preparation:
   1. New concrete shall have cured at least 28 days. Remove loose concrete and laitance from new concrete surfaces by abrasive blasting. Repair voids and cracks as specified in Section 03 30 00. Pre-dampen the surface as recommended by the product manufacturer.
   2. Do not proceed with dampproofing Work until all projections through the concrete surface are installed.

C. Application:
   1. Apply one or more coats at the manufacturer's recommended dry film thickness for optimum performance. Surfaces to be coated must be kept damp during the

application procedure. Drying time between coats: as recommended by the manufacturer.

## 3.03 SHEET MEMBRANE WATERPROOFING

A. Location:
   1. Where indicated on the Drawings, apply below base slab and to earth side of walls and elevated slabs which are common with rooms, tunnels or galleries to be occupied by equipment, piping, conduit, or personnel.

B. Surface Preparation:
   1. Concrete surface shall be clean, dry and free of voids, spalled areas, loose aggregate, sharp protrusions, and with no coarse aggregate visible.

C. Application:
   1. Apply in accordance with the manufacturer's recommendations. Pipes or conduits that enter structure shall be made watertight.
   2. Where the membrane is turned up from the base of the walls, at angles in walls, or at other places where the membrane may be subjected to unusual strain, apply strips consisting of two additional plies of membrane or as recommended by the manufacturer.
   3. Manufacturer's representative shall be present during initial application to certify that installation procedures comply with manufacturer's requirements.

**END OF SECTION**

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SECTION 07 21 00

BUILDING INSULATION

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install building insulation.
   2. Extent of each type of building insulation is shown and indicated in the Contract Documents.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before building insulation Work.

### 1.02 RELATED SECTIONS (NOT USED)

### 1.03 REFERENCES

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. The references listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version reference by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. When document dates are given in the following listing that are not specifically referenced in an applicable code, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. For questions, refer to Engineer.

| Reference | Title |
|---|---|
| ASTM C177 | Test Methods for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus |
| ASTM C203 | Test Method for Breaking Load and Flexural Properties of Block-Type Thermal Insulation |
| ASTM C236 | Test Methods for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box |

| Reference | Title |
|---|---|
| ASTM C272 | Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions |
| ASTM C303 | Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation |
| ASTM C518 | Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus |
| ASTM C520 | Test Methods for Density of Granular Loose Fill Insulation |
| ASTM C531 | Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars and Monolithic Surfacings |
| ASTM C549 | Specification for Perlite Loose Fill Insulation |
| ASTM C553 | Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications |
| ASTM C578 | Specification for Rigid, Cellular Polystyrene Thermal Insulation |
| ASTM C612 | Specification for Mineral Fiber Block and Board Thermal Insulation |
| ASTM C665 | Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing |
| ASTM C764 | Specification for Mineral Fiber Loose-Fill Thermal Insulation |
| ASTM D696 | Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C with a Vitreous Silica dilatometer |
| ASTM D1621 | Test Method for Compressive Properties of Rigid Cellular Plastics |
| ASTM D2126 | Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging |
| ASTM E84 | Test Method for Surface Burning Characteristics of Building Materials |
| ASTM E96 | Test Methods for Water Vapor Transmission of Materials |
| ASTM E119 | Test Methods for Fire Tests of Building Construction and Materials |
| UL 1479 | Fire Tests of Through-Penetration Firestops |



## 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Builder, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Builder with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Shop Drawings:
      a. Drawings showing extent of the building insulation Work and all details required for the Work, referencing system components provided as Samples.

b. Complete selection of fire stop manufacturer's recommended systems for each condition and kind of penetration encountered in the Work. Coordinate with equipment manufacturers for required number and kind of penetrations through fire-rated construction. Provide schedule of penetrations and fire stop system to be included for each condition and kind of penetration encountered.

4. Product Data:
   a. Material specifications and general recommendations from building insulation manufacturer for each type of building insulation product. Include manufacturer's data substantiating that materials comply with Contract Documents.
   b. Test Reports: Copies of reports of tests on materials being furnished or previously-manufactured, identical materials verifying compliance with physical properties and environmental features specified in the Contract Documents
5. Samples:
   a. Twelve-inch by twelve-inch Samples of each required type of building insulation.

B. Informational Submittals:
1. Procedures: Section 01 33 00.
2. Manufacturers' certificates of compliance with specified industry standards.
3. Manufacturer's Instructions: Manufacturer's installation instructions. Indicate by copy of transmittal form that installer has received copy of manufacturer's installation instructions.



## 1.05 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturers:
   a. Obtain building insulations that comply in all respects with Copenhagen Amendments to the Montreal Protocol.
   b. Manufacturer shall provide complete technical services including preparation and review of Shop Drawings and submittals, installation methods, and proposed detailing for the Work.
2. Installer: Engage single installer for each type of building insulation. Each installer shall be skilled, trained, and have record of successful experience in applying and installing each product, and possess successful record of performing work in accordance with recommendations and requirements of manufacturer or that can submit written evidence of being acceptable to manufacturer for providing the required Work. Installers shall employ only tradesmen with specific skill and successful experience in each type of Work required. Submit to Design-Engineer OF RECORD name and qualifications of each installer with the following information for at least three successful, completed projects per installer:
   a. Names and telephone numbers of owner and Architect or Engineer responsible for each project.
   b. Approximate contract cost of the building insulation system installed.
   c. Quantity (area) of building insulation installed.

B. Regulatory Requirements: Comply with code interpretations by authorities having jurisdiction at the Site.

## 1.06 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling of Materials:
   1. Do not deliver insulation materials to the Site before the time of installation.
   2. Deliver materials in sufficient quantities to allow uninterrupted continuity of the Work.
   3. Handle materials carefully to avoid damage and breakage or compressing of boards to less than their specified thickness, or other damage.
   4. Handle materials in manner that prevents inclusion of foreign materials.

B. Storage of Materials:
   1. Store materials in dry, enclosed area, off ground and away from possible contact with water, ice, and snow.
   2. Prevent damage to materials during storage, including minimizing the time materials are stored at the Site before being incorporated into the Work. Store only sufficient quantity of building insulation materials at the Site required for continuous advancement of the Work without causing delay.
   3. Conform to Section 01 66 00 Product Storage and Handling Requirements.

## 1.07 SITE CONDITIONS

A. Environmental Conditions:
   1. Complete the installation and concealment of building insulation materials as rapidly as possible to avoid damage from adjacent construction operations and adverse weather conditions.
   2. Install building insulations when weather and temperature conditions comply with building insulations manufacturers' written recommendations.
   3. Install building insulations when damaging environmental condition are not forecasted for the time when exposed systems materials components would be exposed to potential damage from the elements.
   4. Protect building insulation Work from precipitation, frost, and direct sunlight.
   5. Do not apply pressure sensitive tape when temperature is below 35 degrees F or above 110 degrees F.
   6. Record decisions, conditions, and agreements to proceed with the Work when weather conditions may be unfavorable. State reasons for proceeding, along with names of persons involved, and changes or revisions (if any), if required, to allow the Work to proceed.



## 1.08 SCHEDULING

A. Proceed with building insulation Work when preceding Work is ready to receive the Work of this Section.

B. Proceed with building insulation and associated Work after curbs, blocking, substrate board, nailer strips, vents, drains and other projections through the substrates have been installed, and when substrate construction and framing of openings is complete.

C. Proceed with and complete the Work when materials, equipment and tradesmen required for the installation of building insulation and backfilling operations are at the

Site and ready to follow with the Work in manner that does not leave the Work vulnerable to damage or deterioration.

D. Do not advance installation of building insulation beyond that necessary for proper sequencing of the Work. Do not advance the Work when there is no proper and secure protection from damaging weather and construction activities.

## PART 2 PRODUCTS

### 2.01 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Thermal Conductivity: Thicknesses shown are for thermal conductivity, k-value at 75 degrees F, specified for each material.
   2. Provide adjusted thicknesses based on thicknesses shown or specified for building insulations, as required to comply with required thermal resistances for material having different thermal conductivity.

### 2.02 MATERIALS

A. Foam Plastic Insulations: Provide the following types:
   1. General: Rigid, closed-cell, thermally stabilized, extruded, hydrochlorofluro-carbon blown, foam board insulation consisting of 100 percent virgin extruded polystyrene modified resin complying with ASTM C578.
   2. Provide blowing agent with lowest available ozone depletion potential, such as HCFC-142b or better. HCFC-141b is not acceptable.
   3. Cavity Wall Rigid Insulation Board: Provide the following:
      a. Rigid, rectangular boards of extruded polystyrene complying with ASTM C578, Type X and IV.
      b. Physical Properties: Provide the following:
         1) Minimum Compressive Strength, (at 10 percent deformation), ASTM D1621: 25 psi.
         2) Flame Spread, ASTM E84: 10 maximum.
         3) Smoke Development, ASTM E84: 165 maximum.
         4) Vapor Transmission, ASTM E96: 1.1 perms/inch.
         5) Thermal Resistance, ASTM C177: 5.0 per inch.
         6) Maximum Water Absorption, ASTM C272: 0.10 percent by volume.
      c. Size: one layer of 16 inches by 96 inches by two inches thick.
      d. Products and Manufacturers: Provide one of the following:
         1) CAVITYMATE Plus by the Dow Chemical Company.
         2) Foamular 250 Square Edge by Owens-Corning Fiberglass Corp.
         3) or approved equal.

B. Mineral Fiber Insulation: Provide the following types:
   1. General: Provide insulations formed from inorganic mineral fiber extrusions spun at 2,500 degrees F complying with ASTM C665 and ASTM C764.

2. Loose Mineral Fiber Insulation: Provide non-asbestos rock, slag, or glass processed into fiber and formed into loose resilient wool mass or granular modules complying with ASTM C764, Type 1 (for blowing) Type 2 (for pouring).
    a. Physical Properties:
        1) Thermal Conductivity (k), ASTM C764: 0.46 Btu/inch/hour/square foot/degree F.
        2) Ignition Loss: Less than one percent (99 percent pure mineral fiber).
        3) Density, ASTM C 64: 1.5 pounds per cubic foot (pcf).
    b. Products and Manufacturers: Provide one of the following:
        1) Industrial Mineral Wool Fiber by Rock Wool Industries, Inc.
        2) FBX Insulating Wool by Fibrex, Inc.
        3) or approved equal.
3. Safing Insulation: Provide unfaced semi-rigid non-asbestos, non-combustible blankets composed of compounds of spun mineral fiber felt, complying with ASTM C665, Type I.
    a. Physical Properties:
        1) Thermal Conductivity (k), ASTM C518: 0.25 Btu/inch/hour/square foot/degree F.
        2) Density, Manufacturer's Certified Test: Four pounds per cubic foot (pcf).
        3) Flame Spread, ASTM E84: 15 maximum.
        4) Smoke Developed, ASTM E84: Five maximum.
        5) Fire Resistance Rating, ASTM E119: Three hours.
    b. Thickness: Four inches.
    c. Width: 2.0 feet.
    d. Products and Manufacturers: Provide one of the following:
        1) Thermafiber Safing Insulation by USG Interiors, Inc.
        2) FBX Safing Insulation by Fibrex, Inc.
        3) or approved equal.

C. Loose Granular Perlite Insulations: Provide the following:
1. Loose Fill Insulation: Provide inert asbestos-free volcanic glass-like perlite aggregates expanded by special heat process and treated with non-flammable silicone complying with ASTM C549.
    a. Physical Properties:
        1) Thermal Conductivity (k), ASTM C549: 0.37 Btu/inch/hour/square foot/degree F.
        2) Density, ASTM C520: Five to eight pounds per cubic foot (pcf).
        3) Flame Spread, ASTM E84: Zero.
        4) Fuel Contributed, ASTM E84: Zero.
        5) Smoke Development, ASTM E84: Zero.
    b. Products and Manufacturers: Provide one of the following:
        1) Permalite by Grefco, Inc.
        2) or approved equal.

D. Fire-Stop Sealants and Other Fire-Stop System Components: Provide the following:
   1. Complete selection of fire-stop manufacturer's recommended silicone rubber fire-stop systems. Provide complete systems complying with UL 1479 with two- or three-hour fire rating. Provide equal fire protection as provided by fire-rating of construction penetrated.
   2. Provide multiple component systems coordinated to meet actual conditions encountered in the Work and as recommended by fire-stop manufacturer. In addition to providing fire resistance, fire-stop systems shall also be gas and watertight.
   3. Products and Manufacturers: Provide one of the following:
      a. 3M Fire Stop Systems by 3M, Inc.
      b. or approved equal.

E. Miscellaneous Materials and Accessories: Provide the following:
   1. Adhesive for Bonding Insulation: Type recommended by insulation manufacturer, and complying with fire resistance requirements.
   2. Mechanical Anchors: Type and size shown or, if not shown, as recommended by insulation manufacturer for type of application shown and condition of substrate.
   3. Wire Mesh Insulation Support: Two-inch by 24-gage galvanized steel wire hexagonal woven mesh.
   4. Safing Impaling Clips: Provide galvanized steel impaling clips complying with requirements of code authorities having jurisdiction at the Site and as recommended by insulation manufacturer for full system responsibility.
   5. Protection Board: Fiberboard sheathing or heavy duty asphaltic panels as recommended by insulation manufacturer.
   6. Adhesive Tapes: Complete selection of insulation manufacturer's recommended taping materials.
   7. Bitumen: Asphalt, ASTM D 449.



## PART 3 EXECUTION

### 3.01 INSPECTION

A. Contractor and installer shall examine substrate and conditions under which building insulation Work will be performed and notify Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

A. Surfaces to receive building insulation shall be clean of all debris, dirt, and other contamination before installation begins.

### 3.03 INSTALLATION

A. General:
   1. Comply with manufacturer's instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to Site conditions, before proceeding with the Work obtain from manufacturer and submit to Engineer specific installation recommendations from manufacturer.

2. Extend insulations full thickness over entire surface to be insulated. Cut and fit tightly around obstructions. Fill voids with insulation.
3. Apply number of layers of insulation specified, each of required thickness, or required thickness to provide thermal value shown or indicated in the Contract Documents, to make up the total thickness.

B. Unit-type Building Insulation:
1. Apply insulation units of type shown or indicated to substrate by method indicated. If not otherwise indicated and except for units resting on horizontal surfaces, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
2. Exercise extreme care to avoid damaging and soiling of faces on insulation units that will remain exposed-to-view. Align joints accurately, with adjoining surfaces set flush.
3. Set vapor barrier faced units with vapor barrier to warm side of construction, (usually toward inside), except as otherwise shown or indicated. Do not obstruct ventilation spaces, except for fire-stopping.
4. Tape joints and ruptures in vapor barriers using adhesive tape of type recommended by insulation manufacturer, and seal each continuous area of insulation to surrounding construction so as to ensure vapor-tight installation of the units.

C. Safing Insulations and Fire-Stop Systems:
1. Install safing insulation and fire-stop systems to present continuous fire-rated fire barrier in areas shown and at perimeter of all fire-rated partitions and poke-through floor and wall penetrations, to maintain continuity of fire-rated construction whether or not shown.
2. Install fire stop sealants and other fire stop system components in thicknesses recommended by manufacturer at all locations where poke-through penetrations occur, at all locations where other penetrations such as ducts, pipe, cables, cable trays, and conduit occur and at perimeter of all fire-rated walls.
3. Include all components of manufacturer's fire/smoke-stop systems for complete system responsibility installed in accordance with manufacturer’s written recommendations and specifications.

D. Board-type Perimeter and Under-Slab Insulation:
1. Install perimeter insulation after concrete footings have been poured and before on-grade concrete slab work begins.
2. Remove projections that interfere with placing.
3. Apply single 2.0-foot-wide continuous band of insulation of required thickness and number of layers at slab-on-grade buildings whether or not shown. Stagger joints between layers of insulation and butt insulation tightly together.
4. Protect top surface of horizontal insulation from damage during concrete Work by applying protection course material recommended by insulation manufacturer.
5. On vertical surfaces, set units in adhesive applied in accordance with manufacturer’s instructions. Use type of adhesive recommended by manufacturer of board-type perimeter insulation.
6. Tape bottom edge of insulation before temporarily attaching insulation to wall with mastic.
7. Tape all joints in vertical wall insulation. Tape as recommend by manufacturer.

8. Protect insulation on vertical surfaces from damage during backfilling by applying protection course material recommended by insulation manufacturer. Set in adhesive in accordance with recommendations of insulation manufacturers and protection course material.

E. Cavity Wall Rigid Insulation Board:
   1. Install exterior wall rigid insulation board after all concrete unit masonry Work is complete.
   2. Apply single layer of insulation cut to fit snugly and uniformly and in continuous contact with edges of continuous masonry horizontal joint reinforcement over entire plane of the wall.
   3. Apply exterior wall rigid insulation to exterior concrete unit masonry walls in areas shown or indicated as receiving masonry outer cavity wall wythes.
   4. Set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of board-type cavity wall insulation.

F. Loose Fill Insulation:
   1. Pour granular insulation into spaces and onto surfaces to completely fill all void spaces.
   2. Screed horizontal applications to uniform thickness.

G. Correcting Defective Work:
   1. System components that are dislodged, damaged, expanded, broken, penetrated, or crushed by subsequent installation operations or damaged by detrimental weather shall be immediately replaced with undamaged material in compliance with the Contract Documents and properly protected as specified.
   2. Only original installer shall repair or replace deteriorated or defective Work.



## 3.04 PROTECTION

A. Protection from Elements:
   1. Protect all components of the Work from detrimental weather conditions. Do not allow building insulation materials to become wet or soiled, or covered with ice or snow. Provide continuous protection of materials against damage, wetting and moisture absorption and storing materials as specified.
   2. Work that cannot, for reasons acceptable to Engineer, be covered with complete construction system before onset of weather detrimental to the Work, shall be completely covered and protected in manner that deflects precipitation from building insulations without damaging adjacent Work.
   3. Protect foam plastic building insulation from exposure to sunlight.

B. Protection During Construction:
   1. Protect all components of the Work from construction operations including, but not limited to, backfilling and concrete unit masonry Work, until work is completed and acceptable to Engineer.
   2. Protect building insulations from damage and abuse by other contractors and installers until readiness for final payment.

3. Do not allow building insulations to come into contact with welding operations or other fire or ignition sources.
4. Do not allow construction traffic not associated with installation of building insulation in the area of building insulation Work. Protect the area from access by other installers and contractors until the building insulation Work has been incorporated into finished construction systems.

C. Building insulation that becomes wet, damaged, or deteriorated shall be promptly removed from the Site and replaced with materials conforming to this Section.

**END OF SECTION**

SECTION 07 22 16

ROOF BOARD INSULATION

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope
   1. This Section specifies roof board insulation.
   2. Contractor shall provide all labor, materials, tools, equipment, and incidentals as shown, specified and required to furnish and install all roof board insulation.
   3. The Work also includes:
      a. Providing openings in roof board insulation to accommodate the Work under this Section and others and building into the roof board insulation all items such as sleeves, inserts and all other items to be embedded in roof board insulation for which placement is not specifically provided under other specification sections.
   4. Extent of each type of roof board insulation is shown on the Plans.
   5. Types of products required include the following:
      a. Extruded, CFC, HCFC-free blowing agent, polyisocyanurate rigid board-type insulation.
      b. Miscellaneous materials and accessories.

B. Performance Requirements
   1. General Performance: Installed insulation, membrane roofing, and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing, insulation, and base flashings shall remain watertight.
   2. Material Compatibility: Provide insulation materials that are compatible with other roofing system materials under conditions of service and application required, as demonstrated by membrane roofing supplier based on testing and field experience.

C. Coordination
   1. Review installation procedures under other specification sections and coordinate the installation of items that must be installed with the roof board insulation work.
   2. All framing for openings, edge angles, nailers, curbs and other items shall be in place before start of roof board insulation work.
   3. Coordinate finish of galvanized steel metal roof deck for acceptance by lightweight insulating concrete supplier.
   4. Field-verify location of all roof penetrations, drain locations, and deck deflections.



### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 06 10 00 Rough Carpentry
   2. Section 07 51 00 Built-Up Bituminous Roofing

## 1.03 QUALITY ASSURANCE

A. Reference Codes and Standards

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there was no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. In all cases, the effective version of the Connecticut State Building Code at the time of Advertisement for Bids or Invitation to Bid shall be considered the building code in effect.



| Reference | Title |
|---|---|
| ASHRAE/IESNA 90.1 | Energy Standard for Buildings Except Low Rise Residential Buildings |
| ASTM C 177 | Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus. |
| ASTM C 203 | Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation |
| ASTM C 209 | Test Methods for Cellulosic Fiber Insulating Board |
| ASTM C 272 | Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions |
| ASTM C 303 | Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation |
| ASTM C 518 | Test Method for Steady-State Thermal Transmission Properties by Means of Heat Flow Meter Apparatus |
| ASTM C 550 | Test Method for Measuring Trueness and Squareness of Rigid Block and Board Thermal Insulation |
| ASTM C578 | Specification for Rigid, Cellular Polystyrene Thermal Insulation |
| ASTM C 1289 | Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board |
| ASTM D 696 | Test Method for Coefficient of Linear Thermal Expansion of Plastics between -30 Degrees C and 30 Degrees C with a Vitreous Silica Dilatometer |
| ASTM D 1621 | Method for Compressive Properties of Rigid Cellular Plastics |
| ASTM D 1623 | Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics |
| ASTM E 84 | Test Method for Surface Burning Characteristics of Building Materials |
| ASTM E 96 | Test Methods for Water Vapor Transmission of Materials |
| ASTM E 108 | Test Methods for Fire Tests of Roof Coverings |

| Reference | Title |
|---|---|
| FM Global Loss Prevention Data for Roofing Contractors, 1 29 | Above-Deck Roof Components |
| NRDCA, LICRDC | Accreditation Program |
| UL | Underwriters Laboratory Building Materials Directory |

B. Installer's Qualifications
   1. Roof board insulation work shall be performed by the installer of the associated roofing for undivided responsibility.

C. Source Quality Control
   1. Obtain extruded polyiscoyanurate rigid board-type insulation from suppliers who manufacture specified insulation using a blowing agent containing no chlorine-based compounds.
   2. Engage a single supplier for each type of roofing insulation who shall provide the services of a technical representative to assist Contractor and Engineer by providing technical opinions on the adequacy of materials and methods of installation based on Shop Drawings approved by Engineer.
   3. Provide such services during the time of delivery, storage, handling and installation of all roofing insulation.
   4. The thicknesses shown are based on the thermal conductivity, k value at 75°F specified for each material. Thicknesses of roof board insulation materials submitted by Contractor as "or Approved Equal" to specified materials shall have their thicknesses adjusted to provide the same thermal resistance as materials specified.

D. Requirements of Regulatory Agencies: Comply with fire resistance ratings as required by governing authorities and building codes, and complies with the following roof board insulation requirements:
   1. Underwriters Laboratories requirements for roof deck constructions which are rated "UL Class A".
   2. Factory Mutual requirements for "Class 1-90" rated construction, for wind resistance.



## 1.04 ENVIRONMENTAL CONDITIONS

A. Product in this Section shall be subjected to environmental conditions in accordance with Section 01 11 80 Environmental Conditions.

## 1.05 SUBMITTALS

A. Preconstruction/Action Submittals: The following minimum submittals shall be submitted prior to construction of this element of the Work in accordance with Section 01 33 00 Submittals.
   1. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are

indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The - Engineer shall be the final authority for determining acceptability of requested deviations.

2. The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
3. Shop Drawings for the products supplied under this Section including:
   a. Field verified locations of all roof penetrations and deck deflections.
   b. Complete layout of all roof board insulation showing sizes, placement, number of courses and methods of fastening. Include statement that fastening method, location and density of fasteners have been approved by roof membrane supplier and comply with wind uplift requirements specified.
   c. Weights of all equipment to be used on roof.
   d. All required roof board insulation details approved by the Supplier and the supplier of the respective roofing systems.
4. Operation and maintenance information in accordance with Section 01 77 30 Operating and Maintenance Instructions.
5. Special shipping, storage and protection, and handling instructions.
6. Supplier's specifications and installation instructions for each type of roof board insulation required. Include data substantiating that the materials comply with specified requirements.
7. Qualifications Statements
   a. Supplier
   b. Installer
8. Certificates
   a. Installer's qualifications.
   b. Installer's NRCA Accreditation.
9. Samples
   a. Each fastener to be used in the Work.
   b. 12 inch by 12 inch sample of specified extruded and expanded rigid board type insulation and composite insulation system.

B. Informational Submittals: The following minimum informational submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00 Submittals.
   1. Operations and Maintenance Manuals (including Warranty) in accordance with Section 01 78 23 Operating and Maintenance Data.
   2. Factory Test Reports.
   3. Field Test Reports.
   4. Warranty Documentation
      a. Installer's two (2)-year warranty.

b. In addition to the above Contractor shall provide the Owner with Supplier's one (1)-year warranty.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE PRODUCTS

A. Suppliers
   1. The Engineer believes that the Suppliers indicated in this Section are capable of producing equipment and products, which will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular Supplier or product, nor shall it be construed that a named Supplier's standard product will comply with the requirements of this Section.

B. Supplier Qualifications
   1. The Supplier shall have five (5) years of experience manufacturing and installing roof board insulation in similar-sized projects.
   2. Supplier of the primary roofing membrane systems shall be a supplier who finds the generic types of insulation specified herein as acceptable and bondable if installed according to the roofing supplier's standards for complete product and performance responsibility.



### 2.02 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose. If alternatives are proposed, the proposals shall be accompanied with documentation supporting the claimed superiority of the proposed substitutions. The Engineer shall be the sole decider in the equivalency of alternative materials of construction.
   1. FM Approvals Listing: Provide insulation and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals' markings.
      a. Fire/Windstorm Classification: Class 1A-90

B. Extruded Polyisocyanurate Rigid Board Roof board insulation
   1. Rigid, rectangular boards of extruded closed-cell polyisocyanurate complying with ASTM C 1289, Type II, Grade 3, with low water vapor permeability and laminated to heavy black (non-asphaltic) fiber-reinforced felt facers with one side of board containing perforated facers and the other side containing non-perforated facers.
   2. Provide a blowing agent with zero ozone depletion potential, such as pentane.
   3. Physical Properties: Provide the following
      a. Minimum Compressive Strength, (at 10 percent deformation), ASTM D 1621: 25 psi minimum.
      b. Flame Spread, ASTM E 108: Class A.

c. Smoke Development, ASTM E 84: 120 maximum.
d. Vapor Transmission, ASTM E 96: <1 perms/inch.
e. Thermal Resistance, ASTM C 518: 7/inch.
f. Maximum Water Absorption, ASTM C 209: 0.10 percent by volume.

4. Size: 48-inches by 96 inches by 2-inch thick.
5. Number of Layers: As required by thickness of roof board insulation shown.
6. Products and Suppliers: Provide one of the following:
   a. Tapered HP-H Polyiso Insulation by Carlisle SynTec Systems Division of Carlisle Corporation, or
   b. or approved equal.

C. Miscellaneous Materials
1. Adhesive for Bonding Insulation: The type recommended by the Supplier and complying with fire resistance requirements.
2. Mechanical Anchors: The type recommended by the Supplier for the type of deck used and complying with fire and insurance rating requirements.



## PART 3 EXECUTION

### 3.01 SHIPMENT AND STORAGE

A. Product shall be shipped and stored in accordance with Section 01 66 00 Product Storage and Handling Requirements.

B. Supplier shall provide Contractor with detailed recommendations and instructions for product storage.

C. Delivery of Materials
1. Do not deliver insulation materials to the Site before time of installation.
2. Deliver materials in Supplier's original, undamaged packages or acceptable bulk containers.

D. Storage of Materials
1. Do not allow insulation materials to become wet or soiled, or covered with ice or snow.
2. Protect plastic insulation from exposure to sunlight.
3. Protect plastic insulation against ignition.
4. Store packaged materials to protect them from the weather and physical damage.

### 3.02 INSTALLATION

A. Supplier's services shall be provided as specified in Section 01 60 00 Common Product Requirements.

B. The Supplier shall provide the Contractor with detailed recommendations and instructions for installation of the products specified in this Section.

C. Supplier shall provide assistance during product installation as required by the Contractor.

D. Products shall be installed at the locations shown and in accordance with the recommendations of the Supplier.
   1. Comply with Supplier's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to Site conditions, consult the Supplier for specific recommendations before proceeding. Incorporate recommendations into the Work only as approved by Engineer. Record all such discussions and the basis for discussions in the Job Conditions Report specified in Part 3 of this Section.

E. Inspection
   1. Examine the substrate and the conditions under which the roof board insulation work is to be performed, and notify Engineer, in writing, of any unsatisfactory conditions. Do not proceed with the roof board insulation work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.
   2. Commencement of the Work shall be understood by Engineer to mean that all conditions are acceptable to the Supplier, Contractor, and installer to provide acceptable Work under this Contract.

F. Preparation
   1. Verify that vapor barrier has been installed on decks, with all joints and penetrations in the vapor barrier sealed using techniques recommended by the vapor barrier supplier to retain full perm rating of the vapor barrier.

G. Coordinate heights of wood blocking and continuous wood sleepers to provide flush transition between roof board insulation and perimeter wood blocking.

H. Extend roof board insulation full thickness as shown over entire surface to be insulated.

I. Cut and fit tightly around obstructions, and fill voids with roof board insulation.

J. Job Conditions
   1. Environmental Requirements
      a. Do not install roof board insulation when weather conditions are such that the deck is not completely dry, there is ice or snow on the deck, or where there is no assurance that the roof board insulation can be completely protected from the weather by the end of the day’s work.
   2. Protection
      a. Do not overload the building structure with the weight of stored materials or use of equipment.
      b. Install temporary water cut offs at the end of each day's work to protect the roof board insulation. Remove the temporary water cut offs upon resumption of the Work.

K. Sequencing
   1. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the roofing membrane over the insulation are at the

Site; are installing the vapor barrier, and are ready to follow with this Work immediately (same day) behind the roof board insulation work.

2. Do not install any more rigid board-type roof board insulation each day than can be covered with complete roofing system by the end of that working day.

L. Board-Type Roof Board Insulation Units: Install rigid board-type roof board insulation according to FM 1-29 Wind Storm Resistance Classification specified, and the roofing warranty requirements as follows:

1. Install wood nailers as required by roofing membrane supplier.
2. Secure roof board insulation to deck using mechanically fasteners specifically designed and sized for fastening specified board-type roof board insulation to deck type shown and in accordance with the requirements of applicable governing authorities having jurisdiction and roofing membrane supplier's warranty recommendations, whichever produces the greatest fastener density.
3. Coat edges of closed cell (non-breathing) units with either adhesive or mastic sealer, and shove into place against installed units so that joints are filled and sealed.
4. Extend roof board insulation full thickness as shown over entire surface of roofs.

M. Performance

1. Roof board insulation work shall withstand the uplift forces of wind, as defined by the roofing warranty.
2. Failures of the roof board insulation work in board or anchorage to the substrate, or between courses of roof board insulation, or within the roof board insulation, will be considered failures of materials or workmanship under the roofing warranty.

N. Protection

1. Do not permit construction traffic over completed insulation work, except as required for roofing.
2. Protect roof board insulation work from exposure to moisture, damage and deterioration, primarily by prompt installation of roofing work to be placed over the roof board insulation.

O. Inspection and Acceptance

1. Roof board insulation which has become wet, damaged, or deteriorated, as determined by Engineer, shall be promptly removed from the Site, even if already installed.
2. Correct all improperly sloped, chipped, cracked, improperly set, ridged or rough areas in the roof board insulation to provide substrate acceptable to roofing supplier and the Engineer.
3. Final Acceptance will be contingent upon the receipt by Engineer of a Job Conditions Report certifying conformance of the Work with the requirements of this Section and which includes all information requested by the Contract Documents.

**END OF SECTION**

SECTION 07 26 00

VAPOR RETARDERS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Reinforced vapor retarders.

B. Tape to seal joints and repair vapor retarder.

C. Pipe boots for sealing penetrations.

### 1.02 RELATED SECTIONS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 06 10 00 - Rough Carpentry.

### 1.03 REFERENCES

A. ASTM International (ASTM):
   1. ASTM D 882 - Tensile Properties of Thin Plastic Sheeting.
   2. ASTM D 1709 - Impact Resistance of Plastic Film by the Free-Falling Dart Method.
   3. ASTM D 2582 - Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting.
   4. ASTM D 3776 - Mass Per Unit Area (Weight) of Woven Fabric.
   5. ASTM D 4833 - Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
   6. ASTM E 84 - Surface Burning Characteristics of Building Materials.
   7. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.
   8. ASTM E 1643 - Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
   9. ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

B. National Fire Protection Association (NFPA): NFPA 701 - Fire Tests for Flame-Resistant Textiles and Films.



### 1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00 - Submittals.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Samples: Submit manufacturer's samples of reinforced vapor retarders.

D. Verification Samples: For each product specified, two samples, minimum size 5 inches (125 mm) square, representing actual product.

## 1.05 PRE-INSTALLATION MEETING:

A. Pre-Installation Meeting: Convene a preinstallation meeting two weeks before start of installation of reinforced vapor retarders. Require attendance of parties directly affecting work of this section, including Contractor, Architect, and installer. Review installation, protection, and coordination with other work.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage:
   1. Store products in manufacturer's unopened packaging until ready for installation.
   2. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Handling: Protect materials during handling and installation to prevent damage.

# PART 2 PRODUCTS

## 2.01 MANUFACTURER

A. Acceptable Manufacturer: Griffolyn, Division of Reef Industries, Inc., which is located at: 9209 Almeda Genoa Rd.; Houston, TX 77075; Toll Free Tel: 800-231-6074; Tel: 713-507-4251; Fax: 713-507-4295; Email:request info (ri@reefindustries.com); Web:https://www.reefindustries.com

B. Or approved equal.

## 2.02 REINFORCED VAPOR RETARDERS

A. Reinforced Vapor Retarder: Griffolyn Type-85; complying with ASTM E 1745 Class B.
   1. Material: 5-ply laminate, combining three layers of high-density polyethylene and two high-strength non-woven cord grids.
   2. Weight: 70 lb/1,000 sq ft (34.2 kg/100 sq m), when tested in accordance with ASTM D 3776.
   3. Puncture Propagation Tear: 55 lb (245 N), when tested in accordance with ASTM D 2582.
   4. Permeance (Perm): 0.027 grains/hr-sq ft-in Hg (1.551 ng/(Pa-s-sq m)), when tested in accordance with ASTM E 96.
   5. Drop Dart: 1,900 g, when tested in accordance with ASTM D 1709.
   6. Tensile Strength: 225 lb/3,846 psi (1000 N/26.6 MPa), when tested in accordance ASTM D 882, 3 inch (76 mm) wide specimen.
   7. Puncture Strength: 50 lb (222 N), when tested in accordance with ASTM D 4833.
   8. Usable Temperature Range: Minus 40 to 170 degrees F (minus 40 to 77 degrees C).
   9. Application(s):
      a. Use on roof decks under insulation.

b. Use on exterior walls on inside face of framing.
c. Use under concrete slabs, over aggregate fill.
d. Use under concrete slabs, under aggregate fill.

## 2.03 ACCESSORIES

A. General: Ensure accessories are from same manufacturer as reinforced vapor retarders.

B. Mastic Tape: Griffolyn Fab Tape. RI Part Number: 60-0002.
1. Description: Black, double-sided, asphaltic, pressure-sensitive, mastic tape.
2. Weight: 3.75 pounds per 100 feet (1.7 kg per 30 m).
3. Thickness: 35 mils (0.9 mm).
4. 3 Inch Seam Shear: 35 pounds (156N).

C. Self-Adhesive Repair Tape: Griffolyn Sealant Tape RI Part Number 60-0153.
1. Description: Reinforced white backing with Gray Adhesive.
2. Weight: 3.0 lbs for 4 inch x 50 foot roll.
3. Thickness: 26 mils (0.65 mm).
4. 3-inch Seam Shear: 30 lbs (134 N)

D. Fire Retardant Self-Adhesive Tape: Griff Tape FR RI Part Number 60-0151.
1. Description: White backed adhesive tape.
2. Weight: 3.75 lbs per roll, 4 inches x 180 feet long.
3. Thickness: 5 mils(0.125 mm).
4. Adhesion to Steel: 66 oz/in (18 N/in).

E. Pipe Boots: Griffolyn pipe boots, factory-fabricated.

F. Batten Strips: Manufacturer's standard for required application.

G. Fasteners: Manufacturer's standard for required application.



# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Examine surfaces and areas to receive reinforced vapor retarders. Notify Architect in writing of defects of work and other unsatisfactory site conditions that would cause defective installation of vapor retarders. Do not begin installation until unacceptable conditions have been corrected.

B. Verify site dimensions.

C. Commencement of work will imply acceptance of substrate.

## 3.02 INSTALLATION

A. Install reinforced vapor retarders in accordance with manufacturer's instructions.

B. Install reinforced vapor retarders in accordance with manufacturer's instructions and ASTM E 1643 at concrete slabs.

C. Install vapor retarders continuously at locations as indicated on the drawings. Ensure there are no discontinuities in vapor retarder at seams and penetrations.

D. Install vapor retarders in largest practical widths.

E. Ensure surface beneath vapor retarder is smooth with no sharp projections.

F. Join sections of vapor retarder and seal penetrations in vapor retarder with mastic tape. Ensure vapor retarder surfaces to receive mastic tape are clean and dry.

G. Immediately repair holes in vapor retarder with self-adhesive repair tape.

H. Seal around pipes and other penetrations in vapor retarder with pipe boots in accordance with manufacturer's instructions.

## 3.03 PROTECTION

A. Protect reinforced vapor retarders from damage until covered by roof insulation.

B. Protect reinforced vapor retarders from damage until covered by wall finish.

C. Protect reinforced vapor retarders from damage during installation of reinforcing steel and utilities and during placement of granular materials or concrete slab.

D. Immediately repair damaged vapor retarder in accordance with manufacturer's instructions.

**END OF SECTION**

SECTION 07 51 00

BUILT-UP BITUMINOUS ROOFING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies built-up bituminous roofing with aggregate surfacing.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 06 10 00 Rough Carpentry
   2. Section 07 22 16 Roof Board Insulation
   3. Section 07 62 00 Sheet Metal Flashing and Trim
   4. Section 07 71 00 Roof Specialties

### 1.03 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.



| Reference | Title |
|---|---|
| ASTM D41 | Asphalt Primer used in Roofing, Dampproofing, and Waterproofing |
| ASTM D312 | Asphalt Used in Roofing |
| ASTM D1863 | Mineral Aggregate Used on Built-Up Roofs |
| ASTM D2178 | Asphalt Glass Felt Used in Roofing and Waterproofing |
| ASTM D2822 | Asphalt Roof Cement |
| ASTM D3617 | Sampling and Analysis of New Built-Up Roof Membranes |
| ASTM D3672 | Venting Asphalt-Saturated and Coated Inorganic Felt Base Sheet Used in Roofing |
| FM Global Loss Prevention Data Sheets | 1-28, Wind Loads to Roof Systems and Roof Deck Securement |

| Reference | Title |
|---|---|
| FM Global Loss Prevention Data Sheets | 1-29, Above-Deck Roof Components |
| FM Global Loss Prevention Data Sheets | 1-28R and 1-29R, Roof Systems |
| FM Global Loss Prevention Data Sheets | 1-49, Perimeter Flashing |
| FM Approvals 4470 | Class 1 Roof Covers |
| FM Global | Research Technical Reports |
| UL 790 | Tests for Fire Resistance of Roof Covering Materials; Class A |
| UL BMD | Building Materials Directory |
| AHJ Adopted Building Codes | |

B. Qualification of Installer:
   1. Engage a single installer skilled, trained and with successful experience in the installation of the type of EPDM system specified, who is a recognized roofing installer with specific skill and successful experience in the type of roofing specified in this Section, and equipped to perform workmanship in accordance with the Contract Documents, manufacturer's written instructions for guaranteed construction and the approved Shop Drawings and who agrees to employ only tradesmen with specific skill and successful experience in this type of work. Submit names and qualifications to the Engineer along with the following information on a minimum of three successful projects:
      a. Names and telephone numbers of owners, architects, or Design-Engineers responsible for projects.
      b. Approximate contract cost of the Built-up Bituminous roofing.
      c. Amount of area installed.
   2. The roofing installer shall be an approved roofing applicator who has qualified for appointment and has been trained by the Manufacturer.
   3. Submit proof of acceptability of installer by the Manufacturer to Engineer.

C. Qualifications of Manufacturer
   1. The Manufacturer shall have ten (10) years of experience manufacturing Built-up Bituminous roofing in similar-sized projects.

D. Material Certifications:
   1. Certificates shall be provided from the manufacturer certifying that materials provided conform to all requirements specified herein, and are chemically and physically compatible with each other and are suitable for inclusion within the total roof system specified herein.

E. Warranty for Built-Up Roofing:
   1. A manufacturer's warranty shall be furnished for the roofing system. The warranty shall provide, but not be limited to the following:
      a. The warranty shall be issued directly to the Owner.
      b. The warranty period shall be not less than 20 years from the date of acceptance of the work.

c. The warranty shall cover the overall performance of the system including membrane flashing and the certification that all materials have been installed in accordance with the drawings and specifications.

## 1.04 ENVIRONMENTAL CONDITIONS

A. Product in this Section shall be subjected to environmental conditions in accordance with Section 01 11 80 Environmental Conditions.

B. Do not apply roofing membrane during inclement weather

C. Do not apply roofing membrane to damp or frozen deck surfaces

D. Do no expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during the same day

## 1.05 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Shop Drawings. Submit the following:
    a. Copy of drawings completely dimensioned using field-verified dimensions on plans of each roof area and the accurate location of all roof penetrations roof mounted equipment, curbs, skylights and other features present on the roof areas specified by Engineer to be included under the Work of this Section and all details of construction and erection, including all flashing details coordinated with referenced specification sections under section 1.02, and FM Publications specified, and the location of all walkway pad patterns required by the Manufacturer for warranted construction and as shown. Contractor shall submit all details requiring consideration and the performance of the details shall be approved by the built-up roofing manufacturer for guaranteed construction as specified.
3. Product Data
    a. Manufacturer's specifications and product manuals indicating product information correlated to specified requirements, Manufacturer's installation instructions, maintenance instructions and other data as may be required by Engineer.

b. Copies of the FM Global Loss Prevention Data Sheets and appropriate FM Global Research Technical Reports, indicating compliance with wind uplift pressure-resistant performance criteria, and the requirements for FM Approved 1-90 system construction and perimeter securement conditions.

4. Certificates
   a. Contractor's Review: Accompanying approval request, submit to Engineer a written statement signed by the Contractor, stating that the Contract Documents for roofing, insulation, and flashing have been reviewed with an agent of the roofing material manufacturer and that they are in agreement that the selected systems are proper, compatible and that the details shown are not in conflict with the roofing manufacturer's roofing, insulation, and flashing details. Show by copy of transmittal form that a copy of the statement has been transmitted to the Manufacturer.
   b. Statement of Application: Upon completion of the Work, submit a statement to Engineer signed by the Contractor stating that the Work complies with the requirements of these Specifications and the installation methods comply with the Manufacturer's printed instructions and were proper and adequate for the condition of installation and use.
5. Samples
   a. 12-inch by 12-inch sheet of each item specified and 6-inch-long pieces of each required system component to be used in the Work.
   b. Each fastener type required marked as to type of material and with their intended purpose in the Work.
   c. All components of the built-up roofing and flashing labeled with their intended use in the Work. Compliance with all other requirements is exclusive responsibility of the Contractor.
   d. Color samples of cap sheet.
6. Evidence of Installer qualifications as specified in paragraph 1.03 Qualification of Installer.
7. Evidence of manufacturer qualifications as specified in paragraph 1.03 Qualification of Manufacturer.
8. Material certifications as specified in paragraph 1.03 Material Certifications.
9. Copy of warranty as specified in paragraph 1.03 Warranty for Built Up Roofing.
10. Operation and maintenance information in accordance with Section 01 77 30 Operating and Maintenance Instructions.



## 1.06 PREROOFING CONFERENCE

A. Prior to the installation of the Built-Up Bituminous roofing and associated work, the Contractor shall schedule and meet at the Site with the roofing installer, the installer of each component of associated work, the installers of deck and insulation to receive roofing work, the installers of other work in and around roofing which must follow the roofing work, including mechanical work, Engineer and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the Built-Up Bituminous roofing work, including but not necessarily limited to, the following:
   1. Review project requirements, including Contract Documents.
   2. Review required submittals, both completed and yet to be completed.

3. Review status of substrate including drying, structural loading limitations and similar considerations.
4. Review availability of materials, tradesmen, equipment, and facilities required to make progress and avoid delays.
5. Review required inspection, testing, certifying, and accounting procedures.
6. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
7. Review regulations concerning code compliance, FM compliance, environmental protection, health, safety, fire, and similar considerations.
8. Review procedures required for protection of roofing during the remainder of the Work.

## 1.07 DELIVERY, STORAGE AND HANDLING

A. Manufactured roofing materials shall be delivered in manufacturers' original unopened containers and rolls with labels intact and legible. Where materials are covered by a referenced specification, the containers shall bear the specification number, type, and class as applicable. Materials shall be delivered in sufficient quantity to allow continuity of work. Roll materials shall be handled to prevent damage to edges and ends, and shall be protected against wetting and moisture absorption; they shall be stored on pallets and covered with canvas tarpaulins to keep them clean and dry. Polyethylene covering is not an acceptable method of protecting materials. Materials temporarily stored on the roof shall be located in approved areas and shall be distributed to stay within the indicated live load limits of the roof construction.



## 1.08 PROTECTION OF PROPERTY

A. Flame heated equipment shall be located and used so as not to endanger the structure or other materials on the site or adjacent property. Flame heated equipment shall not be placed on the roof or any structure.

B. Protective coverings shall be provided at all paving and building walls adjacent to hoist and kettles, prior to starting the work. Protective coverings shall be lapped at least 6 inches, shall be secured against wind, and shall be vented to prevent collection of moisture on covered surfaces. Protective coverings shall remain in place for the duration of the roofing work.

# PART 2 PRODUCTS

## 2.01 ACCEPTABLE MANUFACTURERS

A. The Engineer believes that the Manufacturers indicated in this Section are capable of producing equipment and products, which will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular Manufacturer or product, nor shall it be construed that a named Manufacturer’s standard product will comply with the requirements of this Section.
   1. The Garland Company
   2. Soprema
   3. Tremco Roofing
   4. Or Approved Equal

## 2.02 ROOFING SYSTEM

A. Unless otherwise specified, roofing systems shall be as follows:
   1. Type A:
      a. Four ply, hot asphalt applied modified bitumen membrane system with mineral granule surface cap sheet as the fourth ply
      b. Provide manufacturer's recommended high density fiberboard, 1/2 inches thick, above insulation where required by the Contract Documents or where required by the manufacturer to meet design requirements.
      c. Provide vapor barrier.

## 2.03 MATERIALS

A. Asphalt Bitumen:

| | |
|---|---|
| Roof slope, in/ft | ¼" per foot |
| Specification | ASTM D312 |
| Type | Type IV |

   1. Each container of asphalt shall be plainly marked with the flash point (FP), equiviscous temperature (EVT) and finished blowing temperature (FBT).

B. Felts:
   1. Felts for built-up bituminous roofing and flashing shall conform to specifications and requirements listed in the following table:

| Designation | Use | Felt | Impregnant | Coating | Specification |
|---|---|---|---|---|---|
| GB | Base/Ply Felt | Glass – 3 Ply | Asphalt | Asphalt | ASTM D2178, Type VI, UL TYPE G1 BUR |
| GA | Cap Felt | Premium-Fire Retarding Glass | Asphalt | Aggregate | ASTM D6162, Type III, 140 mils min. thickness, 400 lbs tensile/tear strength (ASTM D5147) |
| FF | Flashing Felt | Glass | Asphalt | Asphalt | -- |

*Notes:*

1. *Glass base sheet shall be an asphalt impregnated glass mat consisting of uniformly distributed monofilament type glass fibers with glass textile yarn reinforcing and specifically manufactured for use as a base sheet for built-up roofs. The base sheet shall be coated with asphalt on both sides.*
2. *Flashing felt shall be of a type specifically prepared in the manufacturing process for use in two-ply base flashing construction and shall be one of two types: a single thickness of glass felt conforming to the properties listed in ASTM D2178 for Type IV, or glass felt factory-laminated to a woven glass fiber scrim or cotton fabric. Both types of flashing construction shall be factory-coated on both sides with an asphaltic coating which may include a fine mineral stabilizer insoluble in water and fine mineral surfacing.*

C. Asphalt Primer:
   1. Asphalt primer shall conform to ASTM D41.

D. Asphalt Roof Cement:
   1. Asphalt roof cement shall be asbestos free, meeting the requirements of ASTM D2822; Type I for horizontal surfaces, or Type II for vertical surfaces and built-up bituminous base flashings.

E. Aggregates:
   1. Aggregates for surfacing built-up roofings shall be light colored, water- worn gravel, crushed stone, crushed slag, all conforming to ASTM D1863; or marble, expanded slag, or expanded shale, all conforming to ASTM D1863 except that density shall not be less than 55 lb/cu ft. Aggregate shall be opaque.

F. Fasteners:
   1. General:
      a. Fasteners shall be non-ferrous metal or galvanized steel, except that hard copper nails shall be used for copper items; aluminum or stainless steel nails shall be used for aluminum items; and stainless steel nails shall be used for stainless steel items. For roofing felts, fasteners shall be flush-driven through flat metal discs of zinc-coated sheet metal not lighter than 28 gage and not less than 3/8 inch in diameter. Discs shall be formed to prevent dishing. Bell or cup-shaped caps are not acceptable. Metal discs may be omitted when one-piece composite fasteners with heads not less than 1 inch in diameter or 1-inch square with rounded or tapered corners are used.
      b. Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.
   2. Wood Fasteners:
      a. Fasteners for securing felts and metal items to wood nailers or wood or plywood substrates shall be 11 gauge annular threaded shank nails with 7/16 to 5/8-inch diameter heads; or one-piece composite nails with annular threaded shanks not less than 11 gage. Fasteners shall be long enough to penetrate the nailer not less than 1 inch; the wood substrate not less than 5/8 inch, and plywood substrate 3/8 to 7/16 inch, but not to protrude through the underside of the deck.
   3. Gypsum and Concrete Fasteners:
      a. Fasteners for securing felts to cast-in-place gypsum and lightweight insulating concrete substrates shall be special self-clinching fasteners of a type approved by the substrate material manufacturer having a resistance to pull out of not less than 40 pounds.
   4. Masonry or Concrete Wall Fasteners:
      a. Fasteners for securing felts and metal items to masonry or concrete walls and vertical surfaces shall be hardened steel nails with flat heads, diamond shaped points, and mechanically deformed shanks not less than one inch long.

G. Pressure Relieving Vents: Plastic or Metal one-way valves. Provide vents in accordance with manufacturer's recommendations.

H. Roof Insulation
   1. Refer to Section 07 22 16 Roof Board Insulation.

I. Substrate Board
   1. Provide manufacturer’s recommended high density fiberboard, 1/2 inches thick, above insulation where required by the Contract Documents or where required by the manufacturer to meet design requirements.

2. ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2-inch thick.

J. Vapor Retarder:
   1. Polyethylene Film: ASTM D 4397, 6 mils thick, minimum, with maximum permeance rating of 0.13 perm
   2. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

## 2.04 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Certificates specified in paragraph 1.03 Material Certification.
   2. Warranty specified in paragraph 1.03 Warranty for Built-Up Roofing.

# PART 3 EXECUTION

## 3.01 CONDITION OF SURFACES

A. The Contractor shall ensure that the following conditions exist prior to application of the roofing materials:
   1. Drains, scuppers, curbs, cants, expansion joints, perimeter walls, roof penetrating components, and equipment supports are in place.
   2. Surfaces are rigid, dry, smooth, and free from cracks, holes, and sharp changes in elevation. Joints in deck substrate are suitably sealed to prevent drippage of bitumen into building or down exterior walls.
   3. The plane of the substrate does not vary more than 1/4 inch within an area 10 feet by 10 feet when checked with a 10-foot straight edge placed anywhere on the substrate in any direction.
   4. Substrate is sloped as indicated to provide drainage.
   5. Walls and vertical surfaces are constructed to receive counterflashing, and treated wood nailers are in place to permit nailing of the base flashing at a minimum finish height of 8 inches above the finished roofing membrane surface.
   6. Treated wood nailers are securely fastened in place at eaves, gable ends, openings, and intersections with vertical surfaces for securing of felts, edging strips, gravel stops, and roof fixtures.
   7. Cants are securely fastened in place in the angles formed by walls and other vertical surfaces. The angle of the cant is 45 degrees and the vertical height is not less than 4 inches.
   8. Insulation boards are installed smooth and even and are not broken, cracked, or curled.

## 3.02 PREPARATION

A. General:
   1. Contractor shall coordinate the work with that of other trades to assure that components which are to be secured to or stripped into the roofing system are available and that flashing and counterflashing is installed as the work progresses.

B. Priming of Surfaces:
   1. Surfaces shall be primed at the rate of 0.75 gallons per 100 square feet.
   2. Flanges of metal gravel stops, edging strips, flashing collars and accessories shall be primed with asphalt roof cement prior to stripping into the roofing system.
   3. Concrete or masonry surfaces which are to receive base flashing shall be coated uniformly with primer. Primer shall be allowed to dry thoroughly prior to application of the roofing and flashing materials.

C. Heating of Bitumen:
   1. Solid bitumen shall be broken up on a surface free of dirt and debris and heated in a kettle designed to prevent contact of flame with surfaces in contact with the bitumen. Each kettle shall have a visible thermometer and thermostatic controls set to the temperature limits specified herein. Controls shall be maintained in working order and calibrated. A use immersion thermometer accurate to "plus or minus 2 degrees F" shall be used to check temperatures of the bitumen frequently. If temperatures exceed maximums specified, the bitumen shall be removed from the site. Upon determination that the temperature of the bitumen at the instant of application is below the minimum specified, the affected roofing shall be removed and replaced with new material. Cutting back, adulterating, or fluxing of bitumen is not permitted.

## 3.03 APPLICATION

A. General:
   1. Contractor shall (1) apply roofing materials as specified unless specified or recommended otherwise by the materials manufacturer's printed application instructions and the differences noted and approved; and (2) apply only as much roofing in one day as can be protected the same day.
   2. Contractor will not be permitted to apply roofing materials during inclement weather or when air temperature is below 40 degrees F, or when there is ice, frost, surface moisture, or visible dampness on the roof deck.

B. Bitumen Stops:
   1. Bitumen stops shall be provided at roof edges, openings, and at vertical projections prior to application of the felts. Bitumen stops shall be formed with two 12-inch-wide strips of plying felt. Strips shall be laminated with, and set into, a coating of asphalt roof cement with one half of the width overhanging the edge of the roof or opening. Where nailers are provided, the strips shall be nailed with roofing nails in addition to embedding in asphalt roof cement. After the plies of felt are in place, the free portion of the strips shall be folded back over the roofing membrane, embedded in a continuous coating of asphalt roof cement, and where nailers are present, secured with roofing nails.

C. Felts:
   1. Mechanically fastened base felts shall be applied.
   2. Plying felts shall be applied shingle fashion in hot moppings of bitumen and back-nailed where specified. Starter sheets of felt shall be provided to maintain the specified number of felt plies throughout the roofing. The application of all plies of roofing felts, excluding surfacing, shall be completed in one continuous operation. Felts shall be applied with side laps in accordance with the materials manufacturer's

printed instructions; end laps shall be not less than 6 inches and staggered a minimum of 36 inches. Unless otherwise specified, felts shall be applied at right angles to the roof slope so that the direction of flow of water is over and not against the laps. Felts shall extend 2 inches above the tops of cant strips at vertical surfaces and to the tops of cant strips elsewhere. Felts shall be trimmed to a neat fit around vent pipes, roof drains, and other projections through the roof.

3. In addition to hot-mopping of plying felts with hot bitumen, back-nail felts in accordance with standards and manufacturer recommendations.

D. Hot-Mopping:

1. The felts shall be applied immediately following the application of the hot asphalt. Working ahead with the asphalt is not permitted. The asphalt shall be completely fluid, with mop temperatures within the specified EVT range, at the instant the felts come into contact with the asphalt. Application of asphalt between felts shall be such as to provide voidless coverage and complete penetration of asphalt into the felt above and below.
2. Asphalt shall be heated and applied at the temperatures specified below unless otherwise specified by the manufacturer. Asphalt shall not be heated above its finished blowing temperature (FBT) for longer than 4 consecutive hours, and shall not be heated to the flash point (FP). Asphalt shall be applied and roofing felts embedded when the temperature of the asphalt is within plus or minus 25 degrees F of the equiviscous temperature (EVT).

E. Flashing:

1. General:
   a. Built-up bituminous flashing shall be provided in the angles formed where the roof deck abuts walls, curbs, ventilators, pipes, and other vertical surfaces, and where necessary to make the work watertight. Flashing shall be installed after all plies of felt have been applied but before the top surfacing is applied. Metal flashings are specified under Section 07 62 00.
   b. Install one pressure relief vent per 1,000 square feet or part thereof, or roof surface.
2. Base Flashing:
   a. Unless otherwise specified, base flashing shall consist of one ply of plying felt used in the roofing membrane and one ply of flashing felt embedded in flashing cement, or hot mopped, in accordance with approved manufacturer's installation instructions.
3. Strip Flashing:
   a. Flanges of sheet metal work to be incorporated into the roofing system shall be set into a uniform coating of asphalt roof cement and stripped-in with two layers of plying felt cemented to the tops of the flanges, roofing membrane, and to each other with coatings of asphalt roof cement. The felts shall be extended 3 and 6 inches, respectively, beyond the edges of the flanges and onto the roofing membrane. Finished strip flashing shall be coated with asphalt roof cement.

F. Aggregate Surfacing:

1. Surfacing materials shall be applied after felt flashings, tests, repairs, and corrective actions have been completed and approved. Aggregate shall be uniformly embedded

in a flood coat of hot asphalt. Loose aggregate shall be swept up and removed from the roof.

## 3.04 WALKWAYS

A. Mineral-surfaced asphalt plank or granular surfaced treads shall be provided for access to mechanical equipment and for all traffic areas, where specified. Asphalt planks or treads shall be installed on top of the completed aggregate surfacing after loose aggregate has been swept clear of the area in a hot-mopping of Type III asphalt, applied at the rate of 25 pounds per 100 square feet. A space 6 inches wide shall be provided between adjacent planks for drainage. Provide walkways from point of access to roof installed equipment and at each side of roof installed equipment.

## 3.05 FIELD TESTS

A. After application of the specified roofing felts and prior to applying surfacing, field samples of built-up roofing shall be taken from the deck in the presence of the Construction Manager. The Construction Manager will inspect the sample for specified number of plies, lap widths, evenness of application of bitumen, bond between plies, skips or voids in the interply moppings, presence of harmful foreign materials, visible presence of moisture in the sandwich, and wet insulation. Samples (4-inch by 40-inch) shall be taken in accordance with ASTM D3617 and cut across laps in felts in a manner to expose the specified number of plies. The 4-inch edge shall coincide with an edge lap of felt and shall not be positioned over an end lap. Areas where samples are to be taken shall be selected by the Construction Manager immediately prior to cutting. Roofing will not be permitted to proceed until all deficiencies disclosed as a result of "cut tests" have been corrected and approved.

B. Not less than two samples shall be taken from each 100 squares of roofed area, and at least one sample shall be taken from each day's application, regardless of the quantity applied. If the samples taken show any deficiency, no matter how slight, additional samples will be required in order to determine the extent of the deficiency.

C. Where interply moppings are too light, deficient areas shall have an additional ply of felt applied in a full mopping of bitumen. Felt shall be applied with 4-inch side and end laps. Where free water, or any voids, skips or any delamination whatsoever, is discovered between the plies, the affected area shall be removed and rebuilt in dry conditions. Where insulation is found to be wet, the insulation shall be removed and new built-up roofing and insulation shall be provided.

D. Immediately after inspection, the cut-out sample shall be replaced. Should it become impossible to immediately replace the cut-out sample in the roof, a new section of equivalent size and structure shall be substituted.

E. The area over replaced samples shall then be covered with 4 plies of ply felt, hot-mopped in place with the first ply overlapping the cutout area 3 inches on all sides and each succeeding ply overlapping the previous ply 3 inches on all sides.

**END OF SECTION**

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SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install sheet metal flashing and trim.
   2. The Work also includes:
      a. Providing openings in sheet metal flashing and trim to accommodate the Work under this and other Sections and building into the sheet metal flashing and trim all items such as sleeves, anchor bolts, inserts and all other items to be embedded in sheet metal flashing and trim for which placement is not specifically provided under other Sections.
   3. Types of products required include the following:
      a. Stainless steel sheet flashing.
      b. Lead sheet flashing.
      c. Cast-in-Place and Surface-mounted reglets and counterflashing.
      d. Formed metal coping.
      e. Miscellaneous flashing not supplied under other Sections.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the sheet metal flashing and trim Work.
   2. Work advanced without sheet metal flashing and trim items that are specified to be cast-in-place or built-in-place as the Work advances, shall be stopped, demolished and rebuilt incorporating specified sheet metal flashing and trim Work, at no additional cost to Owner.



### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 04 20 00 Unit Masonry
   2. Section 07 92 00 Joint Sealants

### 1.03 REFERENCES

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. The references listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if

there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version reference by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. When document dates are given in the following listing that are not specifically referenced in an applicable code, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. For questions, refer to Engineer.

| Reference | Title |
|---|---|
| ASTM A 666 | Specification for Annealed or Cold-Worked Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar |
| ASTM B 29 | Specification for Refined Lead |
| ASTM B 32 | Specification for Solder Metal |
| ASTM B 749 | Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products |
| ASTM D 4586 | Specification for Asphalt Roof Cement, Asbestos-Free |
| FM Global | Loss Prevention Data for Roofing Contractors, 1-49 - Perimeter Flashing |
| NRCA | Low-Slope Membrane Roofing Construction Details Manual |
| SMACNA 1013 | Architectural Sheet Metal Manual |
| SSPC | Paint 12, Cold Applied Asphalt Mastic (Extra Thick Film) |



## 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Shop Drawings:
      a. Drawings showing the manner of forming, jointing and securing flashings and trim. Show fully dimensioned joint details and waterproof connections to adjoining Work and details at obstructions and penetrations.

b. Drawings showing the coordination. Provide detailed Shop Drawings showing large scale details of sections and profiles of all sheet metal flashing and trim to be used in the Work, with all items, including fastener locations, cleats and other miscellaneous accessories necessary to complete the Work, fully dimensioned, properly located, quantified and presented such that sequence of installation is acceptable to each roofing system and adjacent construction material installer.

1) Samples:

a) 12-inch square samples of specified sheet metal flashing and trim metals.

2) Product Data:

a) Copies of manufacturer's specifications, installation instructions and general recommendations for sheet metal flashing and trim required. Include manufacturer's data substantiating that the materials comply with the requirements.

B. Informational Submittals:

1. Procedures: Section 01 33 00.
2. Manufacturers' certificates of compliance with specified industry standards.
3. Manufacturer's Instructions: Manufacturer's installation instructions. Indicate by copy of transmittal form that installer has received copy of manufacturer's installation instructions.



## 1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage a single installer who is a recognized flashing and trim installer, skilled and experienced in the type of flashing and trim Work required and equipped to perform workmanship in accordance with recognized standards so that there will be undivided responsibility for the performance of the Work. Submit name and qualifications to Engineer along with at least three successfully completed Projects including names and telephone numbers of owners, architects and engineers, responsible for the project and the approximate contract price for flashing and trim work.

B. Source Quality Control:

1. Except as otherwise shown, comply with recommendations of the roofing manufacturer concerning the installation of flashing and trim that affects the roofing bond or warranty.

## 1.06 DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:

1. Deliver sheet metal flashing and trim materials in manufacturer's original, unopened, and undamaged containers and rolls, with labels intact and legible, indicating compliance with approved Shop Drawings.
2. Items delivered in broken, damaged, rusted, or unlabeled condition shall immediately be removed from Site and not offered again for approval by the Owner/ Engineer.

B. Storage of Materials:
   1. Store materials in an area undercover and protected from construction traffic.
   2. Store materials in same package in which they were shipped, off the ground and on platforms protected from dirt and other contamination.
   3. Store in a manner which does not permit water to remain on sheet metal flashing and trim materials and system components.

C. Handling of Materials:
   1. Protect sheet metal flashing and trim from dents, scratches, warps and bends.
   2. Remove strippable protective film, immediately proceeding installation of each system component.

## 1.07 JOB CONDITIONS

A. Scheduling:
   1. Do not proceed with sheet metal flashing and trim Work until curb and substrate construction, cant strips, blocking, reglets and other construction to receive the Work is completed.
   2. Deliver materials to the Site in sufficient quantities to ensure uninterrupted progress of the Work.
   3. Schedule the installation of sheet metal flashing and trim to coincide with the installation of roofing, waterproofing, drains, piping, blocking, nailers, reglets, framing at openings, curbs, parapets and other adjoining and substrate Work.
   4. Proceed with and complete the Work only when materials, equipment and knowledgeable tradesmen, required for the installation of sheet metal flashing and trim, are at the Site and are ready to follow, and integrate sheet metal flashing and trim Work with roofing Work, in order to maintain watertight conditions.



## 1.08 WARRANTY

A. Provide reglet and counterflashing manufacturer's five-year warranty against defects and workmanship.

# PART 2 PRODUCTS

## 2.01 SYSTEM PERFORMANCE

A. Performance Criteria:
   1. Sheet metal flashing and trim shall be permanently watertight, and not deteriorate in excess of manufacturer's published limitations.
   2. Comply with fabrication details recommended by FM, SMACNA, NRCA and the requirements of the sheet metal flashing and trim manufacturer, and as shown on approved Shop Drawings.

## 2.02 MATERIALS

A. Sheet Metal Flashing and Trim:
   1. Stainless Steel Sheet metal flashing and trim: Provide 26 gage sheet stainless steel, Type 316, complying with ASTM A 666, with No. 2D dead soft, fully annealed finish,

unless required to be harder temper for proper forming and performance for application indicated.

2. Lead Sheet metal flashing and trim: Provide sheet formed from common desilverized pig lead complying with ASTM B 29 and ASTM B 749; weighing 6.0 pounds per square foot.

B. Embedded Sheet Flashing:
   1. Refer to Section 04 20 00 Unit Masonry.

C. Flashing Reglets:
   1. General:
      a. Provide snap-lock type reglets of Type 304 stainless steel, 0.020-inches minimum thickness.
      b. Provide reglets that engage counterflashing by use of a snap-lock or spring-lock profile. System shall employ only mechanical interlocking features for securing counterflashing in reglet, without the need for clips or screws.
      c. Provide manufacturer's standard Type 304 stainless steel spring-lock profile flashing, 5-1/8-inches high, designed to incorporate a positive air break and to engage spring-lock reglet flange.
      d. Provide reglets with 1-inch end laps and spring-lock flashing with 3-inch end laps.
   2. Built-In-Place Masonry Reglets: Provide built-in-place reglets for masonry installation with top flange 4-inches wide to penetrate the first wythe of brick.
      a. Provide reglets without exposed fasteners of any kind. Provide engagement flange 1-1/8-inch high by 1/2-inch wide with snap-lock profile designed to pressure-lock counterflashing in place.
      b. Products and Manufacturers: Provide one of the following:
         1) Type MA-4 Masonry Reglet by Fry Reglet Corporation.
         2) or approved equal.

D. Formed Metal Coping, Caps and Trim: Provide smooth sheet of 16-gage, 5005-H134 aluminum alloy, complying with the following:
   1. Provide coping and cap flashings, sized as shown, that provides for independent mounting and full expansion and contraction over prefabricated 6-inch wide aluminum retainers, compression clips mounted 12 feet - 0 inches on centers, and 2-inch wide aluminum retainer plates with single compression pad mounted between dual compression clips.
   2. Provide system that incorporates a gutter bar with dual compression gaskets at each joint to drain water.
   3. System shall not incorporate exposed sealants.
   4. Provide internal face line-up splices at all joints.
   5. All coping and cap flashings shall have all corners mitered and continuously heliarc welded watertight prior to shop-painting. Exposed mechanical fasteners, blind rivets and similar methods are not approved for the Work. Reinforce metal at welds as may be required to provide welded seams.
   6. Concealed fasteners splice plates and neoprene compression pads shall be as recommended by the manufacturer.

7. Products and Manufacturers: Provide one of the following:
   a. Gutter Splice System TITE-LOC Coping by Peterson Aluminum Corporation.
   b. PAC-CLAD Industrial Downspouts by Peterson Aluminum Corporation.
   c. or approved equal.

E. Miscellaneous Materials:
   1. Burning Rod for Lead: Same composition as lead sheet.
   2. Solder for Stainless Steel: ASTM B 32, 60 percent tin and 40 percent lead alloy grade 60A, used with an acid flux of the type recommended by the stainless steel manufacturer. Use a non-corrosive rosin flux over tinned surfaces.
   3. Stainless Welding Rods: Type recommended by stainless steel sheet manufacturer for the type of metal sheets furnished.
   4. Nails, Screws and Rivets: Same material as flashing sheet, or as recommended by manufacturer of flashing sheet.
   5. Cleats: Same metal and gage as sheet being anchored, 2 inches wide, punched for two anchors.
   6. Bituminous Coating: SSPC-Paint 12, cold-applied solvent-type bituminous mastic coating for application in dry film thickness of 15 mils per coat.
   7. Sealants: Refer to Section 07920, Joint Sealants.
   8. Roofing Cement: Provide a medium to heavy trowel-grade, cut-back asphalt mastic roof cement reinforced with non-asbestos fibers, and containing petroleum solvents and special mineral stabilizers, complying with ASTM D 4586, Type II.
   9. Base Flashing Felts: Asphalt-coated, polyester/glass scrim reinforced flashing sheet or as recommended by the manufacturer of the built-up bituminous roofing.



## 2.03 COMPONENTS (NOT USED)

## 2.04 VENDOR CONTROL PANELS (NOT USED)

## 2.05 FABRICATION

A. Fabricated Metal Flashing: Shop-fabricate metal sheet metal flashing and trim to comply with profiles and sizes shown, and to comply with manufacturer's recommended details. Except as otherwise shown or specified, provide soldered flat-lock seams, and fold back metal to form a hem on the concealed side of exposed edges. Comply with metal producers' recommendations for tinning, soldering and cleaning flux from metal.

B. Where fabricator does not recommend grinding welds smooth, comply with SMACNA formed metal details requiring double lock seamed construction.

# PART 3 EXECUTION

## 3.01 INSPECTION

A. Examine the substrate and the conditions under which the sheet metal flashing and trim Work is to be performed, and notify Engineer, in writing, of unsatisfactory conditions. Do not proceed with sheet metal flashing and trim Work until unsatisfactory conditions have been corrected in a manner acceptable to the Owner/ Engineer.

## 3.02 PREPARATION

A. Before installing sheet metal flashing and trim, verify shapes, and dimensions to be covered.

B. Prepare substrates as recommended by the sheet metal manufacturer.

## 3.03 INSTALLATION

A. General:

1. Separate dissimilar metals from each other by painting each metal surface in the area of contact with a heavy application of bituminous coating, or by other permanent separation as recommended by the manufacturers of the dissimilar metals. Comply with the following:
    a. Separate stainless steel from dissimilar metals, including regular steel and iron, and from cementitious materials by a course of roofing felt wherever possible. Where felt application is not possible, coat the stainless steel or the other material with a 15-mil bituminous coating. Where felt is applied under sheets which will be soldered or welded, cover felt with a course of building paper before installing stainless steel. Comply with manufacturer's recommendations for other forms of protection of the stainless steel against corrosion.
2. Provide thermal expansion for running trim, flashing, valleys, and other items exposed for more than 15 feet-0 inches continuous length. Maintain a watertight installation at expansion seams. Locate expansion seams as shown or, if not shown, at the following maximum spacing for each general flashing use:
    a. Valleys: Midway between drains (at high points in slopes), but in no case more than 30 feet-0 inches apart, except as otherwise shown.
    b. Sheet metal flashing and trim: At 10 feet-0 inch intervals and 2 feet-0 inch each side of corners and intersections.
3. Fabricate and install Work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat flat-locked seams with minimum exposure of solder, welds and sealant. Except as otherwise shown, fold back the sheet metal to form a hem on the concealed side of exposed edges. All exposed edges of all sheet metal flashing shall be hemmed not less than 1/2-inch wide.
4. Conceal fasteners and expansion provisions wherever possible in exposed Work, and locate so as to minimize the possibility of leakage. Cover and seal Work as required for a watertight installation.
    a. Provide cleat-type anchorages for metal flashings and trim wherever practical, arranged to relieve stresses from building movement, and thermal expansion and contraction.
5. On vertical surfaces lap two-piece flashings a minimum of 4-inches.
6. On sloping surfaces, for slopes of not less than 6-inches in 12-inches, lap unsealed flashings a minimum of 6-inches. For slopes less than 6-inches in 12-inches use soldered flat locked seams.
7. For embedment of metal flashing flanges in roofing or composition flashing or stripping, extend flanges for a minimum of 4-inches embedment.

B. Installation of Stainless Steel Sheet Metal Flashing and Trim:

1. Tin the edges of plain stainless steel to be soldered, for a width of 1-1/2-inches, using solder for stainless steel and acid flux. Remove every trace of acid flux residue from the metal promptly after tinning or soldering.
2. Where welded joints are shown, provide upturned, 1/2-inch wide hooked flanges, and weld between adjoining sheets; lay seam flat.

C. Installation of Lead Sheet Metal Flashing and Trim:

1. Where prefabricated units of lead flashing are to be set in felts the underside may be coated with roofing cement.
2. Cut and shape lead sheets in place with minimum of 1-inch lapped joints, and form bends and folds to provide corners and intersections as shown. Shave or wire-brush joint areas immediately before sealing joint.
3. Burn joints in lead sheets to provide true welded construction, exercising care to avoid reduction of sheet thickness.

D. Installation of Reglets and Counterflashing:

1. Install reglets for flashing and other related Work where shown to be built into unit masonry construction.
2. Install counterflashing with positive pressure against base flashing and reglet and with air break at mid-point to prevent capillary action. No screws or exposed fasteners shall be permitted in the finished Work except those required at each pre-punched hole for surface-mounted reglet attachment.
3. End lap counterflashing horizontally a minimum of 3 inches.
4. Overlap base flashing with counter flashing a minimum of 4 inches vertically and fold lower edge back on itself for 1/2-inch.



## 3.04 ADJUSTMENT AND CLEANING

A. Protect sheet metal flashing and trim until Final Acceptance of the Work.

B. Do not permit workmen, or others, to step directly on flashing sheets in place, or to place or move equipment over sheet metal flashing and trim surfaces. Protect surfaces during installation of permanent covering work and adjoining Work.

C. Neutralize excess flux as the Work progresses with five percent to percent washing soda solution and rinse thoroughly.

D. Clean exposed surfaces of every substance which is visible or might cause corrosion or prevent uniform oxidation of the metal surfaces. Exercise extreme care to remove fluxes and ferrous metal particles, including welding splatter and grinding dust.

**END OF SECTION**

SECTION 07 71 00

ROOF SPECIALTIES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope

1. This Section specifies roof specialties.
2. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install all roof specialties work.
3. The extent of the roof specialties is shown on the Plans.
4. The types of roof specialties work required include, but are not necessarily limited to, the following:
   a. Shop-fabricated, snap-lock metal coping flashing and shop-formed cap flashing requiring no exposed fasteners or splice-plates.
   b. Complete selection of full-strength, polyvinylidene fluoride finishes and colors with extended life topcoat.
   c. Protective strippable film on all surfaces of snap-lock metal coping, extruded aluminum gravel stops, fascia extensions and metal coping corner and transition flashings.
   d. Shop-fabricated exposed surface-mounted polyvinylidene fluoride finished aluminum scuppers, conductor heads, and downspouts.
   e. Miscellaneous accessories, fasteners, cleats and incidental sheet metal flashing and trim system components necessary for a complete installation.

B. Coordination

1. Review installation procedures under other sections and coordinate the installation of items that shall be installed with the roof specialties work.



### 1.02 QUALITY ASSURANCE

A. Reference Codes and Standards

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there was no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a

later date, discontinued or replaced. In all cases, the effective version of the Connecticut State Building Code at the time of Advertisement for Bids or Invitation to Bid shall be considered the building code in effect.

| Reference | Title |
|---|---|
| AAMA 621 | Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) & Zinc-Aluminum Coated Steel Substrates |
| FM Global | Loss Prevention Data for Roofing Contractors, 1-49 - Perimeter Flashing. |
| FS H C 494 | Coating Compound, Bituminous, Solvent Type, Acid Resistant |
| FS TT C 494 | Federal Specifications, Coating Compound, Bituminous, Solvent Type, Acid Resistant |
| NRCA | The Roofing Manual |
| SMACNA | Architectural Sheet Metal Manual |

B. Performance Requirements

1. Roof specialties shall be permanently watertight, and not deteriorate in excess of Supplier's published limitations.
2. Snap-lock coping shall be detailed, fabricated and installed to provide a minimum of FM 1-90 wind up-lift resistance and require no exposed fasteners of any kind.
3. Comply with fabrication details recommended by FM Global, Loss Prevention Data for Roofing Contractors; SMACNA, Architectural Sheet Metal Manual; The NRCA Roofing Manual, and the requirements of the roof specialties Supplier, and as shown on approved Shop Drawings.
4. Standards: Comply with applicable standards and recommendations of SMACNA, Architectural Sheet Metal Manual for the fabrication and installation of roof specialties work, except to the extent more stringent requirements are specified.

C. Warranty

1. A warranty for the equipment specified under this Section shall be provided in accordance with the General Conditions. The Warranty shall be for 1 year from the date of the Notice of Substantial Completion certificate issued for the Work. If extended warranties are required, a special paragraph calling for an extended warranty will be included in this Section.
2. Provide coping and cap flashing supplier's 15-year warranty against blow-off, leak, or premature membrane failure in winds of up to 90 miles per hour.
3. Provide Supplier's 20-year warranty on the specified polyvinylidene fluoride based coating.
4. Guarantee that the polyvinylidene fluoride-based coating meets all criteria specified and will not spall, check, craze, peel or otherwise lose adhesion for a period of 20 years from the date of installation, to the extent that such shall create unsightly conditions or otherwise impair the intended architectural qualities of the building.
5. In the event that the polyvinylidene fluoride-based coating fails to meet the specified standards the Supplier shall, at their own expense, replace or field paint, at the discretion of Engineer, all areas affected by the failure. In the event that repainting is selected, it shall be done at mutually agreeable intervals throughout the term of the warranty.

6. The warranty specified shall not deprive the City of other rights the City may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
7. The warranty does not apply where failure is caused by accidents, or external conditions or forces beyond the control of the Supplier.

D. Installer Qualifications
1. Engage a single installer who is a recognized roof specialties installer, skilled and experienced in the type of roof specialties work required, and equipped to perform workmanship in accordance with recognized standards so that there will be undivided responsibility for the performance of the Work. Submit name and qualifications to Engineer along with at least three successfully completed projects including names and telephone numbers of owners, architects and engineers, responsible for the project and the approximate contract price for roof specialties work.
2. The installer of the roof specialties work shall be franchised or otherwise accepted in writing by the roofing materials supplier for installation of fully guaranteed roofing work in accordance with these Specifications.

E. Component Supply and Compatibility: Provide roof specialties as a complete unit produced by a single Supplier specializing in the production of this type of work, including hardware, accessories, mounting and installation components.

F. Scheduling
1. Coordinate roof specialties work with roofing, flashing, trim, and the construction of decks, parapets and other adjoining portions of the Work, to provide a permanently watertight, leak proof, secure and non-corrosive installation.
2. Deliver materials to the Site in sufficient quantities to ensure uninterrupted progress of the Work.
3. Schedule the installation of roof specialties to coincide with the installation of roofing, waterproofing, drains, piping, blocking, nailers, reglets, framing at openings, curbs, parapets and other adjoining and substrate portions of the Work.
4. Proceed with and complete the Work only when materials, equipment, and knowledgeable tradesmen, required for the installation of roof specialties, are at the Site and are ready to follow, and integrate roof specialties work with roofing work, in order to maintain watertight conditions.



## 1.03 ENVIRONMENTAL CONDITIONS

A. Product in this Section shall be subjected to environmental conditions in accordance with Section 01 11 80 – Environmental Conditions.

## 1.04 SUBMITTALS

A. Preconstruction/Action Submittals: The following minimum submittals shall be submitted prior to construction of this element of the Work in accordance with Section 01 33 00 – Submittals.
1. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-

marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (✓) shall denote full compliance with a paragraph as a whole.

If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations.

The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. Shop Drawings
   a. Shop Drawings showing the manner of forming, jointing and securing the metal to form roof specialties work. Show expansion joint details and water-proof connections to adjoining portions of the Work and at obstructions and penetrations.
   b. Drawings showing the coordination. Provide detailed Shop Drawings showing large scale details of Sections and profiles of all roof specialties to be used in the Work, with all items, including fastener locations, cleats and other miscellaneous accessories necessary to complete the Work, fully dimensioned, properly located, quantified and presented such that sequence of installation is acceptable to each roofing system and adjacent construction material installer.
3. Product Data
   a. Copies of Supplier's specifications, recommendations, and installation instructions for roof specialties applications. Include Supplier's certification or other data substantiating that the materials comply with the requirements.
4. Samples
   a. Each item of roof specialty, demonstrating assembly of system joint components and fasteners, securely mounted to substrate simulating actual installation in the Work.
   b. Polyvinylidene fluoride supplier's color samples for final selection by Engineer. After initial selection of colors by Engineer from Supplier's color charts, submit Engineer's preliminary color choices on actual samples of metal substrate for final color selections by Engineer.
   c. Samples will be reviewed by Engineer for color and texture only. Compliance with other requirements is the responsibility of the Contractor.

B. Informational Submittals: The following minimum informational submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00 - Submittals.
   1. Warranty, as specified in this Section.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE PRODUCTS

A. Suppliers

1. The Engineer believes that the following Suppliers indicated in this Section are capable of producing equipment and products, which will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular Supplier or product, nor shall it be construed that a named Supplier's standard product will comply with the requirements of this Section.

B. Supplier Qualifications

1. The Supplier shall have 5-years of experience manufacturing and installing roof specialties in similar-sized projects.

### 2.02 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose. If alternatives are proposed, the proposals shall be accompanied with documentation supporting the claimed superiority of the proposed substitutions. The Engineer shall be the sole decider in the equivalency of alternative materials of construction.

1. Formed Metal Coping, Caps and Trim: Provide smooth sheet of 0.063- inch, 5005-H134 aluminum alloy, complying with the following:
   a. Provide coping and cap flashings, sized as shown, that provides for independent mounting and full expansion and contraction over prefabricated 6-inch-wide aluminum retainers, compression clips mounted 12 feet - 0 inches on centers, and 2-inch wide aluminum retainer plates with single compression pad mounted between dual compression clips.
   b. Provide system that incorporates a gutter bar with dual compression gaskets at each joint to drain water.
   c. System shall not incorporate exposed sealants.
   d. Provide internal face line-up splices at all joints.
   e. All coping and cap flashings shall have all corners mitered and continuously heliarc welded watertight prior to shop-painting. Exposed mechanical fasteners, blind rivets and similar methods are not approved for the Work. Reinforce metal at welds as may be required to provide welded seams.
   f. Concealed fasteners splice plates and neoprene compression pads shall be as recommended by the Supplier.
   g. Products and Suppliers
      1) Gutter Splice System TITE-LOC Coping by Peterson Aluminum Corporation,
      2) Designer Leak-Tite Coping by Metal-Era Incorporated, or
      3) Approved Equal.

2. Custom Thru-Wall Scuppers, Custom Overflow Scuppers, Conductor Heads, and Downspouts:
    a. Provide aluminum sheet 6063-T6 alloy, with smooth finish; in accordance with SMACNA.
    b. Size, Thickness, and Profile
        1) Custom Thru-wall Scupper: .050-inch thick; 6-inches by 12-inches.
        2) Custom Overflow Scupper: .050-inch thick; 6-inches by 12-inches.
        3) Conductor Head: .063-inches thick; Size as required for proper transition between the scupper and the downspout.
        4) Downspouts: 1/8-inch thick; 3-inches by 4-inches.
    c. Products and Manufacturers: Provide one of the following:
        1) Custom Thru-wall Scuppers, Custom Overflow Scuppers, Conductor Heads, and Downspouts by Architectural Products Company.
        2) Custom Thru-wall Scuppers, Custom Overflow Scuppers, Conductor Heads, and Downspouts by Metal-Era Incorporated, or
        3) Approved Equal.

## 2.03 FABRICATION

A. The fabrication requirements for roof specialty work apply to both shop fabricated and on-Site fabricated work.

B. Supplier's Recommendations: Except as otherwise shown or specified, comply with the recommendations and instructions of the Supplier of the roof specialty being fabricated.

C. Provide for thermal expansion of exposed items. Maintain a watertight seal at expansion joints. Locate expansion joints at the following maximum spacings:
    1. Midpoint of run.

D. Fabricate work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves and avoidable tool marks, considering the temper and reflectivity of the metal. Provide uniform, neat seams with minimum exposure of solder, welds and sealant. Fold back the sheet metal to form a hem on the concealed side of exposed edges.

E. Fabricate drainage sumps and downspouts and supports as shown.

F. Support and Anchorage: Fabricate units with adequate provisions for support and anchorage, of the types required for the indicated method of installation.

G. Conductor Heads and Downspouts: Fabricate aluminum sheet using double flat-lock seams. Rivet joints where necessary for strength. Pop rivets are not acceptable.

H. Finishes
    1. High-Performance Organic Finish (Three-Coat Fluoropolymer): AAMA 2605: Supplier's standard three- coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal

surfaces to comply with AAMA 621 and the coating and resin suppliers' written instructions.

2. Colors
   a. Full selection of Supplier's standard colors for final selection by Engineer.
3. Products and Suppliers
   a. Kynar 500 Fluropon by the Valspar Corporation,
   b. Kynar 500 Duranar, or
   c. Approved Equal

## PART 3 EXECUTION

### 3.01 SHIPMENT AND STORAGE

A. Product shall be shipped and stored in accordance with Section 01 66 00 - Product Storage and Handling Requirements.

B. Supplier shall provide Contractor with detailed recommendations and instructions for product storage.

C. Delivery of Materials
   1. Deliver, store and handle materials to preclude denting, scratching or otherwise marring the surface and finish of the roof specialties material.
   2. Items delivered in broken, damaged, rusted, or unlabeled condition shall immediately be removed from Site and not offered again for approval by Engineer.

D. Storage of Materials
   1. Store materials in an area undercover and protected from construction traffic.
   2. Store materials in same package in which they were shipped, off the ground and on platforms protected from dirt and other contamination.
   3. Store in a manner which does not permit water to remain on roof specialties materials and system components.

E. Handling of Materials
   1. Protect roof specialties from dents, scratches, warps and bends.
   2. Remove strippable protective film, immediately preceding installation of each system component.



### 3.02 SUPPLIER'S FIELD SERVICES

A. Supplier shall provide assistance during equipment installation as required by the Contractor.

### 3.03 INSPECTION

A. Examine the supporting structure and other elements of the substrate and conditions under which the roof specialties work is to be performed and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the drainage sumps, roof and overflow drains, and downspouts. Do not

proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

## 3.04 PREPARATION

A. Wherever possible, take field measurements, prior to completion of shop fabrication and finishing of roof specialties work. Do not delay job progress. Allow for erection tolerances corresponding with specified tolerances where final dimensions cannot be established before fabrication.

## 3.05 INSTALLATION

A. The Supplier shall provide the Contractor with detailed recommendations and instructions for installation of the product specified in this Section.

B. Supplier shall provide assistance during product installation as required by the Contractor.

C. Products shall be installed at the locations shown and in accordance with the recommendations of the Supplier.

D. Comply with Supplier's recommendations and installation instructions.

E. Protection of Aluminum from Dissimilar Materials: Coat all aluminum surfaces in contact with dissimilar materials such as concrete, masonry, steel and other metals as specified in Section 09 90 00 - Painting and Coatings.

F. Conceal fasteners and expansion provisions, wherever possible, in exposed work, and locate so as to minimize the possibility of leakage. Cover and seal work, as required, for a tight installation.

G. Provide concealed cleat type anchorages wherever practical and arrange to relieve stresses in the roof specialties work which result from building movement and thermal expansion.

H. Splice and Expansion Units: Use 0.050-inch-thick splice plates.

I. Bed flashing flanges in a bed of roofing cement or other setting compound which is compatible with adjoining portions of the Work and substrate.

J. On vertical overlaps, lap sheet metal a minimum of 3 inches.

K. On sloping overlaps, of slopes of not less than 6 inches in 12 inches, lap unsealed overlaps a minimum of 6 inches.

L. For embedment of metal flanges in elastic sheet flashing or stripping, extend flanges for a minimum of 4-inches embedment.

M. Support and anchor each unit of the Work in the manner as shown, but in no case in a manner which would be inadequate for thermal expansion stresses and the normal loading of water, wind and similar loadings.

N. Install units with lines and corners true and accurate in alignment and location. Install drainage sumps to assure positive drainage to downspouts.

O. Installation of Metal Copings

1. Install metal copings using concealed fasteners and plates in compliance with Supplier's written recommendations as shown on approved Shop Drawings.
2. Coping and cap flashings shall be installed with 3/8-inch-wide butt joints 12 feet-0 inches on center, unless otherwise shown.
3. Use all items supplied by the Supplier for a complete, watertight and blow-off resistant installation.
4. Set all flashings straight, level and plumb.

## 3.06 FIELD TESTING AND COMMISSIONING

A. Field Testing and Commissioning shall be in accordance with the requirements of Section 01 75 00 – Equipment Testing and Plant Startup.

B. The Supplier shall provide detailed procedures for Field Testing and Commissioning procedures for the equipment specified in this Section.

C. Field Testing and Commissioning shall be performed under the direction of experienced and qualified personnel provided by the Supplier.

D. Polyvinylidene Fluoride Based Coatings: Determine conformity of sheet metal flashing and trim Work requiring painted finish to these Specifications as follows

1. The Supplier of the roofing specialties work shall set aside and label samples of each component of the sheet metal flashing and trim Work from each production lot for the Project. Protect samples from weather.
2. Make samples of sheet metal flashing and trim Work available at all times, for comparison with installed sheet metal flashing and trim Work as requested by Engineer, for the full time of the warranty.
3. Make color comparison measurements with a Hunter Tristimulus Color Difference Meter employing methods of computation in use at the National Bureau of Standards.



## 3.07 CLEANING AND PROTECTION

A. Protect the roof specialties from all damage until Final Completion.

B. Roof specialties damaged before Final Completion shall be replaced with new material as specified herein, at no additional cost to the City.

C. Clean exposed surfaces of every substance which is visible or might cause corrosion of the metal or deterioration of the finish.

**END OF SECTION**

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SECTION 07 84 00

FIRESTOPPING

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

### 1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.03 REFERENCES

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. The references listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version reference by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. When document dates are given in the following listing that are not specifically referenced in an applicable code, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. For questions, refer to Engineer.

| Reference | Title |
|---|---|
| ASTM E814 | Standard Test Method For Fire Tests Of Penetration Firestop Systems |
| FMG 4991 | Approval of Firestop Contractors |
| UL 1479 | Standard For Fire Tests of Penetration Firestops |
| UL HXEZ | Fire Resistance Directory |
| UL C-AJ-1008, W-L-1001 | Firestop Systems for Metallic Pipes, Conduit, or Tubing |
| UL C-AJ-2031, W-L-2038 | Firestop Systems for Nonmetallic Pipe, Conduit, or Tubing |
| UL C-AJ-7021, W-L-7007 | Firestop Systems for Miscellaneous Mechanical Penetrants |

## 1.04 DEFINITIONS (NOT USED)

## 1.05 PERFORMANCE REQUIREMENTS

A. General:
   1. For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Fire-resistance-rated walls including fire walls.

C. Rated Systems:
   1. Provide through-penetration firestop systems with the following ratings determined per ASTM E814 or UL 1479:
      a. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equal to, or exceeding fire-resistance rating of constructions penetrated.
      b. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
         1) Penetrations located outside wall cavities.
         2) Penetrations located outside fire-resistance-rated shaft enclosures.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

E. Three subparagraphs below are examples of special requirements.
   1. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and
   2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

F. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E814.

## 1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be

underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Shop Drawings:
   a. For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.
4. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
   a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
5. Qualification Data:
   a. For Installer.
6. Product Certificates:
   a. For through-penetration firestop system products, signed by product manufacturer.
7. Product Test Reports:
   a. From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.



## 1.07 QUALITY ASSURANCE

A. Installer Qualifications:
   1. A firm that has been approved by FMG according to FMG 4991.

B. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
   1. UL in its "Fire Resistance Directory."

## 1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

## 1.09 SITE CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

## 1.10 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.



# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. Available Products:
   1. Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the Work include, but are not limited to, those systems indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 are produced by one of the following manufacturers:
      a. A/D Fire Protection Systems Inc.
      b. Grace, W. R. & Co. - Conn.
      c. Hilti, Inc.
      d. Johns Manville.
      e. Nelson Firestop Products.
      f. NUCO Inc.
      g. RectorSeal Corporation (The).
      h. Specified Technologies Inc.
      i. 3M; Fire Protection Products Division.
      j. Tremco; Sealant/Weatherproofing Division.
      k. USG Corporation.
      l. or approved equal.

## 2.02 FIRESTOPPING, GENERAL

A. Compatibility:
   1. Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

B. Accessories:
   1. Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

## 2.03 FILL MATERIALS

A. General:
   1. Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by referencing the types of materials described in this Article. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.

B. Cast-in-Place Firestop Devices:
   1. Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

C. Latex Sealants:
   1. Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

D. Firestop Devices:
   1. Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

E. Intumescent Composite Sheets:
   1. Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

F. Intumescent Putties:
   1. Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

G. Intumescent Wrap Strips:
   1. Single-component intumescent elastomeric sheets with aluminum foil on one side.

H. Mortars:
   1. Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

I. Pillows/Bags:
   1. Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.

J. Silicone Foams:
   1. Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

K. Silicone Sealants:
   1. Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

L. Grade:
   1. Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and non-sag formulation for openings in vertical and other surfaces requiring a nonslumping, gun-able sealant, unless indicated firestop system limits use to non-sag grade for both opening conditions.



## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:

B. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.

C. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.

D. Remove laitance and form-release agents from concrete.

## 3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General:
   1. Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

C. Install fill materials for firestop systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

## 3.04 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.



## 3.05 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Firestop Systems for Metallic Pipes, Conduit, or Tubing:
   1. Available UL-Classified Systems: C-AJ-1008, W-L-1001.
   2. Type of Fill Materials: One or more of the following:
      a. Latex sealant.
      b. Silicone sealant.
      c. Intumescent putty.
      d. Mortar.

C. Firestop Systems for Nonmetallic Pipe, Conduit, or Tubing:
   1. Available UL-Classified Systems: C-AJ-2031, W-L-2038.
   2. Type of Fill Materials: One or more of the following:
      a. Latex sealant.
      b. Silicone sealant.
      c. Intumescent putty.
      d. Intumescent wrap strips.
      e. Firestop device.

D. Firestop Systems for Miscellaneous Mechanical Penetrants:
   1. Available UL-Classified Systems: C-AJ-7021, W-L-7007.

**END OF SECTION**

SECTION 07 91 26

JOINT FILLERS

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies preformed joint fillers.

### 1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ASTM D994 | Preformed Expansion Joint Filler for Concrete (Bituminous Type) |
| ASTM D1752 | Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |



## PART 2 PRODUCTS

### 2.01 PREFORMED ASPHALT FIBERBOARD

A. Preformed asphalt fiberboard joint filler shall be in accordance with ASTM D994 and shall be 1/2 inch thick unless otherwise specified.

### 2.02 PREFORMED RESIN-BONDED CORK

A. Preformed resin-bonded cork joint filler shall be in accordance with ASTM D1752, Type II. Cork joint filler thickness shall match the specified joint width.

### 2.03 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:

1. Manufacturer's recommendations for handling and installation of the material.

## PART 3 EXECUTION

### 3.01 GENERAL

A. Preformed joint fillers shall be placed into position before the concrete is poured. Where it is necessary for the filler to be fixed to existing concrete or other building materials, a suitable adhesive recommended by the filler manufacturer shall be used. Filler surfaces shall be clean and dry prior to the placement of the concrete.

### 3.02 PREFORMED ASPHALT FIBERBOARD

A. Preformed asphalt fiberboard joint fillers shall be used for expansion joints in concrete sidewalks, curbs, and roadways.

### 3.03 PREFORMED RESIN-BONDED CORK

A. Preformed resin-bonded cork joint filler shall be used for expansion joints in concrete structures. The expansion joint shall be sealed with backer rod and sealant as specified in Section 07 92 00.

**END OF SECTION**

SECTION 07 92 00

JOINT SEALANTS

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies sealants.

### 1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| FEDSPEC TT-S-00230C | Sealing Compound: Elastomeric Type, Single Component |
| FEDSPEC TT-S-00227E | Sealing Compound: Elastomeric Type, Multi-Component |



## PART 2 PRODUCTS

### 2.01 POLYURETHANE SEALANT

A. Acceptable Products:

1. Acceptable products shall be Sikaflex by Sika Chemical Corporation, Vulkem by Mameco International, U-Seal Joint Sealant by Burke Company, or Rubber Calk by Products Research and Chemical Corporation.

B. General:

1. Polyurethane sealants shall conform to FEDSPEC TT-S-0230C for one-component systems and FEDSPEC TT-S-00227E for two-component systems. Polyurethane sealant shall be one of the following two types.
   a. Self-Leveling:
      1) Self-leveling polyurethane sealant shall be Type I, Class A as specified by the FEDSPECs referenced above.

b. Nonsag:
   1) Nonsag polyurethane sealant shall be Type II, Class A as specified by the FEDSPECs referenced above.

C. Primer:
   1. Primer shall be as recommended by the sealant manufacturer.

D. Backer Rod or Backer Tape:
   1. Backer rod shall be open cell polyethylene or polyurethane foam. Rod shall be cylindrical unless otherwise specified. Backer tape shall be polyethylene or polyurethane with adhesive on one side.

## 2.02 MASTIC SEALANT

A. General:
   1. Mastic joint sealant shall consist of a blend of refined asphalts, resins and plasticizing compounds, reinforced with fiber. Sealant shall be compatible with joint fillers and shall be pressure grade.

B. Primer:
   1. Primer shall be as recommended by the mastic sealant manufacturer.

## 2.03 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's product data showing conformance to the specified products.
   2. Manufacturer's recommendations for storage, handling and application of sealants and primers.



# PART 3 EXECUTION

## 3.01 GENERAL

A. Sealants and primers shall be applied according to the sealant manufacturer's recommendations. Polyurethane sealants shall be used on all expansion joints and specified construction joints.

B. Joints and spaces to be sealed shall be clean, dry and free of dust, loose mortar, concrete and plaster. Additional preparation of joints and spaces shall be provided in accordance with manufacturer's recommendations. Primer shall be applied only to the surfaces that will be covered by the sealant.

## 3.02 POLYURETHANE SEALANTS

A. General:
   1. Nonsag polyurethane sealants shall be used on vertical joints. Self-leveling polyurethane sealants shall be used on horizontal joints.

B. Joint Dimensions:

1. Unless otherwise specified, joints and spaces to be filled shall be constructed to the following criteria. Joints and spaces shall have a minimum width of 1/4 inch and a maximum width of 1 inch. The depth of the sealant shall be one-half the width of the joint, but in no case less than 1/4 inch deep. Sealant depth shall be measured at the point of smallest cross section. When joints exceed the depth requirements, backing rod shall be inserted to provide the joint depth specified. If the joint sealant depth is within the specified tolerances, backer tape shall be placed in the bottom of the joint.

## 3.03 MASTIC SEALANT

A. Joint Dimensions:

1. Joints to be sealed shall be 2 inches deep, 1 inch wide at the top, and 3/4 inch wide at the base.

**END OF SECTION**

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# DIVISION 08
# OPENINGS

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SECTION 08 15 00

FIBERGLASS DOORS AND FRAMES

## PART 1 – GENERAL

### 1.01 DESCRIPTION

A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on Drawings and specified herein.

B. Principal Items of work include:
   1. Fiberglass frames and doors.
   2. Fiberglass frames and windows, Fire Rated

### 1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.



| Reference | Title |
|---|---|
| ANSI/DHI A115.1 | Preparation for Mortise Locks for 1-3/8 Inch and 1-3/4 Inch Doors |
| ANSI/DHI A115.2 | Preparation for Bored Locks for 1-3/4 Inch and 1-3/8 Inch Doors |
| ANSI/DHI A115.4 | Preparation for Lever Extension Flush Bolts |
| ANSI/DHI A115.7 | Preparation for Floor Closers--Light Duty, Center Hung, Single or Double Acting; Center Hung, Single or Double Acting; Offset Hung, Single Acting |
| ANSI/SDI 100 | Recommended Specifications--Standard Steel Doors and Frames |
| ASTM C578 | Preformed, Cellular Polystyrene Thermal Insulation |
| ASTM C591 | Unfaced Preformed Rigid Cellular Polyurethane Thermal Insulation |
| ASTM D2863 | Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index) |
| NFPA 80 | Fire Doors and Windows |
| NFPA 252 | Fire Tests of Door Assemblies |

| Reference | Title |
|---|---|
| SDI 105 | Recommended Erection Instructions for Steel Frames |
| SDI 107 | Hardware on Steel Doors (Reinforcement—Application) |
| SDI 111-F | Recommended Completed Opening Anchors for Standard Steel Doors and Frames |
| UL 10B | Fire Tests of Door Assemblies |

B. Certificates Of Compliance: Manufacturers' certificates shall be provided attesting that doors, frames, and accessories meet the specified requirements. The grade and model number of each door shall be included.
   1. Each window unit indicated on the Contract Drawings to be fire rated shall bear a UL and ASTM label warranting that the product complies with UL 263 and ASTM E119.

## 1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04 20 00 - Unit Masonry

B. Section 08 71 00 - Door Hardware

C. Section 08 80 00 - Glass and Glazing

## 1.04 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Samples shall include:
      a. Corner sections of frames and trim.
      b. Corner sections of doors.
      c. Finish and color charts.
   3. Shop drawings containing the following information:
      a. Elevations of each door type
      b. Size of doors and frames
      c. Gages

d. Details of door and frame construction
e. Methods of anchorage
f. Louver details
g. Glazing details
h. Weatherstripping
i. Provisions for and location of hardware
j. Details of installation
k. Schedule showing location of each door, frame, and swing of door

4. Manufacturer's literature.

## 1.05 WARRANTY

A. The Manufacturer shall unconditionally guarantee the fiberglass reinforced-plastic doors and frames for five (5) years against failure due to corrosion by environmental conditions. Under this guarantee a new door will be offered replacement or the original factory price will be refunded at the discretion of the manufacturer.

## 1.06 DELIVERY, STORAGE AND HANDLING

A. All materials shall be boxed or crated and suitably protected prior to shipment from the factory. Protect all hardware which may be attached.

B. Protect products against damage during delivery, storage, and handling. Stack materials on blocking clear of ground, tilted to permit water drainage and protected from corrosion and construction abuse.

C. Frames and doors, after being set, shall be protected with heavy Kraft paper or other approved means in such manner to prevent damage. Protection shall be maintained until such time as directed by the Engineer.



# PART 2 – PRODUCTS

## 2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, provide products from one of the following manufacturers:
1. Tiger Doors by Overly
2. FIB-R-Door Systems
3. Chem Pruf Door Company
4. Or Approved Equal

## 2.02 MATERIALS

A. Provide doors, door frames, windows and window frames from the same manufacturer.

B. Fiberglass reinforced plastic doors , window and door frames shall be resin transfer molded (RTM). The doors shall be molded in one piece with gel-coat, fiberglass reinforcement, resin and core material molded together. Window openings, door hardware openings and flush hinge recesses shall be molded in. Secondary cutting and coating will not be allowed. Continuous stainless steel bars shall be molded in during the initial molding. The steel plates shall be pretapped to receive screws for attachment of hardware. Door hardware shall be stainless steel.

C. Fiberglass reinforcement shall consist of a surfacing mat followed by continuous stand mat wrapped around rigid closed cell polyurethane foam core material. The outer surface shall consist of 30 mils of high quality commercial grade polyester gel-coat. Fiberglass laminate shall be a minimum of 1/8 inch on all sides and edges. The outer surface of the finished door and frame shall have a matte finish and be free of pits, porosity, blisters, wrinkles, dry glass, cracks or crazing.

D. The fiberglass laminate shall have the following minimum physical properties using the applicable ASTM Standards.

| | | |
|---|---|---|
| Tensile strength | 9,000 psi | ASTM D638 |
| Flexural strength | 20,000 psi | ASTM D790 |
| Flexural modulus | $1.0 \times 10^6$ | ASTM D790 |
| Impact, Notched Izod foot pound per inch | 15.0 | ASTM D256 |
| Barcol hardness | 40 min. average | ASTM D2583 |
| Water Absorption, degrees 24 hours | 0.1 percent | ASTM D570 |
| Average coefficient of thermal expansion inch per inch per degree Fahrenheit | $10.5 \times 10^6$ | ASTM D696 |
| Flame Spread | 25 or less | ASTM E84 |



## 2.03 FIBERGLASS REINFORCED PLASTIC DOOR FRAMES

E. FRP frames shall be solid fiberglass. The stop and frame will be molded in one piece. The frame shall be integrally gel-coated to the Owner's color when molded.

F. Hardware Preparations/Internal Reinforcement: Doors shall be reinforced and mortised for hardware with a minimum of 1-1/2 inches x 1-1/2 inches of solid fiberglass to allow application of hinges and locks, in accordance with the hardware schedule, hardware manufacturer’s instructions and templates. Reinforcement Blocking: Non-swelling polymer or firestop blocking will be used for all lockset, surface mounted hardware and thru-bolted hardware blocking.

G. The jamb shall be flat on the backside (against the opening) and uniform in thickness as to provide a solids, uniform surface against the wall opening. No wood blocks or spacers are permitted.

H. Frame shall meet the industry accepted design details of a standard frame profile which is 5-3/4 inches overall jamb depth with a two inch face, 5/8 inch stop and 5/8 inch return for both wrap around or butt mounting.

I. The gel-coat shall be of .025 thick resin rich surface of an isolphthalic or chemical-resistant polyester resin which is resistant to moisture, ultra violet sunlight and many industrial acids, alkalies and solvents and protects the glass reinforcements from degradation.

## 2.04 FIBERGLASS REINFORCED PLASTIC WINDOW FRAMES

A. General:
   1. FRP frames shall be solid fiberglass. The stop and frame will be molded in one piece. The frame shall be integrally gel-coated to the Owner's color when molded.
   2. The gel-coat shall be of .025 thick resin rich surface of an isolphthalic or chemical-resistant polyester resin which is resistant to moisture, ultra violet sunlight and many industrial acids, alkalies and solvents and protects the glass reinforcements from degradation.
   3. The jamb shall be flat on the backside (against the opening) and uniform in thickness as to provide a solids, uniform surface against the wall opening. No wood blocks or spacers are permitted.
   4. Prime windows shall conform to ANSI/AAMA 101 and the requirements specified herein. Windows shall be provided of types, grades, performance classes, combinations and sizes specified. Windows shall be designed to accommodate hardware, glass, weatherstripping, and accessories to be furnished. Each window shall be a complete factory assembled unit with or without glass installed. Dimensions shown are minimum. Windows shall be provided with insulating glass and thermal break necessary to achieve a minimum Condensation Resistance Factor (CRF) of 45 when tested in accordance with AAMA 1503.1.

B. Fixed Windows:
   1. Fixed windows shall be type F.

C. Glass and Glazing:
   1. Materials are specified in Section 08 80 00.

D. Calking and Sealing:
   1. Materials are specified in Section 07 91 26 and 07 92 00.

E. Weatherstripping:
   1. Weatherstripping shall conform to ANSI/AAMA 101.

F. Fire-Rating:
   1. Fire rated window frames and glass shall bear a 2-hour fire rating where indicated on the Contract Drawings. Windows shall conform to UL 263 and ASTM E119 for 90 Minute and 120 Minute fire-rated assemblies.

G. Fabrication
   1. Provisions for Glazing:
      a. Windows and rabbets shall be designed for glass thickness specified. Sash shall be designed for 1” glazing and for securing glass with sealant and glazing compound.

2. Fasteners:
    a. Fasteners shall be standard with the window manufacturer for windows, trim, and accessories. Self-tapping sheet-metal screws are not acceptable for material more than 1/16-inch thick.
3. Drips and Weep Holes:
    a. Drips and weep holes shall be provided as required to return water to the Pump Room.
4. Accessories:
    a. General:
        1) Contractor shall provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation.
    b. Hardware:
        1) Hardware shall conform to ANSI/AAMA 101. The item, type, and functional characteristics shall be the manufacturer's standard for the particular window type. Hardware shall be of suitable design and of sufficient strength to perform the function for which it is used. All operating ventilators shall be equipped with a lock or latching device which can be secured from the inside.
    c. Anchors:
        1) Anchors shall be of the concealed type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners shall be compatible with the window and the adjoining construction. A minimum of three anchors shall be provided for each jamb located approximately 6 inches from each end and at midpoint.



## 2.05 DOORS

A. Fiberglass doors shall be flush type of 1-3/4 inch thickness. Doors shall be constructed with a gel-coat surface of 0.25 resin rich surface of an isophthalic or chemical resistant to moisture, ultra violet sunlight and many industrial acids, alkalies and solvents and protects the glass reinforcement from degradation. The Fiberglass laminate of 1/8 inch thickness shall be the primary structural component of the door. Color shall be selected from manufacturer's standard colors.

B. The core shall be continuously bonded to the laminate for structural support and rigidity. To enhance this bond, the core shall be perforated so that resin posts are formed during the molding process which additionally ties the outer laminates together.

C. The fiberglass door shall be formed to size to produce a totally seamless door.

D. The fiberglass door shall have continuous steel reinforcement for hinge mounting. The lock edge of the door shall be the same steel reinforcement, except it will be interrupted at the lock location for lock installation. The manufacturer shall provide a 1/8 inch thick, 5-inch high x 18 inch long steel reinforcement for closer mounting. Totally encapsulated reinforcements in fiberglass.
    1. The door shall be prepared for hardware specified in Section 08 71 00 - Door Hardware.

## 2.06 FIRE RETARDANT

A. The doors and frame shall be "Fire Resistant" and will not support combustion.

## 2.07 ANCHORS

A. Jamb anchors shall be 14 gauge galvanized, flat, "T" anchors to suit frame size with legs not less than three inches by 10 inches. Set anchors at every three masonry courses, a minimum of three per jamb.

B. For cast-in-place concrete, anchor frame jambs with 3/8 inches minimum counter-sunk stainless steel bolts into expansion shield or inserts, with crush-proof sleeves. Provide a minimum of three per jamb.

C. Floor anchors at doors shall be 16 gauge galvanized sheet steel at each jamb. Clip type anchors with two holes to receive fasteners.



# PART 3 – EXECUTION

## 3.01 FRAME INSTALLATION

A. Install plumb, level and true to line, rigidly secured in openings. Set frames in masonry walls prior to beginning masonry work.

## 3.02 DOOR INSTALLATION

A. Install plumb, level and true to line. Apply and adjust hardware to achieve quiet and smooth operation.

B. Doors shall fit snugly and close without forcing or binding. Door clearances shall not exceed 1/8 inch at jambs and heads and meeting stiles at pairs of doors. Clearance between bottom of door and finished floor material or threshold shall not exceed 1/4 inch. Frames shall be manufactured and machined to within 1/32 inch for all dimensions.

## 3.03 WINDOW INSTALLATION

A. General:
   1. Windows shall be installed in accordance with the window manufacturer's printed instructions and details and built in as the work progresses or installed without forcing into prepared window openings. Contractor shall set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes shall be bedded in mastic sealant of a type recommended by the window manufacturer. Windows shall be installed in a manner that will prevent entrance of water and wind and insect screens shall be fastened securely in place.

B. Dissimilar Materials:
   1. Paint the dissimilar metal with one coat of heavy-bodied bituminous paint.

2. Apply a good quality elastomeric sealant between the aluminum and the dissimilar metal.
3. Paint the dissimilar metal with one coat of primer and one coat of aluminum paint.
4. Use a nonabsorptive tape or gasket in permanently dry locations.

C. Anchors and Fastenings:
1. Contractor shall make provision for securing units to each other, to masonry, and to other adjoining construction. Windows installed in masonry walls shall have head and jamb members designed to recess into masonry wall not less than 7/16 inch.

## 3.04 CLEANING

A. Contractor shall clean interior and exterior surfaces of window and door units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weather-stripping, and to prevent interference with the operation of hardware. Use of abrasive, caustic, or acid cleaning agents is not allowed. Protective coating shall be removed when completion of construction activities no longer requires its retention. All stained, discolored, or abraded windows and doors that cannot be restored to their original condition shall be replaced with new windows and doors.

## 3.05 PROTECTION

A. Protect installation from damage and touch up scratched areas with same paint used for shop coats. Damaged work shall be repaired or replaced.

END OF SECTION

SECTION 08 31 20

FLOOR ACCESS DOORS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Factory-fabricated single or double leaf stainless steel floor access doors and frames with water drainage. Include odor resistant gasket and fall protection grating system.

### 1.02 REFERENCES

A. The references listed below are a part of this section. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ASTM A276 | Stainless Steel Bars and Shapes |
| ASTM A793-96 | Rolled Floor Plate, Stainless Steel |
| ASTM A240 | Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| ASTM F593 | Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594 | Stainless Steel Nuts |
| AASHTO | American Association of State Highway and Transportation Officials |
| OSHA | U.S. Dept. of Labor, Occupational Safety and Health Administration |



### 1.03 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. Statement of experience for both manufacturer and installer.
   5. Fabrication drawings showing layouts, connections to structure, and anchoring details.
   6. Erection and installation drawings showing construction details, reinforcement, anchorage, and installation with relation to the building construction.

7. Drainpipe layout from the drain coupling to the discharge point.

B. Informational Submittals:
   1. Manufacturer's product data showing conformance to the specification.
   2. Structural calculations for the floor access door design provided by the manufacturer and sealed by a registered professional engineer registered in the State of Connecticut.
   3. Instructions for the storage, handling, installation, and operation.
   4. Manufacturer's warranty.

## 1.04 QUALITY ASSURANCE

A. Manufacturer: Minimum of 5 years' experience manufacturing similar products.

B. Installer: Minimum of 2 years' experience installing similar products.

## 1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original packaging, stored in a dry, protected, well-vented area. Inspect product upon receipt and report damage to carrier and manufacturer.

## 1.06 SPECIAL WARRANTY

A. Materials shall be free of defects in material and workmanship for a period of 5 years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.



# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. The following manufacturers are acceptable. The manufacturer's standard product may require modification to conform to specified requirements.
   1. The Bilco Company.
   2. Babcock Davis.
   3. Halliday Products.
   4. East Jordan Iron Works (EJ).
   5. Approved Equal.

## 2.02 PERFORMANCE/DESIGN CRITERIA

A. Door leafs shall be reinforced to support a minimum live load of AASHTO H-20 wheel load with a maximum deflection of 1/150th of the span. See Floor Access Door Schedule at the end of this section, which indicates loading criteria required at each location.

B. Nominal opening sizes and hinge opening side shall be as noted on the Drawings and in the Floor Access Door Schedule.

## 2.03 MATERIALS

A. Access doors, single or double leaf: 1/4 inch minimum stainless steel with diamond tread pattern; ASTM A793-96.

B. Channel frame shall be 1/4" (6mm) steel with full anchor flange around the perimeter: ASTM A36.

C. Hardware: ASTM A240 Type 316 stainless steel throughout.

D. Fasteners:
   1. Bolts: ASTM F593
   2. Nuts: ASTM F594

## 2.04 COMPONENTS/ FEATURES

A. Manufacturer shall provide the required number and size of compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled door leaf operation throughout the entire arc of opening; and to act as a check in retarding downward motion of the cover when closing.

B. Spring tubes shall be constructed of a reinforced nylon 6/6-based engineered composite material. The upper tube shall prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe fastened to a formed 1/4 inch gusset support plate.

C. Door leafs shall be equipped with a hold-open arm which automatically locks the door in the open position. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the door and the latch release shall be protected by a flush, gasketed, removable screw plug. A stainless steel snap lock with fixed handle shall be mounted on the underside of the door.

D. Provide heavy forged stainless steel hinges with 1/4 inch minimum diameter stainless steel pins.
   1. Hinges must operate in such a manner to prevent the door leafs from protruding into the channel frame.
   2. Design hinges specifically for horizontal installation.
   3. Hinges shall be through-bolted to the cover with tamperproof stainless steel lock bolts and through-bolted to the frame with stainless steel bolts and locknuts.

E. A continuous ethylene propylene diene monomer (EPDM) gasket shall be mechanically attached to the stainless steel frame to create a barrier around the entire perimeter of the cover and significantly reduce the amount of dirt and debris that may enter the channel frame.

F. A 1.5 inch drain coupling shall be provided.

G. Provide a continuous EPDM odor resistant gasket along the inside edge of the frame. This gasket is in addition to the perimeter debris gasket.

H. Provide telescoping ladder safety posts for easy, safe ladder access through the access door openings.
   1. Material: Stainless steel.
   2. Telescoping post to be permanently mounted to the top two rungs of fixed ladders.
   3. Post must automatically lock in the fully raised position to provide the user with a firm and steady hand-hold.
   4. Post to have release lever that allows the post to be easily lowered to its retracted position.

I. Provide a fall protection grating system where indicated in the Floor Access Door Schedule. Manufacturer shall install the grating system when the door is fabricated.
   1. Design Criteria: Meet OSHA 29 CFR 1910.23 requirements for fall protection.
   2. Grating panel material: Stainless steel with powder coat paint finish.
   3. Grating panel color: High visibility OSHA safety yellow or orange.
   4. Grating panel shall lock automatically in the full open position.
   5. Grating panel shall lift open in the opposite direction as the door(s).
   6. Hold open feature: Stainless steel hold open device shall be provided to lock the cover in the fully open 90 degree position.
   7. Lift mechanism and hardware: Stainless steel lifting mechanisms as specified above for all fall protection panels that weigh over 50 pounds.
   8. Grating openings: Reinforced with easy open stainless steel covers for removal of instrumentation below access doors.



## 2.05 FINISHES

A. Door and frame: Mill finish stainless steel with heavy bituminous coating where in contact with concrete.

B. Telescopic safety post: aluminum or stainless steel.

C. Springs: Electro coated acrylic finish.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.02 INSTALLATION

A. Installation shall conform to the manufacturer's recommendations.

B. Frame shall be accurately cast in place and securely anchored to concrete. Installation of access doors after concrete is placed is not allowed.

C. Set frame level, plumb and in proper alignment with adjacent work.

D. Contractor shall field route a 1-1/2- inch Schedule 80 PVC drain pipe from the 1-1/2-inch drain coupling on all access doors to the water or floor level below. Place drain pipe clear of the access area below the door and as approved by the Owner's Representative.

## 3.03 REPAIR/RESTORATION

A. Repair finishes damaged during installation.

B. Remove and replace doors that are warped, bowed, or otherwise damaged.

## 3.04 ADJUSTING

A. Adjust doors and hardware after installation for proper operation.

## 3.05 CLEANING

A. Clean exposed surfaces using methods acceptable to the manufacturer that will not damage finish.

## 3.06 FLOOR ACCESS DOOR SCHEDULE



| Floor Access Doors | | | | | | |
|---|---|---|---|---|---|---|
| Mark | Location/Room Number | Clear Opening Size (north/south x east/west) [1] | Leafs | Loading | Fall Protection Grating | Comments |
| H-01 | FOG Receiving Building – Lower Level Tanks | 4'-0" x 4'-0" | Double | H20 | Yes | Odor Gasket, drain channel to process drain |
| H-02 | FOG Receiving Building – Lower Level Tanks | 4'-0" x 4'-0" | Double | H20 | Yes | Odor Gasket, drain channel to process drain |

*Note:*

1. *Clear opening is defined as the dimensions such that objects can pass through the floor access door. Lifting and other hardware shall be outside of the opening dimensions.*

**END OF SECTION**

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SECTION 08 33 00

OVERHEAD ROLLING SERVICE DOOR

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes manually operated overhead insulated rolling doors.

B. Related Sections:
   1. Section 05 50 00 Metal Fabrications
   2. Section 09 90 00 Painting and Coating

### 1.02 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Air Infiltration to Comply With:
      a. ASHRAE® (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Standard 90.1-2007, 2010 & 2013 requirements of less than
      b. .3 CFM/FT2.
      c. IECC® (International Energy Conservation Code) 2021 requirements of less than
      d. 1.0 CFM/FT2.
   2. Wind Loading:
      a. Supply doors to withstand up to 34.5 psf design wind load.
   3. Cycle Life:
      a. Design doors of standard construction for normal use of up to 20 cycles per day maximum, and an overall maximum of 50,000 operating cycles for the life of the door.
   4. Seismic Performance:
      a. Provide manufacturer's seismic calculations confirming ASCE7-10
   5. Insulated Door Slat Material Requirements:
      a. Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E84.
      b. Sound Transmission Class (STC) rating up to 30 for the curtain and up to 22 for the entire assembly. If an STC of 32 is desired, additional options are required. All configurations are evaluated per ASTM E90 and based on testing a complete, operable assembly.
      c. Minimum R-value of 8.0 (U-value of 0.125) as calculated using the ASHRAE Handbook of Fundamentals.
      d. Insulation to be CFC Free with an Ozone Depletion Potential (ODP) rating of zero.
   6. Safety:
      a. Chain operated doors shall be designed so that the door immediately stops upward or downward travel and is maintained in a stationary position when the hand chain is released by user.

## 1.03 SUBMITTALS

A. Reference Section 01 33 00; submit the following items:
   1. Product Data
   2. Shop Drawings: Include special conditions not detailed in Product Data. Show interface with adjacent work.
   3. Quality Assurance/Control Submittals:
      a. Provide manufacturer ISO 9001:2015 registration.
      b. Provide manufacturer and installer qualifications - see below.
      c. Provide manufacturer's installation instruction.
      d. Manufacturer must provide independent testing lab results proving 0.3 CFM/FT2 or less air infiltration.
   4. Closeout Submittals:
      a. Operation and Maintenance Manual.
      b. Certificate stating that installed materials comply with this specification.

## 1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer Qualifications: ISO 9001:2015 registered and a minimum of five years' experience in producing doors of the type specified.
   2. Installer Qualifications: Manufacturer's approval.

## 1.05 DELIVERY STORAGE AND HANDLING

A. Follow manufacturer's instructions.

## 1.06 WARRANTY

A. Standard Warranty: Two years from date of shipment against defects in material and workmanship.

B. Maintenance: Submit for the Owner's consideration and acceptance of a maintenance service agreement for installed products.



# PART 2 PRODUCT

## 2.01 MANUFACTURER

A. Manufacturer:
   1. Cookson.
   2. Cornell.
   3. Wayne Dalton.
   4. Approved equal.

## 2.02 PRODUCT INFORMATION

A. Cookson Model: ESD20 shall serve as the standard of quality for rolling service door requirements specified herein.

## 2.03 MATERIALS

A. Curtain: Air infiltration rate of less than .3 CFM/FT2, as tested per ASTM E283 validated by an independent testing agency. Test report required.
   1. Fabrication:
      a. Aluminum: 0.040 inch (1.016 mm) aluminum.
      b. Insulation: 7/8 inch (22 mm) foamed-in-place, closed cell urethane.
      c. Total Slat Thickness: 15/16 inch (24 mm).
      d. Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E84.
      e. R-value: 8.0.
      f. STC Rating: Sound Transmission Class (STC) rating up to 30 for the curtain and up to 22 for the entire assembly. If an STC of 32 is desired, additional options are required. All configurations are evaluated per ASTM E90 and based on testing a complete, operable assembly.
   2. Exterior Slat Finish:
      a. Atmoshield® Powder Coating System (Color Selected by Owner):
         1) ASTM A 653 galvanized base coating treated with dual process rinsing agents in preparation for chemical bonding, gray baked-on base coat and gray baked-on polyester finish coat
         2) Zirconium pre-treatment followed by baked-on polyester powder coat, with color to be selected by Owner; minimum 2.5 mils (0.065 mm) cured film thickness; ASTM D-3363 pencil hardness: H or better
   3. Interior Slat Finish:
      a. Atmoshield® Powder Coating System (Color Selected by the Owner):
         1) ASTM A 653 galvanized base coating treated with dual process rinsing agents in preparation for chemical bonding, gray baked-on base coat and gray baked-on polyester finish coat
         2) Zirconium pre-treatment followed by baked-on polyester powder coat, with color to be selected by the Owner; minimum 2.5 mils (0.065 mm) cured film thickness; ASTM D-3363 pencil hardness: H or better

B. Endlocks: Fabricate interlocking sections with high strength nylon endlocks on alternate slats each secured with two 1/4-in. (6.35 mm) rivets. Provide windlocks as required to meet specified wind load.
   1. Nylon: Required up to 21-ft 5-in width (DBG - Distance Between Guides).

C. Bottom Bar
   1. Configuration:
      a. Insulated Bottom Bar: Reinforced extruded aluminum interior face with full depth insulation and exterior skin slat to match curtain material and gauge. Minimum 4-in. tall by 1-1/16-in. thickness.
   2. Finish:
      a. Exterior: Match slats.
      b. Interior: Powder coat to match slats.
   3. Air Infiltration Certification Label: Must be affixed to bottom bar.

D. Guides:
   1. Fabrication:
      a. Thermal break required. Minimum 3/16 inch (4.76 mm) aluminum angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Top of inner and outer guide angles to beflared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.
      b. Top 16 1/2 in. (419.10 mm) of coil side guide angles to be removable for ease of curtain installation and as needed for future curtain service.
   2. Finish:
      a. AtmoShield Powder Coat (Color Selected by Architect): Zirconium pre-treatment followed by baked-on polyester powder coat, [Color to be selected by Owner; minimum 2.5 mils (0.065 mm) cured film thickness; ASTM D-3363 pencil hardness: H or better.

E. Counterbalance Shaft Assembly:
   1. Barrel: Steel pipe capable of supporting curtain load with maximum deflection of
   2. 0.03 inches per foot (2.5 mm per meter) of width.
   3. Spring Balance: Oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door to ensure that maximum effort to operate will not exceed 25 lbs (110 N). Provide wheel for applying and adjusting spring torque.

F. Brackets:
   1. Fabricate from minimum 3/16 in. (5 mm) steel plate with permanently lubricated ball or roller bearings at rotating support points to support counterbalance shaft assembly and form end closures.
      a. Finish:
         1) AtmoShield Powder Coat (Color Selected by Owner): Zirconium pre-treatment followed by baked-on polyester powder coat, color to be selected by the Owner; minimum 2.5 mils (0.065 mm) cured film thickness; ASTM D-3363 pencil hardness: H or better.



G. Hood:
   1. Minimum 0.040 inch (1.016 mm aluminum] with reinforced top and bottom edges. Provide minimum 1/4-in. (6.35 mm) steel intermediate support brackets as required to prevent excessive sag.
      a. Finish:
         1) Atmoshield® Powder Coating System (Color Selected by Owner):
            a) ASTM A 653 galvanized base coating treated with dual process rinsing agents in preparation for chemical bonding, gray baked-on base coat and gray baked-on polyester finish coat.
            b) Zirconium pre-treatment followed by baked-on polyester powder coat, with color selected by the Owner; minimum 2.5 mils (0.065 mm) cured film thickness; ASTM D-3363 pencil hardness: H or better.

H. Weatherstripping:
   1. Bottom Bar:
      a. Manually Operated Doors: Neoprene astragal extending full width of door bottom bar.

2. Guides: Replaceable vinyl strip on guides sealing against both sides of curtain
3. Lintel Seal: Double brush seal with EPDM sandwiched between the two brush seals at door header to impede air flow.
4. Hood: Neoprene/rayon baffle to impede air flow above coil.

## 2.04 OPERATION

A. Manual Control Guard Chain Hoist: Provide chain hoist operator with endless steel chain, chain pocket wheel and guard, geared reduction unit, and chain keeper secured to guide. Chain hoist to include integral brake mechanism that will immediately stop upward or downward travel and maintain the door in a stationary position when the hand chain is released by the user.

## 2.05 ACCESSORIES

A. Locking: Padlockable slide bolt on coil side of bottom bar at each jamb extending into slots in guides. Provide interlock switches on Motor operated units.

# PART 3 EXECUTION

## 3.01 EXAMINATION

A. Examine substrates upon which work will be installed and verify conditions are in accordance with approved shop drawings.

B. Coordinate with responsible entity to perform corrective work on unsatisfactory substrates.

C. Commencement of work by installer is acceptance of substrate.

## 3.02 INSTALLATION

A. General: Install door and operating equipment with necessary hardware, anchors, inserts, hangers and supports in accordance with the door manufacturer's written instructions.

## 3.03 ADJUSTING

A. Following completion of installation, including related work by others, lubricate, test, and adjust doors for ease of operation, free from warp, twist, or distortion.

## 3.04 CLEANING

A. Clean surfaces soiled by work as recommended by manufacturer.

B. Remove surplus materials and debris from the site.

## 3.05 DEMONSTRATION

A. Demonstrate proper operation to Owner.

B. Instruct Owner in maintenance procedures.

**END OF SECTION**

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TRANSLUCENT UNIT SKYLIGHT PANEL SYSTEM

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope
   1. This Section specifies the removable structural translucent unit skylight panel system.
   2. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install the translucent unit skylight panel system.
   3. The extent of the translucent unit skylight panel system is shown and specified.
   4. Types of products required include the following.
      a. Factory fabricated structural insulated translucent sandwich panel system.
      b. Structural aluminum box beam superstructure with permanent eye-hooks.
      c. Anchors, inserts, support brackets, expansion devices, fasteners and flashings.
      d. Custom and premium, custom blended, full strength polyvinylidene fluoride finishes and colors, with extended life topcoat.
      e. Sealants, setting blocks and miscellaneous materials and accessories.

B. Coordination
   1. Review installation procedures under other specification sections and coordinate the installation of items that must be installed prior to the translucent unit skylight panel system work.
   2. Notify other Contractors in advance of the installation of the translucent unit skylight panel system to provide them with sufficient time for the installation of items included in their Contracts that must be installed with, or before, the translucent unit skylight panel system.

C. Performance Requirements:
   1. The Supplier shall be responsible for the configuration and fabrication of the complete translucent unit skylight panel system, including the aluminum box beam superstructure with lifting eye-hooks .
      a. System to conform to applicable sections of the International Building Code.
      b. Include structural analysis data signed and sealed by the qualified State of Connecticut professional engineer responsible for their preparation.
      c. Skylight shall be removable as a complete unit by lifting eye-hooks with a crane. Disassembling individual or small groups of panels does not meet the design intent and is not acceptable.
      d. Structural Loads: Provide removable skylight system capable of handling the Roof Live Loads and Wind Loads.
      e. Deflection Limits: Skylight Panels – Limited to L/240 of the clear span.

## 1.02 QUALITY ASSURANCE

A. Reference Codes and Standards

1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

   Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there was no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. In all cases, the effective version of the Connecticut Building Code (CBC) at the time of Advertisement for Bids or Invitation to Bid shall be considered the building code in effect.

| Reference | Title |
|---|---|
| CBC | Connecticut Building Code with Local Amendments |
| American Society for Testing and Materials (ASTM) | See this Section |
| Occupational Safety and Health Administration | OSHA 1910.22 |



B. Warranty

1. A warranty for the equipment specified under this Section shall be provided in accordance with the General Conditions. The Warranty shall be for one (1) year from the date of the Notice of Substantial Completion certificate issued for the Work. If extended warranties are required, a special paragraph calling for an extended warranty will be included in this Section.
2. Special Warranty 1: Translucent Unit Skylight Panel System: Submit copies of written guarantee agreeing to repair or replace skylight which fail to perform as specified, including failure of the seal due to faulty manufacture of the unit for a period of twenty (20) years.

C. Supplier's and Erector's Qualifications

1. Translucent unit skylight panel system Supplier must be listed by a recognized building code authority such as the Connecticut Building Code, which requires quality control inspections by an approved agency.
2. Quality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with AC177 “Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems” as issued by the ICC-ES.

3. Materials and products shall be supplied by a company continuously and regularly employed in the manufacture of similar materials for a period of at least ten consecutive years; and which can show evidence of these materials being satisfactorily used on at least six (6) projects of similar size, scope and type within such a period. At least three of the projects shall have been in successful use for ten (10) years or longer.
4. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an accredited agency.
5. Erection shall be by an installer which has been in the business of erecting similar materials for at least five consecutive years; and can show evidence of satisfactory completion of projects of similar size, scope, and type.

## 1.03 ENVIRONMENTAL CONDITIONS

A. Product in this Section shall be subjected to environmental conditions in accordance with Section 01 11 80 – Environmental Conditions.

## 1.04 SUBMITTALS

A. Preconstruction/Action Submittals: The following minimum submittals shall be submitted prior to construction of this element of the Work in accordance with Section 01 33 00 - Submittals.
   1. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (✓) shall denote full compliance with a paragraph as a whole.

      If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations.

      The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
   2. Samples of each required type and color of aluminum finish, on 12 inch long sections of extrusion shapes used in the Work, 14” x 28” unit of the translucent unit skylight panel and accessories. Samples will be reviewed by Engineer for color and texture only. Compliance with other requirements is the exclusive responsibility of Contractor.
   3. Engineer reserves the right to require samples showing fabrication techniques and workmanship of component parts, and the design of accessories and other exposed auxiliary items for translucent wall panel system work, before fabrication of the Work proceeds.
   4. One of each type of fastener employed, with statement of intended use. Samples will be reviewed by Engineer for material and color only. Compliance with other requirements is the exclusive responsibility of Contractor.

5. Shop Drawings: Submit for approval the following:
    a. Shop Drawings for the assembly and erection of the entire translucent unit skylight panel system, showing all dimensions, gages, finishes, location of joints, connections, fasteners, expansion provisions, and locations and types of glazing gaskets, pressure plates and snap covers and other related items as required. Provide elevations at 1/4 inch scale, and full size detail sections of every typical composite member. Coordinate the submittal of Shop Drawings for component parts (as specified in other Sections) with this submittal. Show anchorages and alignments not shown on Shop Drawings of the components. Indicate clearly on Shop Drawings, all deviations from the Plans. Include structural calculations required to show compliance with wind pressure loading requirements in the Work.
    b. Copies of Suppliers' specifications and installation instructions for required materials and components which are not included in the other submittals specified in other sections of these Specifications. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other sections of these Specifications.

B. Informational Submittals: The following minimum informational submittals shall be submitted in accordance with the timing requirements specified in these Contract Documents, prior to Substantial Completion and in accordance with Section 01 33 00 - Submittals.
    1. Maintenance Manuals (including Warranty) in accordance with Section 01 77 30 - Operating and Maintenance Instructions
        a. Product name and number.
        b. Name, address and telephone number of Supplier and local distributor.
        c. Detailed procedures for routine maintenance and cleaning.
        d. Detailed procedures for light repairs such as dents, scratches and staining.
    2. Test reports to be furnished by translucent unit skylight panel system Supplier. The Supplier shall submit certified test reports made by an independent testing organization for each type and class of panel system. Reports shall verify that the material will meet all performance requirements of this specification. Previously completed test reports will be acceptable if current and indicative of products used on this project. Test reports required are:
        a. International Building Code Evaluation Report (AC 177)
        b. Flame Spread and Smoke Developed (UL 723) – Submit UL Card
        c. Burn Extent (ASTM D-635).
        d. Color Difference (ASTM D-2244).
        e. Impact Strength (UL 972).
        f. Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
        g. Bond Shear Strength (ASTM D 1002)
        h. Insulation U-Factor (NFRC 100)
        i. NFRC System U-Factor Certification (NFRC 700)
        j. Solar Heat Gain Coefficient (NFRC or Calculations)
        k. Condensation Resistance Factor (AAMA 1503)
        l. 1200°F Fire Resistance (SWRI)

m. Fall Through Resistance (ASTM E 661) / OSHA 1910.22
n. Class A Roof Covering Burning Brand (ASTM E 108)
o. Contractor shall submit written guarantee accompanied by test reports that state that the products to be furnished are in accordance with or exceed this specification.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE PRODUCTS

A. Suppliers
1. The Engineer and the Department believe that the following Suppliers are capable of producing equipment and products which will satisfy the requirements of this Section.

B. Candidate Suppliers include the following:
1. Translucent Unit Skylight Panel System by Kalwall Corporation;
2. Translucent Unit Skylight Panel System by Skywall, Incorporated; or
3. Approved Equal.



### 2.02 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose. If alternatives are proposed, the proposals shall be accompanied with documentation supporting the claimed superiority of the proposed substitutions. The Engineer shall be the sole decider in the equivalency of alternative materials or construction.

B. Translucent Facing
1. Translucent faces shall be manufactured from glass fiber reinforced thermoset resins by translucent unit skylight panel system fabricator especially for architectural use.
2. Interior Face Sheet
a. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 50 and smoke developed no greater than 250 when tested in accordance with UL 723.
b. Burn extent by ASTM D 635 shall be no greater than 1”.
3. Exterior Face Sheets
a. Color stability: Full thickness of the exterior face sheet shall not change color more than 3 CIE Units DELTA E by ASTM D 2244 after 5 years outdoor Connecticut weathering at 5° facing south, determined by the average of at least three white samples with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
b. Strength: Exterior face sheet shall be uniform in strength, impenetrable by hand held pencil and repel an impact minimum of 70 ft. lbs. without fracture or tear when impacted by a 3-1/4” diameter, 5 lb. free-falling ball per UL 972.

c. Strength: Exterior face sheet shall be uniform in strength, with panel meeting ASTM E1996 and ASTM E1886 or TAS 201, 202 and 203.

d. The exterior face shall have a permanent glass erosion barrier to provide maximum long-term resistance to reinforcing fiber exposure and shall be warranted against same for 25 years.

e. The exterior face shall have a self-cleaning thermoset acrylic urethane surface molecularly bonded under factory controlled conditions, minimum 1.2 mils thick, and fully field restorable if worn or damaged.

4. Appearance

a. The face sheets shall be uniform in color to prevent splotchy appearance. Faces shall be completely free of ridges and wrinkles which prevent proper surface contact in bonding to the aluminum grid core. Clusters of air bubbles/pinholes which collect moisture and dirt will not be acceptable.

b. Exterior face sheet: Smooth, .070" thick and Crystal in color.

c. Interior face sheet: Smooth, .045" thick and Crystal in color.

d. Face sheets shall not vary more than ± 10% in thickness and be uniform in color.

C. Grid Core

1. Composite I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16".

2. I-beam: Minimum 1", thermoset fiberglass composite.

D. Adhesive

1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the 2021 International Building Code "Acceptance Criteria for Sandwich Panel Adhesives".

2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.

3. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions:

a. 50% Relative Humidity at 68° F: 540 PSI

b. 182° F: 100 PSI

c. Accelerated Aging by ASTM D 1037 at room temperature: 800 PSI

d. Accelerated Aging by ASTM D 1037 at 182° F: 250 PSI

## 2.03 PANEL CONSTRUCTION

A. Provide non-thermally broken 2-3/4" panel with 0.29 U-factor/35% Light Transmission (Crystal Exterior .070 and Crystal Interior .045).

B. Unit skylights that are removable shall be fully removable and self-contained as a unit.

C. Translucent panels shall be a true sandwich panel of flat fiberglass sheets bonded to a grid core of mechanically interlocking aluminum I-beams and shall be laminated under a controlled process of heat and pressure. Tape bond systems are not allowed.

D. All grid patterns shall be 8-inches by 20-inches and be symmetrical about the horizontal center line of each panel of the skylight.

E. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge. In order to ensure bonding strength, white spots at intersections of muntins and mullions shall not exceed four for each 40 square feet of panel, nor shall they be more than 3/64 inches in width.

## 2.04 BATTENS AND PERIMETER CLOSURE SYSTEM

A. Extruded 6063-T6 and 6063-T5 aluminum closure system. Perimeter system shall be factory prefabricated with "U" = .50 or less.

B. All battens and perimeter closures shall be installed with concealed fasteners, 410 series stainless steel screws.

C. Ridge, hip and eave type channel members, closure members, and interior angles to have a minimum fillet of .090-inch to ensure strength at point of greatest stress.

D. Fasteners to the skylight curb shall be 300 Series stainless steel screws or bolts in expansion anchors of the size required to support the unit skylight system and provide a removable unit skylight connection as recommended by the Supplier.

E. Finish: Supplier's factory applied finish, which meets the performance requirements of AAMA 2604. Color to be selected from supplier's full range of standards.



## 2.05 SUPERSTRUCTURE

A. The superstructure shall be pre-fabricated of extruded aluminum alloy 6005-T5, 6005A-T61 or 6061-T6 box beams. Ferrous metals shall not be allowed. All parts shall be pre-assembled at the factory and knocked down for shipment. System shall be a center ridge with hipped ends, rigid frame design.

B. Finish: Supplier's factory applied finish, which meets the performance requirements of AAMA 2604. Color to be selected from supplier's full range of standards.

C. Aluminum structural system design and calculations must be furnished in accordance with the Aluminum Association “Specifications for Aluminum Structures” and the applicable building code. Design calculations must be prepared and stamped by a Licensed Professional Engineer in the State of Connecticut.

## 2.06 FLEXIBLE SEALING TAPE

A. Sealing tape shall be Supplier's standard pre-applied to closure system at the factory under controlled conditions.

## 2.07 COATINGS

A. Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength poly-vinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded material. Comply with the following:

1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
2. Prepare a chemical conversion coating on the surface, using phosphates or chromates followed by a cold water rinse. Seal with a chromic acid rinse and dry, except where the Supplier recommends another method to achieve greater coating reliability.
3. Apply a base prime coat of epoxy paint to the prepared surface in its coil form, by reverse roller coating. Fully cure in a gas fired oven to a dry film thickness of 0.2 - 0.4 mils.
4. Apply finish coating over the primer by roller coating for coil material and airless or Ransburg Elastrostatic Hand Spray for extrusions and fuse at a peak metal temperature of 440 F for a dry film thickness of 0.7 mils for coil coating and 1.2 mils for spray coating so that the total dry film is approximately 1.0 mil thick for coil material and 1.5 mils thick for extruded material.
5. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to Engineer:
   a. Weathering, ASTM D 659: Chalking, not more than No. 8, after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
   b. Color Change, ASTM D 2244: No greater than 5 N.B.S units after removal of external deposits and after exposure for 5000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
   c. Humidity Resistance, ASTM D 2247; few scattered blisters no larger than ASTM No. 4, after 1000 hours.
   d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16 inch creep from areas scribed to bare metal after 500 hours.
   e. Dry Adhesion: No pick off when tape tested over 1/16 inch cross hatch.
   f. Wet Adhesion: No pick off when tape tested over 1/16 inch cross hatch; extruded material only.
   g. Boiling Water Adhesion: No pick off when tape tested over cross hatch area after 1 hour immersion in distilled boiling water.
   h. Water Immersion: No pick off when tape tested over cross hatch area after immersion in aerated distilled water 80 ±10F after 500 hours.
   i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67 minimum.
   j. Gloss, ASTM D 523: 30±5 reflectivity at 60 F.
   k. Pencil Hardness: F minimum.
   l. Dry Film Thickness: Primer, 0.2 0.4 mils, polyvinylidene fluoride based coating, 0.7 1.5 mils.
   m. Solvent Resistance: 100 Double MEK rubs minimum.
   n. Flexibility, ASTM D 1737: No cracking prior to metal fracture.
   o. Acid Resistance, ASTM D 1308: 16 hour spot test with 5% hydrochloric acid no effect.

p. Alkali Resistance, ASTM D 1308: 16 hour spot test with 5% sodium hydroxide no effect.

B. Color: Finish color of battens and perimeter closure is to be selected by Engineer.

C. Product and Supplier
1. Kynar 500 Fluropon by DeSoto Incorporated;
2. Kynar 500 Duranar by PPG Industries, Incorporated; or
3. Approved Equal.

## PART 3 EXECUTION

### 3.01 SHIPMENT AND STORAGE

A. Product shall be shipped and stored in accordance with Section 01 60 00 - Common Product Requirements.

B. Supplier shall provide Contractor with detailed recommendations and instructions for product storage.

C. Storage of Materials
1. Store skylights to permit easy access for inspection and identification. Keep all materials off the ground, using pallets, platforms, or other supports.
2. Protect from weather and damage.
3. Store in designated areas as close as possible to point of installation.



### 3.02 INSTALLATION

A. Inspection
1. Contractor and his installer must examine the substrate and conditions under which translucent unit skylight panel system work is to be installed and notify Engineer in writing of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Comply with Supplier's specifications and recommendations for the installation of the translucent unit skylight panel system.

C. Set the skylight units plumb, level and true to line, without warp or rack of frames. Anchor securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

D. Field Quality Control
1. Water Test: Installer to test skylights according to procedures in AAMA 501.2.
2. Repair or replace work that does not pass testing or that is damaged by testing and retest work.

E. Adjustment and Cleaning

1. Clean aluminum surfaces and translucent surfaces promptly after installation, exercising care to avoid damage of the finish. Remove excess glazing and sealant compounds, dirt and other substances.
2. Advise Contractor of protective treatment and other precautions required through the remainder of the construction period, to ensure that skylight units will be without damage or deterioration, other than normal weathering, at the time of Final Acceptance.

**END OF SECTION**

SECTION 08 71 00

DOOR HARDWARE

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Scope:
   1. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install finish hardware. Furnish finish hardware for all doors in compliance with these Specifications herein.
   2. Extent of finish hardware is specified. Finish hardware is defined to include all items known commercially as finish hardware, except special types of unique and non-matching hardware specified in the same Section as the door and doorframe.
   3. Types of products required include the following:
      a. Mortise hinges.
      b. High-security mortise locksets.
      c. High-security mortise latchsets.
      d. Panic exit devices.
      e. Overhead, surface-mounted, door closers.
      f. Heavy-duty, concealed, adjustable, overhead holders and stops.
      g. Flush bolts and automatic flush bolts.
      h. Coordinators.
      i. Astragals.
      j. Dust-proof strikes.
      k. Door pulls, push plates and protection armor plate.
      l. Stripping and seals.
      m. Thresholds.
      n. Silencers.
      o. Floor stops.
      p. Wall stops.
      q. Protection Armor.
      r. Miscellaneous items and accessories for a complete installation functioning in compliance with the requirements of governing authorities having jurisdiction at the Site.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the finish hardware.
   2. Coordinate the Work of other Sections to provide clearances and accurate positioning of recessed or cast-in-place items.

### 1.02 REFERENCES

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are

included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. The references listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version reference by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. When document dates are given in the following listing that are not specifically referenced in an applicable code, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. For questions, refer to Engineer.



| Reference | Title |
|---|---|
| ANSI A117.1 | Accessible and Usable Buildings and Facilities |
| ANSI/BHMA A156.1 | Butts and Hinges |
| ANSI/BHMA A156.3 | Exit Devices |
| ANSI/BHMA A156.4 | Door Controls - Closers |
| ANSI/BHMA A156.6 | Architectural Door Trim |
| ANSI/BHMA A156.7 | Template Hinge Dimensions |
| ANSI/BHMA A156.8 | Door Controls - Overhead Stops and Holders |
| ANSI/BHMA A156.13 | Mortise Locks and Latches, Series 1000 |
| ANSI/BHMA A156.16 | American National Standard for Auxiliary Hardware |
| ANSI/BHMA A156.18 | Hardware - Materials and Finishes |
| ANSI/BHMA A156.21 | Thresholds |
| ANSI/BHMA A156.22 | Door Gasketing and Edge Seal Systems |
| ANSI/DHI A115.1 | Preparation of Mortise Locks in 1-3/8-inch and 1-3/4-inch Standard Steel Doors and Frames |
| ANSI/NFPA 252 | Standard Methods of Fire Tests of Door Assemblies |
| DHI | Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames |
| DHI | Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames |
| DHI | Sequencing and Format for the Hardware Schedule |
| HMMA 830 | Hardware Preparation and Locations for Hollow Metal Doors and Frames |
| NFPA 80 | Fire Doors and Fire Windows |
| SDI 109 | Hardware for Standard Steel Doors and Frames |
| SDI 118 | Basic Fire Door Requirements |
| UL | Building Materials Directory |
| UL 10B | Fire Tests of Door Assemblies |
| UL 305 | Panic Hardware |
| Public Law 101-336 | Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG) |

## 1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Provide finish hardware and accessories manufactured by firms specializing in the production of this type of Work and complying with specified standards of ANSI, BHMA, DHI, NFPA, HMMA, SDI and UL.
   2. Provide finish hardware from manufacturers who are members of BHMA and participate in BHMA certification programs.

B. Installer's Qualifications:
   1. The finish hardware installer shall have in his employ an architectural hardware consultant. The architectural hardware consultant shall be a member of the Door and Hardware Institute, (DHI), who has passed the DHI certification examine and successfully completed an apprenticeship program. The architectural hardware consultant shall be responsible for preparing finish hardware schedules and Shop Drawings and be present at the Site for the purpose of checking and supervising the Work of the installer during the time of installation and adjustment of the finish hardware Work, and shall prepare a written field report on status of completed finish hardware installation as specified.
   2. Submit name and qualifications of the installer to the Engineer.

C. Requirements of Regulatory Agencies:
   1. Provide finish hardware for fire-resistance-rated openings in compliance with NFPA 80.
   2. Provide only finish hardware that has been tested, listed and labeled by UL for the types and sizes of doors required, and complies with the requirements of the door and doorframe labels.
   3. Modify features of finish hardware items specified and provide additional accessories and features as required to meet UL and NFPA requirements, at no additional cost to the Owner.

D. Codes: Comply with applicable requirements of codes.

E. Source Quality Control:
   1. Obtain each type of finish hardware item from only one manufacturer.
   2. Provide finish hardware schedule, for submission to, and for approval by the Design-Engineer, prepared in compliance with DHI standards.
   3. Comply with specified BHMA standards.



## 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (☐) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be

underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Manufacturers' certificates of compliance with specified industry standards.

C. Samples:
   1. Actual unit of each finish hardware item specified incorporating all standard and special features and finishes specified, demonstrated and identified by manufacturer's representative to the Engineer. Samples shall be presented at time of Shop Drawing submittal, as Engineer will not review or approve Shop Drawings without concurrent sample submissions.
   2. Approved samples may be incorporated into the finish hardware Work.
   3. Engineer's review will be for appearance and for general compliance with required features. Compliance with all other requirements is the responsibility of Contractor.

D. Shop Drawings:
   1. Copies of manufacturer's data for each item of finish hardware. Include whatever information may be required to show compliance with specified requirements and include instructions for installation and for maintenance of operating parts and exposed finishes. Include mounting heights and locations for each item of finish hardware. Provide Engineer with latest complete technical catalogue of all available finish hardware manufactured by proposed manufacturers, even if manufacturer specified by Engineer is submitted by Contractor to perform the Work. Furnish templates to fabricators of other Work, which is to receive finish hardware.
   2. Copies of the Finish Hardware Schedule in the manner and format specified, complying with the actual construction Progress Schedule requirements (for each draft). Include explanation of abbreviations, symbols, and codes used to present scheduled information.
      a. Prepare and submit Finish Hardware Schedule in compliance with HDI standards.
   3. Based on the finish hardware requirements specified, organize the final Finish Hardware Schedule into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other Work (such as hollow metal frames) which may be critical in the Project Schedule. Furnish final draft of schedule after Samples, manufacturer's data sheets, coordination with Shop Drawings for other Work, delivery schedules and similar information have been completed and accepted.
   4. Include a separate key schedule, showing clearly how Owner's final instructions on keying of locks have been fulfilled.

5. Finish Hardware Schedules are intended for coordination of the Work. Review and acceptance by Engineer does not relieve Contractor of responsibility to fulfill the requirements as shown and specified.
6. Installer's qualifications.
7. Maintenance Manual: Upon completion of the Work, furnish five copies of detailed maintenance manuals, including the following information:
    a. Product name and manufacturer.
    b. Name, address, e-mail address and telephone number of manufacturer and local distributor.
    c. Detailed procedure for routine maintenance and cleaning.
    d. Detailed procedures for repairs such as dents, scratches and staining.
    e. Parts identification manual and maintenance manuals for each piece of finish hardware.

E. Test Reports: Submit for approval certified independent laboratory test reports for BHMA certification program and certification tests for each type of product specified.

## 1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
2. Deliver all items of finish hardware in manufacturer's original, undamaged packages, bearing accurate representation of the item within each package.
3. Pack each piece of finish hardware separately, complete with screws, keying, instructions and templates, tagged to correspond with items submitted on approved Shop Drawings and as specified.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Provide secure storage area for finish hardware items, secured by locks and accessible only to finish hardware installer, Engineer and Contractor.
3. Store finish hardware in manufacturers' original packages.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Owner, in writing, if any loss or damage exists to equipment or components. Items that arrive in a damaged condition shall be removed from the Site and not offered again for acceptance. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

## PART 2 PRODUCTS

### 2.01 SYSTEM PERFORMANCE

A. Description:

1. Where the finish, shape, size, fire-resistance-rating, frequency of use, or function of a member receiving finish hardware is such as to prevent, or make unsuitable, the types of finish hardware specified, furnish similar types having as nearly as practicable the same operation but of type or kind more appropriate to the design intension and requirements of governing authorities having jurisdiction at the Site. Clearly identify and highlight to the Engineer and Owner all such required modifications on Shop Drawings submitted for approval.
2. If finish hardware for any location is not specified, provide finish hardware equal in design and quality to adjacent finish hardware specified for comparable openings at no additional cost to Owner.
3. Furnish finish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements, as necessary for proper installation and function.
4. Unless otherwise specified, comply with DHI, Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames and Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.



### 2.02 DETAILS OF CONSTRUCTION

A. General:

1. Hand of Door: The Drawings show the swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish each item of finish hardware for proper installation and operation of the door swing as shown.
2. Manufacturer's Name Plate: Do not use manufacturer's products which have manufacturer's name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with labels required by governing authorities having jurisdiction at the Site.
3. Base Metals: Produce finish hardware units of the basic metal and forming method specified, using the manufacturer's standard metal alloy, composition, temper and hardness. Do not substitute materials or forming methods for those specified.
4. Fasteners: Manufacture finish hardware to conform to published templates, generally prepared for machine screw installation. Do not provide finish hardware, which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
5. Furnish screws for installation, with each finish hardware item. Provide Phillips flat-head screws except as otherwise specified. Finish exposed (exposed under any condition) screws to match the hardware finish or, if exposed in surfaces on other Work, to match the finish of such other Work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.
6. Provide fasteners which are compatible with both the unit fastened and the substrate, and which will not cause corrosion or deterioration of finish hardware, base material or fastener.
7. Provide concealed fasteners for finish hardware units, which are not exposed when the door is closed, except to the extent no standard manufacturer units of the type

specified are available with concealed fasteners. Do not use through bolts for installation where the bolt head or the nut on the opposite face is exposed in other Work under any condition, except where it is not possible to adequately reinforce the Work and use machine screws or concealed fasteners of another standard type to satisfactorily avoid the use of through bolts.

8. Tools for Maintenance: Furnish two complete sets of specialized tools as required for Owner's continued adjustment, maintenance, removal and replacement of finish hardware.

B. Mortise Hinges:
   1. Templates and Screws: Provide only template-produced units.
   2. Base Metal: Except as otherwise specified, fabricate hinges from stainless steel and finish to match the latch and lock set.
   3. Number of Hinges: Provide two hinges on each door leaf of less than 60-inches in height; provide one additional hinge for next 30-inches of door height or fraction thereof; provide two additional hinges for each 30-inches or fraction thereof, for doors above 90-inches tall.
   4. Hinge Size: Except as otherwise specified or as required to comply with UL and NFPA, provide hinges of the following sizes:
      a. Interior Doors:
         1) Average Use, Maximum 36-Inches Wide: 4-1/2-inch standard weight (0.134-inches).
         2) Heavy Use, Maximum 36 Inches Wide: 4-1/2-inch heavyweight (0.180-inches).
      b. Exterior Doors, Maximum 36-Inches Wide: 4-1/2-inch heavyweight (0.180-inch).
      c. Wide Exterior and Interior Doors:
         1) Maximum 48-inches wide: 5-inch heavyweight (0.190-inch).
         2) Over 48 inches wide: 6-inch heavy weight (0.203-inch).
   5. Types of Hinges: Provide full-mortise type, ball-bearing hinges, swaged for mortise applications, inner leaf beveled, square cornered, unless manufacturer's recommendations indicate that half-mortise, half-surface, full-surface or other type should be used for the frame and door type or condition.
   6. Hinge Pins: Except as otherwise specified, provide hinge pins as follows:
      a. Pins: Stainless steel.
      b. Exterior Doors: Non-removable pins. Provide setscrew in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed.
      c. Tips: Slope ends of hinge barrel.
   7. Conform to ANSI/BHMA A156.7.
   8. Comply with UL, List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
   9. Products and Manufacturers: Provide one of the following:
      a. FBB 199 and FBB 191 by Stanley Commercial Hardware, Division of The Stanley Works.
      b. T4B3386 and TB3313 by McKinney Products Company, Division of ESSEX Industries, Incorporated.
      c. Or approved equal.

C. High-Security Mortise Locks and Latch Sets:
   1. Strikes: Provide manufacturer's standard wrought box strike, for each location and use shown. Provide stainless steel curved lip strikes, unless otherwise recommended by manufacturer, finished to match lock or latch set trim.
   2. Lock Throw: Provide minimum of 3/4-inch anti-friction latch bolt and 1-inch dead bolt throw. Comply with UL requirements for throw of latch bolts and deadbolts on fire-resistance-rated openings.
   3. Materials: Provide the following features and materials:
      a. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.
      b. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
      c. Case: Wrought steel, zinc dichromatized.
      d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
      e. Armor Front: 8-inches by 1-1/4-inches wide, minimum, steel.
      f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
      g. Hubs: Sintered steel, copper infiltrated.
      h. Lever with Stop Pin: Brass, plated to match stainless steel, with additional built-in stop to prevent over-torquing of lever.
      i. All components shall be of marine quality, wherever possible.
   4. Backset: 2-3/4-inches.
   5. Modify specified locks and latches to comply with UL, Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
   6. Finish: US 32D satin.
   7. Conform to ANSI/BHMA A156.13, Series 1000, Security Grade 1.
   8. Products and Manufacturers: Provide one of the following:
      a. Sargent 9 or 10 Line Series to match existing locks on site, coordinate with owner.
      b. High Security SL8800 Mortise Lockset with Augusta - AUSL Lever Handles and Trim by Yale Commercial Locks and Hardware, an ASSA ABLOY Group company.
      c. ML2000 Series Mortise Lockset and with Newport NSM Lever Handles and Trim by Corbin Russwin Architectural Hardware, an ASSA ABLOY Group Company.
      d. Or approved equal.

D. Panic Exit Devices:
   1. Exit Doors: Where required by governing authorities having jurisdiction at the Site, provide panic exit devices, of the type required, including UL labels.
   2. Fire Doors: Where shown or specified as a fire-resistance-rated door, provide units listed and labeled by UL, to comply with the fire-resistance-rating and size of door shown.
   3. Strikes: Provide manufacturer's standard wrought stainless steel jamb-mounted top latch bolt and bottom latch bolt for each location and use shown to allow independent opening and closing of each leaf of double doors with panic exit

devices; complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.

4. Lock Throws: Provide minimum of 3/4-inch latch bolt throw complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.
5. Provide concealed vertical rod type exit device and mortise type exit devices as specified.
6. Provide the following features and materials:
   a. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.
   b. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
   c. Case: Wrought steel, zinc dichromatized.
   d. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.
   e. Armor Front: 8-inches by 1-1/4-inches wide, minimum; steel.
   f. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
   g. Hubs: Sintered steel, copper infiltrated.
   h. Crossbar: Oval, seamless with interlocking expansion collets and roll pins; knurled, satin stainless steel, 0.062-inches minimum thickness, with steel reinforcing tube.
   i. Concealed bolts: Minimum 1/2-inch diameter, stainless steel.
7. Backset: Provide minimum backset of 2-3/4-inches.
8. Finish: US 32D satin.
9. ANSI/BHMA: A156.3, Type 3 and Type 4, Grade 1; F08, entrance by lever, key locks or unlocks lever for entrances shown as accessible to people with disabilities as required by ADAAG; and F05, entrance by thumb piece, key locks or unlocks thumb piece.
10. Products and Manufacturers: Provide one of the following:
    a. 1530 J8 (F) and J78 (F) Series Mortise Exit Devices and 1520(F) CVR Concealed Vertical Rod Exit Devices; with Escutcheon Trim and Augusta - ASL Lever Handles and Thumbpiece/Handle/Cylinder Unit by Yale Security, Incorporated, Division of Yale Security Group.
    b. Or approved equal.

E. Cylinders and Keying System:
   1. Standard System: Except as otherwise specified, provide new master key system for the Project.
   2. Multiple-Building System: Except as otherwise specified, provide new grandmaster key system for Project.
   3. Existing System: Grandmaster key or great-grandmaster keys the locks to Owner's existing system, with a new master key for the Project.
   4. Review the keying system with Owner’s and provide the type required (master, grandmaster or great grandmaster), either new or integrated with Owner's existing system.
   5. Furnish all locks with manufacturer's cylinders for interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period, and remove these

before Substantial Completion. Construction control keys and cores shall not be part of Owner's permanent keying system. Permanent cores and keys shall be furnished to Owner prior to Substantial Completion.

6. Comply with the Owner's instructions for master keying and, except as otherwise specified, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.
7. Permanent keys and cores shall be stamped with the applicable key mark for identification. These visual key control marks or codes shall not include the actual key cuts. Permanent keys shall also be stamped "DO NOT DUPLICATE".
8. Cylinder Material: Brass, bronze or Series 300 stainless steels.
9. Cylinder Features: Seven-pin, high-security, removable core.
10. Key Material: Nickel silver.
11. Key Quantity: Furnish three keys for each lock and five keys for each master and grandmaster system. Provide one extra key blank for each lock.
12. Provide a key control system including envelopes, labels, tags with self-locking key clips, receipt forms, three-way visible card index, temporary markers, permanent markers and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150 percent of the number of locks required for the Project. Provide a hinged-panel type cabinet, for wall mounting.

F. Overhead, Surface-Mounted, Door Closers:

1. Provide all doors, unless specially shown or specified as being provided with floor-mounted or concealed overhead closers, with surface-mounted overhead door closers. Provide both active and inactive door leafs with closers.
2. Size of Units: Except as otherwise specified, comply with the manufacturer's recommendations for size of door control unit, depending upon size of door, exposure to weather, and anticipated frequency of use.
3. Where parallel arms are specified, and for closers on exterior doors, provide closer unit one size larger than recommended for use with standard arms.
4. Use parallel arm arrangement for doors that would otherwise have the door closer appearing in finished corridors or entries.
5. Comply with UL Building Materials Directory, and List of Inspected Fire Protection Equipment and Materials, and NFPA 80. Modify closers specified as required.
6. Provide hold open feature for all non-fire-resistant-rated doors, unless otherwise specified.
7. Provide corner bracket mounting on exterior doors. Select all arms to clear weather-stripping, and overhead door holders.
8. Provide long arm to allow door to swing 180 degrees where long arm will eliminate floor-mounted stops.
9. Provide closers with spring power adjustment feature capable of increasing spring power 15 percent minimum in all closer sizes.
10. Provide individual regulating valves for closing and latching speeds, and separate adjustable back check valve.
11. Provide delayed closing action feature on all door closers. Position valve at top of closure.
12. Provide the following materials and features:
    a. Full Metal Cover: Aluminum.

b. Case: Cast-iron.
c. Arms: Plated to match full metal covers.
d. Other Parts: Steel.
e. Extreme temperature fluid.
f. Security torx machine screws.
g. Ten-year warranty.
h. Provide manufacturer's optional corrosion protection.

13. Finishes: US 26D satin chrome. Color coordinate all arms and other accessories.
14. Highly Corrosive Atmospheres: Provide all closers with specified manufacturer's optional corrosion protection.
15. ANSI/BHMA: A156.4, C02011, in compliance with PT 1 and PT 4.
16. Products and Manufacturers: Provide one of the following:
    a. DC2000DA M71, M73, M74, M75, M87 by Corbin Russwin, Incorporated, Division of Yale Security Group.
    b. or approved equal.

G. Heavy-Duty, Concealed Overhead Holders and Stops:
1. Provide heavy-duty, concealed overhead holders and stops on all exterior and all interior doors, unless otherwise specified to receive an extra heavy-duty overhead holder and stop in List of Finish Hardware Items at end of Part 3. Comply with UL and NFPA requirements for hold-open feature.
2. Provide the following features and materials:
    a. Shock Absorber Spring: Heavy tempered steel.
    b. Channel: Heavy-gauge brass.
    c. All other Parts: Stainless steel.
    d. Adjustment: Degree of hold-open and stop shall be adjustable after installation.
3. Finish: US 32D satin.
4. Coordinate placement of concealed overhead holder and stop with overhead closers.
5. ANSI/BHMA: A156.8, C51511.
6. Products and Manufacturers: Provide one of the following:
    a. Heavy-Duty 100H (ADJ) Series Concealed Holders and Stops by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
    b. or approved equal.

H. Protection Armor:
1. Protection Armor:
    a. Provide one armor plate per leaf of each door scheduled to receive armor-plate protection.
    b. Provide 16-gauge stainless steel with No. 4 finish 2 foot-0 inches high by 2-inches less in width than width of door.
    c. ANSI/BHMA: A156.6, J101; B3E.
    d. Products and Manufacturers: Provide one of the following:
        1) 193S Beveled Stainless Steel Armor Plate by Hager Hinge Company.
        2) or approved equal.

I. Stripping and Seals:
   1. Provide perimeter weather stripping at all exterior doors. Provide stripping and seals for interior doors where scheduled in List of Finish Hardware Items at end of Part 3.
   2. Continuity of Stripping: Except as otherwise specified, stripping at each opening shall be continuous and without unnecessary interruptions at door corners and hardware.
   3. Replaceable Seal Strips: Resilient or flexible seal strip of every unit shall be easily replaceable and readily available from stocks maintained by the manufacturer.
   4. Provide bumper-type weather-stripping at jambs and head, including a resilient insert and metal retainer strip, surface-applied, of the following metal, finish and resilient bumper material:
      a. Housing: Extruded aluminum with dark bronze anodized finish; 0.062-inch minimum thickness of main walls and flanges.
      b. Dimensions: 1-3/8-inches by 7/8-inches, stop-mounted.
      c. Seals: Closed-cell extruded silicone.
      d. ANSI/BHMA: A156.22, R3E264.
      e. Products and Manufacturers: Provide one of the following:
         1) No. 350DSPK and 2891 DPK (for parallel arms) by Pemko Manufacturing Company.
         2) or approved equal.
   5. Provide heavy-duty automatic drop-seal sound-stripping door-bottom unit of manufacturer's standard design, with operating seal bar of the following material, retained in an extruded metal bar and capable of operating to close a 3/4-inch gap (from door bottom to floor or threshold). House mechanism and operating bar in the following metal housing, for mounting in doors as follows:
      a. Housing: Extruded aluminum, 0.062-inch thick, with mill aluminum finish.
      b. Seal: Closed-cell extruded silicone.
      c. Mounting: Full-mortise.
      d. ANSI/BHMA: A156.22, R3E344.
      e. Products and Manufacturers: Provide one of the following:
         1) No. 434APKL by Pemko Manufacturing Company.
         2) or approved equal.



J. Thresholds:
   1. All exterior and interior doors shall be provided with thresholds.
   2. Metal: Mill finish extruded bronze.
   3. Surface Pattern: Fluted tread, manufacturer's standard.
   4. Provide countersunk stainless-steel screws and expansion shields.
   5. Width: Five-inches wide and of length sufficient to span full width of rough openings, coped and scribed neatly at and around doorframes.
   6. Construction:
      a. Single-piece, complying with manufacturer's recommendations.

7. Profile: Provide manufacturer's unit, which conforms to the minimum size and profile requirements specified.
    a. Floor Drop: Except where no change in floor elevation is shown from one side of threshold to the other, provide profile that accommodates 1/2-inch drop in floor elevation, unless another dimension is shown.
    b. For doors equipped with panic hardware, including floor bolts, provide profile with stop bar of proper size and shape to function as the strike plate for the floor bolts.
8. Thickness: 1/2-inch, minimum.
9. ANSI/BHMA: A156.21, J12100.
10. Products and Manufacturers: Provide one of the following:
    a. 171B by Pemko Manufacturing Company.
    b. or approved equal.

K. Wall and Floor Stops: Provide the following where scheduled in List of Finish Hardware Items at end of Part 3:
1. Dome-Type Floor Stops:
    a. Cast bronze extra heavy-duty wall mounted doorstop, one per leaf.
    b. Coordinate height of dome-type floor mounted doors stops with threshold condition and undercut of door.
    c. Finish: US 26D satin chrome.
    d. ANSI/BHMA: A156.16, L12161.
    e. Products and Manufacturers: Provide one of the following:
        1) FB13/14R, FB17 by Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation.
        2) or approved equal.

L. Sealants: Provide elastomeric sealant complying with FS TT-S-00227, Type 2 (non-sag) Class A for use with thresholds.



## 2.03 HARDWARE FINISHES

A. Provide matching finishes for finish hardware units at each door or opening, to the greatest extent possible in compliance with ANSI/BHMA A156.18.

B. Reduce differences in color and textures as much as commercially possible where the base metal or metal forming process is different for individual units of finish hardware exposed at the same door or opening. In general, match all items to the manufacturer's standard finish for the latch and lock set for color and texture.

# PART 3 EXECUTION

## 3.01 INSPECTION

A. Examine the substrate to receive finish hardware, and the conditions under which the Work will be performed, and notify the Owner, in writing, of unsatisfactory conditions. Do not proceed with the finish hardware Work until unsatisfactory conditions have been corrected in a manner acceptable to the Owner.

## 3.02 PREPARATION

A. Templates: Furnish finish hardware templates to each fabricator of doors, frames and other Work to be factory-prepared for the installation of finish hardware. Check the Shop Drawings of such other Work, to confirm that adequate provisions are made for the proper installation of the finish hardware.

B. Prepare Work to receive finish hardware Work in compliance with ANSI/DHI A115.1.

## 3.03 INSTALLATION

A. Installer shall check and approve the installation before operation. Installer shall assure that the system operates to the Owner's satisfaction.

B. Mount finish hardware units at heights recommended in, Door and Hardware Institute, “Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames” and “Recommended Locations for Builders’ Hardware for Custom Steel Doors and Frames", except as otherwise specified or required to comply with governing authorities having jurisdiction at the Site, HMMA 830 and ADAAG requirements.

C. Install each finish hardware item in compliance with the manufacturer's instructions and recommendations and approved Shop Drawings. Wherever cutting and fitting is required to install finish hardware onto or into surfaces that are later to be painted or finished in another way, install each item completely, then remove, and store in a secure place during the finish application. After completion of the finishes, re-install each item. Do not install surface-mounted items until finishes have been completed on the substrate.

D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

F. Cut and fit threshold and floor covers to profile of doorframes, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel that will not corrode in contact with the threshold metal.

H. Set thresholds in a bead of elastomeric sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant before sealant cures to a firm set.

I. Adjust and check each operating item of finish hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with the type lubrication recommended by manufacturer (graphite-type if no other recommended). Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.

J. Final Adjustment: Where finish hardware installation is made more than one month prior to Substantial Completion, return to the Work during the week prior to acceptance or occupancy, and make a final check and adjustment of all finish hardware items in each space and area. Clean and re-lubricate operating items as necessary to restore proper function and finish of finish hardware and doors. Adjust door control devices to compensate for final operating of heating and ventilating equipment.

K. Provide manufacturer's authorized representative to instruct and train Owner's personnel in proper adjustment and maintenance of finish hardware during the final adjustment of finish hardware.

L. Finish hardware, which is blemished or defective, will be rejected even though it was set in place before defects were discovered. Remove and replace with new finish hardware. Repair all resultant damage to other Work.

M. Continued Maintenance Service: Approximately six months after the acceptance of finish hardware in each area, the installer, accompanied by the representative of the latch and lock manufacturer, shall return to the Project and re-adjust every item of hardware to restore proper function of doors and finish hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Clean and lubricate operational items wherever required. Replace finish hardware items that have deteriorated or failed due to faulty design, materials or installation of finish hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance or the finish hardware.



## 3.04 FIELD QUALITY CONTROL

A. Provide a written field report, prepared by installer's architectural hardware consultant, identifying actual condition, location, manufacturer, and product designation for each item of finish hardware actually present on each door at the Site, including whether finish hardware is adjusted and operating properly, compared with each item referenced to approved Shop Drawings and Contract requirements.

B. Installer's hardware consultant shall provide opinions to, and assist Engineer in determining, acceptability of installation as Work proceeds. All comments and discussions, conversations and meetings with Engineer shall be included in written field report for submission to Engineer for review and approval at completion of finish hardware installation.

C. As part of written field report to be submitted to Engineer for approval, recommend remedial actions for Work not in compliance with these Specifications. No payment for Work shall be made until remedial recommendations and actions have been approved by Engineer and incorporated into the Work.

## 3.05 LIST OF FINISH HARDWARE ITEMS

A. Scheduled items for each door are generic and rely on information specified above. The listing of hardware functions and types provided are only a general guideline for the final Finish Hardware Schedule. Contractor shall submit a Finish Hardware Schedule acceptable to all governing authorities having jurisdiction at the Site. If door is missing provide hardware set similar to other doors on project.

B. Hardware Set Schedule: Provide the following finish hardware items:
   1. FOG Building:
      a. Doors 101A, 102A - Single Doors
         1) Mortise Hinges
         2) Panic Exit Device
         3) Overhead Surface Mounted Door Closer
         4) Heavy Duty Concealed Overhead Holder and Stop
         5) Stripping and Seals
         6) Threshold
         7) Protection Armor
      b. Door 101B - Overhead Coiling Doors
         1) Coordinate with specification 08 33 00 Overhead Coiling Service Door

**END OF SECTION**

SECTION 08 80 00

GLAZING

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Scope:
   1. The Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install glass and glazing.
   2. Extent of glass and glazing is shown.
   3. Types of products required include the following:
      a. Clear, fully tempered, float glass.
      b. Fully tempered, insulating, float glass.
      c. Fire Rated Glass
      d. Structural and non-structural glazing sealants.
      e. Miscellaneous glazing, spacers, tapes and other materials.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with or before, the glass and glazing Work.



### 1.02 REFERENCES

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. The references listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version reference by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. When document dates are given in the following listing that are not specifically referenced in an applicable code, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. For questions, refer to Engineer.

| Reference | Title |
|---|---|
| AAMA 800 | Voluntary Specifications and Test Methods for Sealants |
| ANSI Z97.1 | Safety Glazing Materials Used in Buildings |
| ASTM E119 | Standard Test Methods for Fire Tests of Building Construction and Materials |
| ANSI/ASTM E 774 | Specification for Classification of the Durability of Sealed Insulating Glass Units |
| ANSI/ASTM E 1300 | Practice for Determining Load Resistance of Glass in Buildings |
| ASCE 7 | Minimum Design Loads for Buildings and Other Structures |
| ASTM C 509 | Specification for Elastomeric Cellular Performance Gasket and Sealing Material |
| ASTM C 719 | Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement (Hockman Cycle) |
| ASTM C 793 | Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants |
| ASTM C 794 | Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants |
| ASTM C 864 | Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers |
| ASTM C 920 | Specification for Elastomeric Joint Sealants |
| ASTM C 1021 | Practice for Laboratories Engaged in Testing of Building Sealants |
| ASTM C 1036 | Specification for Flat Glass |
| ASTM C 1048 | Specification for Heat-Treated Flat Glass-Kinds HS, Kind FT Coated and Uncoated Glass |
| ASTM C 1087 | Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems |
| ASTM C 1115 | Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories |
| ASTM C 1172 | Specification for Laminated Architectural Flat Glass |
| ASTM C 1249 | Guide for Secondary Seal for Sealed Insulating Glass Units for Structural Sealant Glazed Applications |
| ASTM C 1281 | Specification for Preformed Tape Sealants for Glazing Applications |
| ASTM C 1330 | Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants |
| ASTM D 412 | Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension |
| ASTM D 624 | Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers |
| ASTM D 2240 | Test Method for Rubber Property-Durometer Hardness |
| ASTM E 548 | Guide for General Criteria Use for Evaluating Laboratory Competence |
| 16 CFR CPSC Part 1201 | Safety Standard for Architectural Glazing Materials |
| GANA | Glazing Manual |
| GANA | Laminated Glass Design Guide |
| GANA GTA 95-1-31 | Specification for Decorative Architectural Flat Glass |
| LBL-35298 Window 4.1 | Analyzing the Thermal Performance of Fenestration Products |
| NFPA 80 | Standard for Fire Doors and Fire Windows |
| NFPA 252 | Standard Methods of Fire Tests of Door Assemblies |
| NFPA 257 | Standard on Fire Tests for Window and Glass Block Assemblies |
| NFRC 100 | Procedure for Determining Fenestration Product U-Factors |
| NFRC 200 | Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence |

| Reference | Title |
|---|---|
| NFRC 300 | Procedures for Determining Solar Optical Properties of Simple Fenestration Products |
| NGA | Glazier Certification Program |
| PGMC | Specifiers' Guide to Architectural Glass |
| SIGMA TM-3000-90 | Vertical Glazing Guidelines |
| TB-3001-90 | Sloped Glazing Guidelines |
| UL | Building Materials Directory |
| UL 263 | Fire Tests of Building Construction and Materials |

## 1.03 QUALITY ASSURANCE

A. Primary Glass Manufacturer and Glazing Materials Manufacturer Qualifications:
   1. Provide glass and glazing materials manufactured by firms specializing in the production of the types of glass and glazing products specified, in compliance with specified standards.
   2. Provide glass from manufacturers who are members of GANA and PGMC and participate in certification programs.
   3. Obtain glass and glazing materials from manufacturers who will send a qualified technical representative to the Site, for the purpose of advising the installer of proper procedures and precautions for the use of the materials and who will assist the Engineer with opinions on the acceptability of materials and Work.

B. Fabricator Qualifications:
   1. Provide laminated and insulating glass fabrications from fabricators who are licensed by primary glass manufacturer to produce specified units and with documented skill and successful experience in this type of Work and who agree to employ only tradesmen who are trained, skilled and have successful experience in this type of Work.
   2. Provide laminated and insulating glass fabrications from fabricators who are members of GANA or SIGMA and participate in certification programs.
   3. Obtain laminated and insulating glass fabrications from fabricators who will, if required, send a qualified technical representative to the Site, for the purpose of assisting the Engineer with opinions on the acceptability of materials and installation methods.

C. Installer's Qualifications:
   1. The installer of the glass and glazing materials shall be a firm with documented skill and successful experience in the installation of the types of materials required and who agrees to employee only tradesmen who are trained, skilled and have successful experience in the types of materials and glazing systems specified and who are certified under the National Glass Association Glazier Certification Program as Level 3 (Master Glaziers).
   2. Submit records of experience and certifications to Engineer.

D. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing specified, as documented according to ASTM E 548.

E. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct testing specified, as documented according to ASTM E 548.

F. Source Limitation: All materials provided under this Section shall be obtained from a single supplier or manufacturer who, with the Contractor, shall assume full responsibility for the completeness of the Work. The supplier or manufacturer shall be the source of information on all material furnished regardless of the manufacturing source of that material.

G. Regulatory Requirements:
   1. Wherever a fire-resistance-rating classification is shown or scheduled for doors or windows, (1-hour, 2-hour, 3-hour), provide glass complying with the requirements specified and established by UL, ASTM, NFPA and other governing authorities having jurisdiction at the Site.
   2. Safety Glass: Comply with ANSI Z97.1, with label on each piece of glass as required by governing authorities having jurisdiction.

H. Codes: Comply with applicable code requirements.



## 1.04 SUBMITTALS

A. Submit the following in accordance with the Section 01 33 00.

B. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

C. Samples:
   1. 12-inch square samples of each type of glass required.
   2. Insulating glass samples need not be hermetically sealed, but edge construction, wavelength-selective interlayer and low-E coatings shall be included and identified. Include specially prepared samples with each interlayer film product's identity marked on film and incorporated into sample.
   3. Submit 12-inch long samples of each color for each type of exposed-to-view glazing sealant and gasket. Install sample between two strips of material similar to, or representative of, channel surfaces where sealant or gasket will be used, held apart to represent typical joint widths.
   4. Review of samples by Engineer will be for color, texture and pattern only. Compliance with other requirements is the responsibility of the Contractor.

D. Shop Drawings:
   1. Copies of manufacturers' specifications, "Spec-Data" sheets, installation instructions for each type of glass, glazing sealant or compound, gasket and associated miscellaneous material and all recommended installation precautions for required materials and components, which are not included in other submittals, specified in other Sections. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.
   2. Delegated Design: structural performance calculations indicating that detailing and fabrication have been based on the results of the required analysis and performance criteria specified. Calculations shall be prepared, signed and stamped with the seal of a Registered Professional Engineer, licensed to practice in the State of Connecticut, and recognized as an expert in the required Work.
   3. Plans and elevations showing location of each type and kind of glass specified and details of glazing system. Include manufacturer's recommendations for glazing.
   4. Manufacturer’s and fabricator’s guarantees, as specified.
   5. Fabricator's qualifications.
   6. Installer's qualifications.
   7. Age of silicone sealant.
   8. Certification that fabricated products comply with manufacturer's published performance.
   9. Dimensions and details of manufacturer’s glue line thickness and bite dimensions and verifications.

E. Test Reports:
   1. Certified laboratory test reports for required performance tests in compliance with ASTM E 548.
   2. Delegated Design; structural silicone sealant performance features and calculations indicating sealant joints have been detailed and fabricated in compliance with silicone sealant manufacturer’s recommended guidelines for dissimilar metal adhesion. Structural and other performance calculations for the structural silicone joints shall be prepared, signed and stamped with the seal of a Registered Professional Engineer, licensed to practice in the State of Connecticut, and recognized as an expert in the required Work.
   3. Adhesion and compatibility test report from glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

F. Certificates of Compliance:
   1. Certification that all glass materials subject to the applicable standards of the CPSC are in compliance. The certification shall be issued in conformance with procedures stated in the standard.
   2. Certification that all glass, where indicated on the Contract Drawings to be fire rated, is fire-resistive-rated glass that meets UL 263 and ASTM E119.
   3. Include primary glass manufacturer's and fabricator’s published data, and letters of certification, based on certified test laboratory reports, indicating that each material complies with specified requirements and is acceptable for the applications shown.

## 1.05 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Protect glass and glazing materials according to manufacturer's and fabricator's written instructions to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
   3. For insulating glass that will be exposed to substantial altitude changes, comply with insulating glass fabricator's written recommendations for venting and sealing to avoid hermetic seal ruptures.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.



## 1.06 SPECIAL WARRANTIES

A. General: The special warranties specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents.

B. Special Warranties:
   1. Laminated Glass: Provide written warranty, signed by the fabricator and Contractor and running to benefit of Owner, agreeing to replace, for a period of five-years from the date of Substantial Completion, glass units that show deterioration, as specified.
   2. Insulating Glass: Provide written warranty, signed by the fabricator and Contractor and running to the benefit of Owner, agreeing to replace, for a period of ten-years from the date of Substantial Completion, glass that shows signs of deterioration, as specified.
   3. Structural Silicone: Provide structural silicone manufacturer's twenty-year limited adhesion warranty and non-staining warranty for silicone structural adhesive, commencing from the date of Substantial Completion. Perform all testing required to achieve the warranties.

## PART 2 PRODUCTS

### 2.01 SYSTEM PERFORMANCE

A. Design Criteria: For glass performance, manufacture, size, type, construction and thickness, comply with the following:

1. Provide glass and glazing systems capable of withstanding normal thermal movements and wind and impact loads without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants (both structural and weather-resisting) to remain watertight, airtight and to maintain structural performance characteristics specified; deterioration of glazing materials; or other defects in construction.
2. Normal Thermal Movement: Provide glass that allows for thermal movements resulting from a maximum temperature range of 120 degree F in ambient and 180 degrees F surface temperature acting on glass framing members and glazing components. Base structural performance calculations on surface temperatures of materials caused by both solar heat gain and nighttime sky loss.
3. Comply with requirements of Consumer Product Safety Commission, Part 1201, Safety Standards for Architectural Glazing Materials, for all the Work.
4. Structural Performance: Provide structural calculations for analysis of required glass thicknesses for glass lites shown, that are used to establish final fabricating and detailing requirements. Indicate compliance with the following minimum criteria for all glass shown:
   a. Project Wind Speed: 70 miles per hour based on ASCE 7 and the other governing authorities having jurisdiction at the Site.
   b. Importance Factor: Category 1; Iw = 1.15; Design Factor: 1.15.
   c. Exposure Category: Exposure C; Ce = 1.13.
   d. Wind Stagnation Pressure: qs = 12.6 psf.
   e. Long-Duration Loading: One month.
   f. Short-Duration Loading: Sixty seconds, based on three-second gust speed.
   g. Probability of Breakage for Vertical Glazing: Eight lites per 1,000 under wind action.
   h. Maximum Lateral Deflection: For glass supported on all four edges, provide thickness required to limit center deflection at design wind pressure to 1/50 times the short side length or 1-inch, whichever is less.
5. Glass thicknesses shown are minimums. Confirm glass thicknesses by analyzing Project structural loadings and in-service conditions using glass manufacturer's recommended load tables and other structural performance criteria specified. Where manufacturer’s load tables indicate acceptability of lesser thickness material than required by performance criteria specified, provide specified thicknesses and features as a minimum. Where load tables indicate the need for greater thickness, or additional features, than specified, provide greater thicknesses and features at no additional cost to Owner. Comply with practice for determining minimum thickness and types of glass, to resist loadings required by governing authorities having jurisdiction at the Site, according to ANSI/ASTM E 1300.
6. Test sealant in accordance with sealant manufacturer’s recommendations.

7. Glazing Sealant System Compatibility:
    a. Glazing sealants shall be compatible with the channel surfaces, joint fillers, insulating glass sealing system, laminated glass interlayer material and other materials in contact with the glazing channel in compliance with ASTM C 1087.
    b. Provide insulating glass secondary sealant system compatible with structural silicone glazing system and in compliance with ASTM C 1249.
    c. Provide only materials and manufacturer's recommended variation of the specified materials, which are known to be fully compatible with the actual installation conditions, as shown by manufacturer's published data or certification submitted to Engineer for approval.
8. Adhesion of Elastomeric Joint Sealants: Comply with ASTM C 793 and ASTM C 794.
9. Center-of-Glass U-Values: NFRC 100 methodology using LBL-35298 WINDOW 4.1 computer-aided software design, expressed as Btu/square foot by height by degree F.
10. Center-of-Glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBL-35298 WINDOW 4.1 computer-aided software design.
11. Solar Optical Properties: NFRC 300.

B. Definitions:
1. Interspace: The space between lites of an insulating glass unit that contains dehydrated air or a specified gas.
2. Deterioration of Coated Glass: Defects that develop from normal use, that are attributed to the manufacturing process, and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
3. Deterioration of Laminated Glass: Defects that develop from normal use, that are attributed to the manufacturing process, and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass or structural performance or safety of units; blemishes exceeding those allowed by specified laminated glass standards; and cracking, crazing or color change of films concealed in the lamination.
4. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use that is attributed to the fabricating process or incompatibility of sealants or mishandling during installation, and not to causes other than glass breakage and practices for maintaining and cleaning glass contrary to manufacturer's written instructions. Evidence of failure shall include the obstruction of vision by dust, moisture, or film on interior surfaces of insulating glass.



## 2.02 GLASS

A. Clear, Fully Tempered, Float Glass: For all non-fire rated interior doors and windows.
1. Uncoated, Monolithic, Clear, Fully tempered, Float Glass: Provide clear glass, with roll-wave distortion parallel to bottom edge of glass, in compliance with ASTM C 1048, Type I (transparent glass, flat), Class 1 (clear), Quality $Q^3$ (glazing select), Kind FT.

2. Provide heat-treated glass that has been fully tempered by manufacturer's special process (after cutting to final size,) to achieve a flexural strength of two times that of annealed glass strength.
3. For uncoated glass, comply with requirements for Condition A.
4. Thickness: 1/4-inch thick, minimum.
5. Visible Light Transmission: < 91 %.
6. Products and Manufacturers: Provide one of the following:
    a. Clear, Fully Tempered, Float Glass by PPG Industries, Incorporated.
    b. Clear, Fully Tempered, Float Glass by Pilkington North America, Incorporated.
    c. or approved equal.

B. Low-E, Tinted, Fully Tempered, Insulating, Float Glass Units: For all exterior doors and windows.
1. Insulating Glass Units: Provide preassembled units consisting of two lites of glass separated by a dehydrated interspace and complying with ASTM E 2190 for Class C units, permanently and hermetically sealed together at edges with spacers and sealant.
2. System Sealing: Dual seal with polyisobutylene primary sealant and silicone secondary sealant, complying with ASTM C 1249.
3. Overall Unit Thickness: 1 inch.
4. Thickness of Each Glass Lite: 1/4 inch.
5. Outdoor Lite: Tinted, fully tempered, float glass, Kind FT.
6. Interspace Content: Argon.
7. Indoor Lite: Clear, Low-E, fully tempered, float glass; Kind FT.
8. Low-E Coating: Pyrolytic on third surface.
9. Visible Light Transmittance: 36 percent minimum.
10. Winter Nighttime U-Factor: .29.
11. Summer Daytime U-Factor: .28 maximum.
12. Solar Heat Gain Coefficient: 0.40, maximum.
13. Light to Solar Gain Ratio: 1.78
14. Shading Coefficient: 0.40.
15. Outdoor Visible Light Reflectance: 7 percent.
16. Provide safety glazing labeling.
17. Products and Manufacturers: Provide one of the following:
    a. Sungate 500, OptiGray, Fully Tempered, Insulating Glass by PPG Industries, Incorporated.
    b. Energy Advantage, Gray, Fully Tempered, Insulating Glass by Pilkington North America, Incorporated.
    c. or approved equal.

C. Fire rated glass shall be FireLite Plus® as manufactured by Nippon Electric Glass Company, Ltd., and distributed by Technical Glass Products or equal glass shall be 5/16" thick. Provide glass fire rated tested for fire rated assembly (doors, windows, or walls) shown in accordance with UL and NFPA requirements. Provide glass that additionally meets the requirements of ANSI Z97.1 and CPSC 16CFR1201 (Cat 1 and II). Glass shall

be premium grade ground and polished both sides. Permanently label each piece of glass.

## 2.03 GLAZING SEALANTS, TAPES AND GASKETS

A. General:

1. Colors: Provide black or other natural color wherever no other color is available. Wherever material is not exposed-to-view, provide manufacturer's standard color, which has the best overall performance characteristics for the application shown.
    a. Provide manufacturer's standard colors as shown or, if not shown, provide color selected by Engineer from manufacturer's standard colors to either blend or contrast with adjoining surfaces.
2. Hardness specified is intended to indicate the general range necessary for overall performance. Submit glazing and sealant manufacturer's recommendations for actual hardness for each condition of installation and use. Except as shown or specified, provide glazing materials within the following ranges of hardness (Shore A, fully cured, at 75 degrees F):
    a. 15 to 35 for elastomeric compounds and tapes used with rigid stops and frames for large glass sizes (in excess of 100 united inches). Provide material sufficiently hard to withstand exposure to abrasion and vandalism.
    b. 25 to 50 for rubber-like curing compounds used with rigid stops and frames for medium and small glass sizes (less than 100 united inches). Provide materials sufficiently hard to withstand impact of moving sash and doors.
    c. 35 to 60 for molded gaskets used with rigid stops and frames, depending upon strength needed for application or insertion of units.
    d. 75 to 80 for structural gaskets (not supported by stops).
    e. Non-Elastomeric Compounds: (Shore A not applicable) 2 to 12 mm penetration for 5.0 seconds of penetrometer needle on nominally cured compound, complying with ASTM D2451.
3. Provide size and shape of gaskets and preformed glazing units as recommended by the manufacturer and as indicated on approved Shop Drawings.
4. Comply with ASTM C 920 and other requirements for each liquid-applied, chemically curing sealant specified.
5. Where additional movement capability is specified, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement, in compliance with ASTM C 719, to withstand the specified percentage change in the joint width existing at the time of installation and remain in compliance with other requirements in ASTM C 920 for uses shown.

B. Preformed Butyl Rubber Back-Bedding Mastic Glazing Tape:

1. Preformed tape of polymerized butyl or mixture of butyl and polyisobutylene with inert fillers with built-in spacer of synthetic rubber, solvent-based with minimum 95 percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, complying with AAMA 806.3.
2. Products and Manufacturers: Provide one of the following:
    a. Polyshim II Glazing Tape by Tremco, Incorporated.
    b. or approved equal.

C. Dense Compression Wedge Gaskets:
   1. Provide molded or extruded, closed-cell silicone wedge gaskets in compliance with ASTM C 1115, Type C.
   2. Products and Manufacturers: Provide one of the following:
      a. Dense Silicone Wedge Gaskets SCR-900 by Tremco, Incorporated.
      b. or approved equal.

D. Exterior, One-Part, Silicone Rubber Sealant:
   1. Silicone rubber-based, one-part elastomeric sealant, complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT, M, G, A and O.
   2. Products and Manufacturers: Provide one of the following:
      a. Spectrem I by Tremco, Incorporated.
      b. 863 Architectural Silicone Sealant by Pecora Corporation.
      c. or approved equal.

E. Structural Silicone Sealant:
   1. Provide a one-component, self-priming, shelf-stable, neutral-cure, elastomeric adhesive complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT, G and A, and specifically formulated for silicone structural glazing complying with the following as-cured physical properties, after seven days at 77 degrees F and 50 percent relative humidity:
   2. Durometer Hardness, Shore A, points; ASTM D 2240: 27 to 40.
   3. Ultimate Tensile, ASTM D 412: 225 to 350 psi.
   4. Ultimate Elongation, ASTM D 412: 525 to 550 percent.
   5. Tear Strength, Die B; ASTM D 624: 40 to 49 ppi.
   6. Peel Strength, ASTM C 794: 30 to 40 ppi.
   7. Products and Manufacturers: Provide one of the following:
      a. DOW CORNING 995 Silicone Structural Adhesive by Dow Corning Corporation.
      b. 895 Silicone by Pecora Corporation.
      c. or approved equal.



## 2.04 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standards, requirements of manufacturers of glass and glazing materials for applications shown, and approved Shop Drawings. Provide materials with a proven record of compatibility with surfaces shown and specified.

B. Setting Blocks: Elastomeric material, 80 to 90 Shore A durometer hardness, with proven compatibility with sealants used in the Work and as recommended by the glass manufacturer.

C. Spacers and Edge Blocks: Elastomeric blocks or continuous extrusions, with a Shore A durometer hardness recommended by glass manufacturer to maintain lites in place and to limit lateral movement for installation shown, and with proven compatibility with sealants used in the Work.

D. Cylindrical Glazing Sealant Backing: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam complying with ASTM C 1330, Type O (open-cell material), proven to be compatible with sealants used, flexible and resilient, with 5 to 10 psi compression strength for 25 percent deflection.

E. Cleaners, Primers and Sealers: Type recommended by sealant, gasket and glass manufacturer.

## 2.05 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

A. Glass manufacturer's recommended glazing channel dimensions are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. Contractor shall be responsible for correct glass size for each opening, within the tolerances and necessary dimensions established on approved Shop Drawings.

## 2.06 TOLERANCES

A. Allowable Tolerances: Provide fully tempered and heat strengthened glass, formed by horizontal roller-hearth process, free of tong marks and not exceeding the following flatness tolerances (either face, any direction, any location) based on 1/4-inch glass thickness with inversely proportionate tolerances for other thicknesses:
   1. For 12-inch Run: 1/16-inch bow.
   2. For 3-foot Run: 1/8-inch bow.
   3. For 7-foot Run: 1/4-inch bow.
   4. For 10-foot Run: 3/8-inch bow.



## 2.07 SOURCE QUALITY CONTROL

A. To the greatest extent possible, provide each type of glass and glazing materials from one manufacturer.

B. Providing insulating glass with a certified Class A rating according to SIGMA.

C. Obtain glass and sealant test results for product test reports from qualified testing agencies regularly engaged in the business of testing glass and sealant products.

# PART 3 EXECUTION

## 3.01 INSPECTION

A. Examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glass and glazing is to be performed, and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the glazing until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

## 3.02 PREPARATION

A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings, which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

B. Apply primer or sealer to joint surfaces wherever recommended by sealant and glass manufacturer.

## 3.03 INSTALLATION

A. General:
   1. Comply with combined recommendations of glass, window and glazing products manufacturers and other materials used in glazing, except where more stringent requirements are shown or specified, and as shown on approved Shop Drawings.
   2. Comply with GANA, Glazing Manual, except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass and glazing materials, as accepted by Engineer on approved Shop Drawings.
   3. Inspect each piece of glass immediately before installation and remove from Site all that have observable edge damage or face imperfections.
   4. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.
   5. Cut and install tinted and reflective glass as recommended in manufacturer's technical bulletin as provided on approved Shop Drawings.
   6. Install sealants as recommended by sealant manufacturers, and as recommended on approved Shop Drawings.
   7. Do not attempt to cut, seam, nip or abrade glass on Site, which is tempered, heat strengthened, or coated.
   8. Do not proceed with installation of liquid glazing sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
   9. Proceed with glazing only when forecasted weather conditions are favorable to proper cure and development of high early bond strength. Wherever channel action is affected by ambient temperature variations, install glazing sealants only when temperatures are in the middle third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation or compression, and bond stress will not be excessive at extremely low or high temperatures.
   10. Coordinate the installation of the glass and glazing Work with the Progress Schedule in order to avoid delay of Project.
   11. Install fire rated glass in strict accordance with manufacturer’s requirements to meet fire rated assembly shown on Drawings.

B. Tape and Sealant Glazing:
   1. Place setting blocks in sill rabbets, sized and located to comply with referenced glazing publications. Set blocks in thin course of compatible sealant for heel bead. Position glass on setting blocks and press against tape for full contact.

2. Provide spacers for glass lites where the length plus width is larger than 4 foot-2 inches. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
3. Provide 1/8-inch minimum bite for spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
4. Provide edge spacers are shown on approved Shop Drawings and as required to prevent glass lites from moving sideways in glazing channel.
5. Cut glazing tape to length and set against permanent stops. Install horizontal strips first, extending over width of opening, before applying vertical strips.
6. Remove paper backing from tape. Place glazing tape on free perimeter of glass. Install tapes continuously. Do not stretch tape to make them fit openings. Place joints in tapes at corners of openings with adjoining lengths butted together, not lapped. Seal butt joints of tape with joint sealant.
7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
8. Install removable stop, avoiding displacement of tape, and exert pressure on tape for full continuous contact. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Calk space above glazing tape to top of glazing stop. Tool exposed surfaces of sealant compounds to provide a substantial "wash" away from the glass.
9. Clean and trim excess glazing materials from the installation and eliminate stains and discolorations.
10. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
11. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended on approved Shop Drawings and to prevent corners from pulling away; seal corner joints and butt joints with sealant as recommended by gasket manufacturer and as shown on approved Shop Drawings.

C. Dry Gasket Glazing: Install glass in gaskets as recommended by the glass and window manufacturer.

D. Structural Sealant Glazing: Install glass using a system of structural silicone sealants as recommended by the glass and sealant manufacturers.

E. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

F. The installer shall advise Contractor of procedures required for the protection of glass and glazing sealants and compounds during the construction period, so that they will be without deterioration or damage, other than normal weathering, at the time of Substantial Completion.

G. Furnish specific instructions on the precautions and provisions required to prevent glass damage resulting from the alkaline wash from concrete surfaces and similar sources of possible damage.

H. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.

I. Remove and replace glass, which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.

J. Maintain glass in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash-off) to the deterioration of glazing materials and other work.

K. Remove non-permanent labels and wash and polish glass on both faces not more than four days prior to Substantial Completion. Comply with glass manufacturer's recommendations for cleaning.



## 3.04 FIELD QUALITY CONTROL

A. Watertight and airtight installation of each piece of glass is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the Work.

B. After nominal cure of exterior glazing sealants, which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4-inch hose held perpendicular to wall face, 2 foot-0 inches from joint, connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 foot-0 inches per minute.

C. Test approximately five percent of total glazing system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct tests in the presence of Engineer, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.

D. Repair glazing installation at leaks or, if leakage is excessive, replace glazing sealants as directed by Engineer.

E. Wherever nature of observed leakage indicates the possibility of inadequate glazing joint bond strength, Engineer may direct that additional testing be performed at a time when joints have been fully cured, followed by natural exposure through both extreme

temperatures, and returned to the range of temperature in which it is feasible to conduct testing. Repair or replace Work as required and directed by the Engineer.

**END OF SECTION**

SECTION 08 92 00

REMOVABLE ALUMINUM FLOOD BARRIER

## PART 1 GENERAL

### 1.01 DESCRIPTION & GENERAL NOTES

A. Scope:
   1. This section specifies removable aluminum flood barriers.

B. Work Included:
   1. Provide flood barrier(s) factory assembled with frame(s) and hardware in accordance with the contract documents.
   2. All Barrier heights shall be finished to 54” min. above Base Flood Elevation (BFE) unless otherwise stated by the Engineer of Record (EOR). The BFE is 12.00 feet-NAVD88.

C. General Notes:
   1. The structural design of these Removable Flood Panels is generic and has been designed for hydrostatic hydrodynamic and impact debris flood loads with water pressures corresponding to maximum water height and flow speed of 5 ft. /sec. up to 8 ft. /sec. in order to certify minimum required flood elevation to top of Flood Panels.
   2. It shall be determined, on a job by job basis, the required Panel height and flow speed for the design of Removable Flood Panels, based on FEMA's criteria (See Note #2) as well as per ASCE 24-14 Standard. Installation and construction of these Flood Panels for use within flood hazard areas shall be in accordance with the American Society of Civil Engineers Flood Resistant Design and Construction Standard SEI/ASCE 24-14.
   3. Design criteria is for Type 2 Closures in chapter 7, section 70 1.1.2 of the Army Corp of Engineers, EP 1165-2-314 12/1195 and based on the 2021 Edition of the International Building Code, the corresponding provisions of ASCE 24-14, FEMA flood proofing non- residential structures manual FEMA 102, FEMA P-936 and FEMA Technical Bulletin 3-93. Design flood loads have been determined in accordance with ASCE 7-16. Design wind loads have been determined in accordance with ASCE 7-16 for 130 mph Basic Wind Speed for category 3 building. This flood barrier design criteria is for buildings in an "A" or "AE" flood zone and is not to be used in a Coastal "A" zone or high velocity "V" zone.
   4. Flood barrier design have tested by an independent testing lab for water infiltration in accordance with FEMA 102 manual for flood proofing of non-residential structures, specifications Section 8, Page 70. Type 2 Flood closures or barriers are permitted allowable seepage rates. Seepage amounts will vary with building conditions encountered. ASCE 24-14 chapter 6 states "sump pumps shall be provided to remove water accumulated due to any passage of vapor and seepage of water during the flooding event." Owner acknowledges and is responsible for all drains, piping and sump pumps required to meet ASCE 24-14 requirements to offset water build up behind the barrier system.
   5. Flood Panel manufacturer to install and use gaskets and approved sealants following all the recommendations and specifications of the manufacturers respectively.

6. Contractor or installer to verify all dimensions, wall and floor conditions at site before proceeding with the work, and shall notify this engineer if any discrepancy is found that would alter the structural design of these Flood Panels.
7. Existing slabs and walls adjacent to opening where Flood Panel is to be installed shall be given a surface treatment by means of water proof sealer before flood Panel is installed. Surface must be smooth, square, plumb and level.
8. Existing slabs and walls adjacent to openings where Flood Panels are to be installed shall be structurally designed by engineer of record, to sustain the same hydrostatic, hydrodynamic and impact pressures that correspond to maximum water elevation above finished floor at top of Panel.
9. Drop-in anchors embedded into concrete for removable support installation shall be covered with a cap or similar device to protect their inside hold from dust, so that machine screws can easily be installed at time of flood warning. Concrete anchors by others.
10. Separation of Panel to window/door shall be measured from back of Panel to window/door including any knob, handle, or protruding device, and shall be 2" minimum.
11. All aluminum extrusions to be 6063-T6 alloy, and 6005-T5 alloy.
12. All sheet metal screws shall be as manufactured by ITW Buildex "TEK Screws", or equal, and to be made of non-corrosive material.
13. All bolts to be galvanized steel ASTM A-307 designation or 304 Series Stainless Steel.
14. All gaskets installed shall be neoprene per drawings.
15. All welding to conform to the American Welding Society AWS D1.2/d1.4m 2017 Regulations. Use certified welders. Use ER-5356 Electrodes for aluminum a E70 for steel.
16. The engineer or Flood Panel Manufacturer is not responsible for construction safety at site which is the owner, general contractor or installer's responsibility. Flood Panel Manufacturer to be responsible for providing the tenant with shop drawings and proper instructions for the installation of these Flood Panels.
17. Surfaces against which the sealing gasket presses must be built "paper-smooth" to prevent excessive water extrusion, beyond that allowed by requirements. All surfaces must be plumb, square and level.



## 1.02 STANDARDS

A. Comply with the provisions of (as applicable):
   1. AWS Structural Welding Code D1.2/D1.4M 2017 Reg.
   2. ASTM A36, A240
   3. ASCE 7-16, ASCE 24-14, SEI/ASCE 24-14
   4. QA program that is registered to ISO 9001:2000
   5. 2021 Edition of the International Building Code
   6. FEMA 3-93, FEMA 102, FEMA P-936

## 1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Calculations and signed and sealed drawings:
      a. Submit calculations, approved by a qualified engineer, to verify the barrier's ability to withstand the design pressure loading, based on current building code and specified load combinations. Signed and sealed drawings and calculation set available upon request.
   3. Shop Drawings:
      a. Submit shop drawings for flood barriers including dimensioned plans and elevations, sections, connections and anchorage.
   4. Manufacturers Data:
      a. Submit installation and maintenance instructions for flood barriers.
   5. Warranties:
      a. Provide manufacturer's warranty and warranty qualification stating that flood barriers for above project will be free from defects and workmanship for a period of three (3) year from date of substantial completion.
      b. Flood Certificate, signed final inspection by Architect or EOR of installed flood barriers and final installation pictures of each opening shall be submitted for Manufacturer to issue a warranty.
   6. Flood Certificate:
      a. Responsibility for filing the building FEMA "Flood Proofing Certificate" is the responsibility of the Contractor.
   7. Flood Emergency Operation Plan per FEMA 3-93
      a. Responsibility of building owner and design professional.
   8. Inspection and Maintenance Plan per FEMA 3-93
      a. Responsibility of owner and Building Manager.



## 1.04 QUALIFICATIONS

A. The manufacturer of the flood barrier(s) shall present evidence attesting to at least 5 years of successful experience in the design, manufacture, and site implementation of the flood barrier system type specified.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE FLOOD BARRIER MANUFACTURERS

A. Flood barriers shall be as manufactured by Flood Panel LLC or approved equal.

### 2.02 MATERIALS

A. Aluminum Panels to be of 6005-T5.

B. Intermediate and End Posts:
   1. The majority of the post is to be from grade ST37 (S235 JR) or galvanized steel with the exception of below ground supports which are to be of grade 304 stainless steel or equal.

C. All steel to be primed with one coat Sherwin Williams Kern Flash rust inhibitive, lead free, primer, or equal.

D. Base Gaskets to be sandwich composite combination low/high compressed set gaskets mechanically retained in the flood barriers; 40D medium compression set gaskets retained mechanically in the top of each flood barrier and low compression gaskets in the jambs and mid-span supports.



### 2.03 DESIGN

A. The Flood Barrier System shall be designed for the loads and load combinations listed on the ASCE 7-16, Section 2.0 (Combinations of Loads), including the following flood loads according with ASCE 7-16 Section 5.3.3 (Loads During Flooding):
   1. Hydrostatic Loads, caused by water which is either stagnant or moves at velocities less than 8 ft./sec., according with ASCE 24-14, Section 6.2.1 and ASCE 7-16, Sections 5.3.3.2 and C5.3.3.2.
   2. Hydrodynamic Loads: Hydrodynamic loads not considered since flow of water is moving at velocities less than 8ft./sec., according with ASCE 24-14, Section 6.2.1 (Dry Flood proofing Limitations).
   3. Wave Loads: Only Non-breaking wave action is considered since Non-breaking waves on vertical walls can also be computed as hydrostatic forces, according with FEMA 550-2006, Section 3.4 (Wave Loads) and ASCE 7-16 Section 5.3.3.4 (Wave Loads). Breaking waves and broken waves are proper of other areas where Dry-Flood proofing is not allowed according with ASCE 24- 14, Section 6.2.1 (Dry Flood proofing Limitations).
   4. Impact Loads: Not considered since Hydrostatic analysis is performed for flow of water moving at velocities of less than 5 ft/sec.

B. The Flood Barrier System shall be designed for a maximum wind load pressure of +/- 34.5 psf.

C. Frame(s) and Intermediate post(s) shall have mounting holes for connecting anchors and bolts. Anchor type, size, and method dependent on load capabilities of structure.

D. The individual Flood barrier sections shall be 3” deep by 66” tall with a top interlocking gasket slot system which includes gaskets and gasket channels between sections and full height in the jamb channels. Multiple barriers are to be stacked to meet or exceed the base flood elevation as noted below. Embed plates may be required at the sill and jambs based on the condition at the opening and the loads imposed on the system. Jamb supports are to be continuous structural steel channels designed specifically for the Flood barrier system and are to be anchored and sealed to the condition with embeds or mechanical anchors.

E. Dimensions and quantities:
   1. Height: 66” above finished floor elevation, refer to contract drawings.
   2. Width: General Contractor to coordinate with door widths provided on the door schedule in the Contract Drawings. Widths of barriers at each opening are 8’-0” +/-, 3’-4” +/-, and 3’-4” +/-.
   3. Quantity: Three (3) barrier for the FOG Screening Building (one per door)

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Flood barrier(s) shall be installed in accordance with Manufacturer's instructions and approved shop drawings.

B. Contractor to verify that all surfaces against which the sealing gasket presses must be built "paper-smooth" to prevent excessive water extrusion, beyond that allowed by requirements. All surfaces must be plumb, square, and level before installation can begin.

C. All embed plates shall be installed using Dow Corning 995 caulk or equal or waterproof grout at back of support covering full height and width of support and producing squeeze out on all sides to assure proper seal.

D. Existing slabs, walls, and columns adjacent to openings where flood barriers are to be installed shall be waterproofed with a waterproof membrane or a water proof sealer surface treatment prior to the installation of the flood barriers by the Contractor.

E. All fixed mill finish aluminum supports must have a protective barrier between the support and the concrete and any dissimilar metals to prevent corrosion.

F. Install all supports true and plumb without racking or warping.

G. The Flood Barrier installer must provide photos of each opening during and following installation. Inspection of each opening is required per the Flood Certificate by the architect or engineer of record to verify installation compliance with the manufacturers shop drawings and installation instructions. Installer can then uninstall the barrier system and the building contractor shall move the barriers to a storage location as directed by the Building Manager or Owner.

## 3.02 HANDLING, CLEANING, INSPECTION, AND STORAGE

A. Materials delivered to the site shall be unloaded and stored with minimum handling. Storage space shall be in a dry location with adequate ventilation, free from dust or water, and easily accessible for inspection and handling. Materials shall be stacked on nonabsorptive strips or wood platforms. Doors and frames shall not be covered with tarps, polyethylene film, or similar coverings. Finished surfaces shall be protected during shipping and handling using manufacturer's standard method, except that no coatings or lacquers shall be applied to surfaces to which calking and glazing compounds must adhere.

B. Inspect all barriers for damaged parts.

C. Repair or replace damaged installed products and components.

D. Touch up all damaged surfaces. Use of abrasive, caustic, or acid cleaning agents is not allowed.

E. Clean all exposed surfaces and let dry before storing.

## 3.03 PROTECTION

A. Contractor shall move all barriers to designated storage location and shall stack the barriers in a manner that does not damage the gaskets. Position all gaskets away from high traffic areas in the storage area to prevent damage to the gaskets.

B. Protect installed product and finish surfaces from damage during handling, storage, and installation.

C. Protect all installed product and finished surfaces during normal and general operation.



**END OF SECTION**

# DIVISION 09
# FINISHES

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SECTION 09 90 00

GENERAL COATING SPECIFICATION

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This Section specifies coating system materials, surface preparations, application, and quality control (QC) requirements.
   2. This Section includes:
      a. All substrates exposed to non-corrosive or moderately corrosive environment.
      b. Atmospheric, weathering exposure, non-corrosive building exposure conditions and piping, equipment, and structures not exposed to immersion services, corrosive headspace (gaseous) exposures, and internal building surfaces substrates for areas occupied by personnel.
   3. The Contractor is solely responsible for all aspects of QC inspections for the work covered by this Section. The QC inspection personnel and coating manufacturer technical representative (CTR) are provided by the General Contractor at no additional cost to the Owner. Inspections, testing, or other forms of quality checks may be provided by the Construction Manager for quality assurance (QA) checks but in no way relieve the Contractor of sole responsibility for quality and performance of the installed coating system.



### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 07 10 00 Dampproofing and Waterproofing
   2. Section 09 96 00 High-Performance Protective Coatings for Wastewater

### 1.03 DEFINITIONS

A. Specific coating terminology used in this Section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions.
   1. Abrasive: Material used for blast cleaning, such as sand, grit or shot.
   2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed by compressed air.
   3. AMPP: Association for Materials Protection and Performance (Merger of National Association of Corrosion Engineers and Society for Protective Coatings).
   4. Anchor Pattern: Profile or texture of prepared surface(s).
   5. ANSI: American National Standards Institute.
   6. Bug Holes: Cavities or air voids resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.
   7. Coating Thickness: The total dry film thickness of primer, intermediate, and/or finish coats.

8. Coating System Applicator (CSA): A generic reference to the specialty subcontractor or subcontractors retained by the Contractor to install the coating systems specified in this Section.
9. Coating System Manufacturer (CSM): Refers to the acceptable coating system manufacturer, abbreviated as the CSM.
10. Coating System Manufacturer's Technical Representative(s) (CTR): Refers to the independent technical representative(s) of the acceptable Coating System Manufacturer and is abbreviated as CTR. This refers to a CSM technical representative and not a sales or marketing representative. The cost of this independent technical representative is the responsibility of the General Contractor.
11. Dew point: Temperature of a given air/water vapor mixture at which condensation starts.
12. Dry Film Thickness (DFT): Depth of cured film, usually expressed in mils (0.001 inch). DFT is the thickness of a coating as measured above the substrate.
13. Dry Spray: Dry, flat, probably textured coating surface when spray gun held too far from substrate.
14. Drying Time or curing time: Time interval between application and curing of material before exposure to service conditions.
15. Dry to Recoat: Time interval between application of material and ability to receive next coat.
16. Dry to Touch: Time interval between application of material and ability to touch lightly without damage.
17. Feather Edging: Reducing the thickness of the edge of paint.
18. Feathering: Operation of tapering off the edge of a point with a comparatively dry brush.
19. Field Coat: The application or the completion of application of the coating system after installation of the surface receiving coating at the site of the work.
20. Fish Eyes: Separation or pulling apart of wet film of coating to expose underlying film or substrate.
21. Flash Report: A report by email or text to the Construction Manager and Engineer identifying issues requiring immediate attention and approval.
22. Hold Point: A defined point, specified in this Section, at which work shall be halted for a quality inspection.
23. Holiday: A discontinuity, skip, or void in coating or coating system film that exposes the substrate.
24. Honeycomb: Segregated condition of hardened concrete due to non-consolidation.
25. ICRI: International Concrete Repair Institute.
26. Incompatibility: Inability of a coating to perform well over another coating because of lack of cure of prior coating, poor bonding, or lifting of old coating; inability of a coating to perform well on a substrate.
27. Laitance: A layer of weak, non-durable concrete containing cement fines that are brought to the surface through bleed water because of concrete finishing and/or over-finishing.
28. LEED: Leadership in Energy and Environmental Design certification program by the US Green Building Council.
29. Mil: 0.001 inch, one thousandth of an inch.

30. Mudcracking: Deep irregular cracks in coating that resemble dried mud caused by non-flexible coatings applied too thickly or built-up in corners.
31. NACE: National Association of Corrosion Engineers to be renamed Association of Materials Performance and Protection or AMPP.
32. NAPF: National Association of Pipe Fabricators.
33. Certified Coatings Inspector: Must be AMPP Certified to Level 3 and have at least 10 years' experience in wastewater coatings inspection
34. Overspray: Coating spray, particularly such coating that failed to strike the intended surface and ended up on surfaces not to be coated.
35. Pinhole: A small diameter discontinuity in a coating or coating system film that is typically created by outgassing of air from a void in a concrete substrate resulting in exposure of the substrate or a void between coats.
36. Pot Life: Time interval after mixing of components during which the coating can be satisfactorily applied.
37. QA: Quality Assurance
38. QC: Quality Control
39. QCP: Quality Control Person representing the Contractor and responsible for QC Testing, Inspection and associated documentation.
40. Quality Control Testing and Inspection Plan (QCTIP).
41. QP3: AMPP accredited program that evaluates the practices of shop painting facilities.
42. Repair Mortars: Cementitious, polymer modified cementitious, or polymer-based mortars used to restore concrete or masonry substrates to overall continuous, coatable surfaces by filling voids and excess substrate profile that cannot be hidden by the DFT of the coating system.
43. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-base material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces at typically shallow depths up to 1/4 inch thick.
44. Shelf Life: Maximum storage time for which a material may be stored without losing its usefulness.
45. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of the work, where the field or finishing coat is applied.
46. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
47. SSPC: The Society for Protective Coatings soon to become part of AMPP.
48. Stripe Coat: A separate coat of paint applied to all weld seems, pits, nuts/bolts/washers and edges by brush. This coat shall be applied prior to full coat application.
49. Saturated Surface Dry (SSD): Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.
50. Tie Coat: An intermediate coat used to bond different types of paint coats. Coatings used to improve the adhesion of a succeeding coat.
51. Touch-Up Painting: The application of paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.
52. TPC: Technical Practice Committee.

53. Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter (g/l) or pounds per gallon (lb/gal).
54. Immersion: Refers to a service condition in which the substrate is below the waterline or submerged in a liquid such as water or wastewater at least intermittently if not constantly.
55. Weld Spatter: Beads of metal scattered near seam during welding.
56. Wet Film Thickness (WFT): The primer or coating film's thickness immediately following application. Wet film thickness is measured in mils or thousandths of an inch (0.001 inch) and is abbreviated WFT.

## 1.04 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, use the last version of the document before it was discontinued.



| Reference | Title |
|---|---|
| ANSI/ASC 29.4 Exhaust Systems | Abrasive Blasting Operations – Ventilation and Safe Practice |
| ANSI/NSF 61 | Drinking Water System Components Health Effect |
| ANSI B74.18 | Grading of Certain Abrasive Grain on Coated Abrasive Material |
| ASTM C1583 | Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-Off Method) |
| ASTM D16 | Standard Terminology for Paint, Related Coatings, Materials, and Applications |
| ASTM D2200 (SSPC-VIS1) | Pictorial Surface Preparation Standards for Painting Steel Surfaces |
| ASTM D3359 | Standard Test Methods for Rating Adhesion by Tape Test |
| ASTM D3960 | Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings |
| ASTM D4262 | Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces |
| ASTM D4263 | Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method |
| ASTM D4414 | Standard Practice for Measurement of Wet Film Thickness by Notch Gages |
| ASTM D4541 | Standard Test Methods for Pull-Off Strength of Coatings on Metal Substrates Using Portable Adhesion Testers |
| ASTM 5402 | Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs |
| ASTM D6677 | Standard Test Method for Evaluating Adhesion By Knife |

| Reference | Title |
|---|---|
| ASTM D7234 | Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Adhesion Testers. |
| ASTM E337 | Standard Test Method for Measuring Humidity With a Psychrometer |
| ASTM F22 | Water Break Test |
| FS 595b | Federal Standard Colors |
| ICRI 310.2 | Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays |
| NACE Publication 6D-163 | A Manual for Painter Safety |
| NACE Publication 6G-164 A | Surface Preparation Abrasives for Industrial Maintenance Painting |
| NACE Standards | National Association of Corrosion Engineers, TPC. |
| NACE Standard RP0188 | Standard Recommended Practice – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates |
| NAPF 500-03 | Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings |
| NAPF 500-03-04 | Abrasive Blast Cleaning for Ductile Iron Pipe |
| NAPF 500-03-05 | Abrasive Blast Cleaning for Cast Ductile Iron Fittings |
| OSHA 1910.144 | Safety Color Code for Marking Physical Hazards |
| OSHA 1915.35 | Standards – 29CFR – Painting |
| SSPC-AB 1 | Mineral and Slag Abrasives |
| SSPC-PA 1 | Shop, Field, and Maintenance Painting of Steel |
| SSPC-PA 2 | Measurement of Dry Coating Thickness with Magnetic Gages |
| SSPC-PA 9 | Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages |
| SSPC-PA Guide 1 | Guide for Illumination of Industrial Painting Project |
| SSPC-PA Guide 3 | A Guide to Safety in Paint Application |
| SSPC-PA Guide 6 | Guide for Containing Debris Generated During Paint Removal Operations |
| SSPC-PA Guide 11 | Guide for Protecting Corners, Edges, Crevices and Irregular Steel Geometries by Stripe Coating |
| SSPC-SP 1 | Solvent Cleaning |
| SSPC-SP 2 | Hand Tool Cleaning |
| SSPC-SP 3 | Power Tool Cleaning |
| SSPC-SP 5/NACE #1 | White Metal Blast Cleaning |
| SSPC-SP 6/NACE #3 | Commercial Blast Cleaning |
| SSPC-SP 7/NACE #4 | Brush-Off Blast Cleaning |
| SSPC-SP 10/NACE#2 | Near-White Blast Cleaning |
| SSPC-SP 11 | Power Tool Cleaning to Bare Metal |
| SSPC/NACE WJ 1-4 | Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating |
| SSPC-SP 13/NACE #6 | Surface Preparation of Concrete |
| SSPC-CAB 1-3 | Abrasive Blasting of Concrete and Masonry |
| SSPC-SP 16 | Brush-off Blast Cleaning Non-Ferrous Metals |
| SSPC-TR2 | Wet Abrasive Blast Cleaning |
| SSPC-TU-3 | Overcoating |
| SSPC-Guide 15 | Field Methods for Retrieval and Analysis of Soluble Salts on Substrates. |
| SSPC V2 | Systems and Specifications: Steel Structures Painting Manual, Volume 2 |
| SSPC-VIS 1 | Visual Standard for Abrasive Blast Cleaned Steel |

| Reference | Title |
|---|---|
| SSPC-VIS 3 | Visual Standard for Power and Hand – Tool Cleaned Steel |
| SSPC-VIS 4 | Visual Standards (Waterjetting) |
| SSPC-VIS 5 | Visual Standards (Wet Abrasive Blast Cleaning) |
| WPCF Manual of Practice No. 17 | Paints and Protective Coatings for Wastewater Treatment Facilities. Guide and Paint Application Specifications. |
| LEED | Leadership in Energy and Environmental Design |

## 1.05 QUALITY ASSURANCE

A. Standardization:
   1. Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.
   2. The standard products of CSMs other than those specified may be acceptable when it is demonstrated to the Engineer that they are equal in generic resin type, composition, durability, range of film thickness, and usefulness, for the purpose intended. Requests for consideration of CSMs other than those specified in this Section will be considered, provided the following minimum conditions are met.
      a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total DFT.
      b. The proposed coating system shall use coatings of the same generic type as that specified including curing agent type.
      c. Requests for consideration of products from CSMs other than those specified in this Section shall include information listed in paragraph 1.07, demonstrating that the proposed CSM's products equal to the specified coating system.
      d. The Contractor and the proposed alternative CSM shall provide a list of references for the proposed product in similar situations where the coating of the same generic type has been applied. The reference list shall include the project name, city, state, owner, phone number of owner; coating system reference and number from this Section 09 90 00; type of facility in which it was used, generic coating type, and year coating was applied.
      e. Alternate coating systems submitted by the Contractor must be approved by the Engineer. There is no guarantee that alternate systems will be approved, and this is left exclusively up to the discretion of the Engineer. At least 3 competitive products have been provided in this Specification. The Contractor is encouraged to submit one of the specified coating systems.
      f. At any time when there is conflict between the CSM's product data and the COAT SPEC requirements regarding surface preparation, material application, or any other coating details, the more stringent requirements will take precedent.

B. Field and Shop Contractors Quality Control Requirements:
   1. Prior to any work, the Contractor shall hold a pre-construction meeting with the coating subcontractor, coating system manufacturer's technical representatives (CTR) to review the scope of work, the accepted submittals and any comments, and review all surface preparation, application, curing, mixing, storage, and overall QC and testing requirements. The Contractor shall provide a minimum of 48 hours' notice to the Engineer and Owner in case they desire to attend the meeting.

2. The Contractor is solely responsible for the workmanship and quality of the coating system installation by the Contactor's CSA. Inspections by the Construction Manager, the Engineer, the Owner, or the CTR will not relieve or limit the Contractor's responsibilities for the quality of the coating system.
3. The Contractor's methods shall conform to requirements of this specification and the standards referenced in this Section. Changes in the coating system installation requirements will be allowed only with the written acceptance by the Engineer and CSM before work commences.
4. Only personnel who are trained by the CTR specifically for this contract or who are approved by the CSM specifically for this contract shall be allowed to perform the coating system installation specified in this Section. The CTR shall verify in writing that the Contractor's personnel installing the coating systems covered by this Section have the appropriate training and/or experience to properly perform the coating systems work.
5. All shop surface preparation and coating applications shall be performed by an AMPP QP3 certified blast and painting shop in good standing.
6. The Contractor shall provide a Quality Control Person (QCP) who is a certified NACE, SSPC, or AAMP Coatings Inspector with at least 5 years of experience inspecting coating work similar to the work covered by this Section. The QCP shall perform all QC inspection testing and inspection tasks while fully documenting all efforts required by these specifications and/or the manufacturer if they have additional requirements.
7. Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.
8. For repairs, the Contractor/CSA shall provide the same products, or products recommended by the CSM, as used for the original coating.
9. The Contractor/CSA shall identify the points of access for inspection by the Owner, Engineer and/or Construction Manager. The Contractor shall provide ventilation, ingress and egress, and other means necessary for the Engineer, Owner, or Construction Manager's personnel to safely access the work areas.
10. The Contractor's CSA shall conduct the work so that the coating system is installed as specified and shall inspect the work continually to ensure that the coating system is installed as specified. Coating system work that does not conform to the specifications or is otherwise not acceptable shall be corrected to the as-specified requirements at no additional cost to the Owner.
11. The Contractor shall ensure the CSA shall at all times have trained and certified QC inspectors performing all QC procedures. All persons performing QC duties shall be a minimum AMPP Certified Coating Inspector (NACE/SSPC Level 2) with a minimum of 5 years of experience in QC processes. QC inspectors must work under the direct supervision of an AMPP Senior Coatings Inspector (NACE/SSPC Level 3) in good standing, with at least 10 years of similar coatings work experience. The trained QC Program inspectors shall perform all routine QC testing and inspection tasks as the coating work proceeds in accordance with the requirements of this specification. If the CSA does not employ QC personnel that hold the required certifications listed above, it is the CSA's responsibility to retain the services of an independent inspector or inspection firm to provide the necessary QC throughout the project to ensure compliance to the specification.
12. The Contractor's QC personnel shall measure DFT of metal surfaces as per SSPC-PA2. Measurements shall be taken as often as necessary to ensure the DFT requirements of the specification are met. DFT of metallic surfaces shall be

measured using Type II Magnetic (Ferrous) and Type II Eddy Current Non-Ferrous) Dry Film Thickness gauges. Gauges must be calibrated within 1 year of use. Testing of DFT on concrete substrates shall be performed as per SSPC-PA9 using Ultrasonic DFT gauges or another suitable method (e.g., Calculating material usage vs square feet coverage) to ensure DFT requirements are met.

13. The Contractor/CSA shall submit for approval a QCTIP for the work covered by this Section (see 00 97 00A Inspection Check List). The QCTIP shall list all tests and inspection tasks including referenced and applicable standards to be conducted and the frequency in which these tests or tasks shall be performed. This frequency can be addressed for certain tests such as air and substrate temperature or dew point on an hourly per shift basis. Or this frequency can be addressed on a per number of square feet basis for tests and tasks such as wet and DFT tests or adhesion tests. The QCTIP must provide a written record which identified when (time and date) work not conforming to the specification requirements is identified. The QCTIP must also provide a written record of the proposed corrective actions for such non-conforming work as well as a record of when that action was performed (time and date). All corrective action for non-conforming work shall be described in writing in detail with referenced digital photographs taken of that re-work for subsequent review by the Owner's QA representative.
14. The Contractor shall complete the Coating System Inspection Checklist, Form 09 90 00-A, included in Section 09 90 00 – Part 4 for coating system installations. Follow the sequential steps required for proper coating system installation as specified and as listed in the Coating System Inspection Checklist. For each portion of the work, install the coating system, document all QC measures performed, and complete sign-offs as specified prior to proceeding with the next step. After completing each step as indicated on the Coating System Inspection Checklist, the Contractor shall sign the checklist indicating that the work has been installed and inspected as specified and attach a final copy of all individual QC checks or test results as applicable and required.
15. The Contractor's (CSA's QC person or persons shall submit a daily QC inspection report that describes and documents all QC tests and inspection tasks performed including frequency of performance and test results (including test data) and referenced standard followed for each shift the CSA works. These reports shall be submitted on the morning of the following day the work was performed to the Construction Manager/Engineer or Owner's representative for recordkeeping. If any non-conforming work is identified, a written account of those non-conforming issues and corrective measures and annotated digital photographs of such work shall be included with the daily QC report. The CSA shall submit a standard inspection form to be used for these reports for review by the Engineer. The approved inspection report forms shall be used by the CSA's QC Inspector to record all QC inspection and testing throughout the performance of the coating work.

C. Quality Control Hold Points:

1. The Contractor's QCP shall conduct QC inspections of the coating work as it proceeds to meet all specified quality requirements. In addition, the Contractor shall conduct inspection at Hold Points during the coating system installation and record the results from those inspections on Form 09 90 00-A. The Contractor shall coordinate such Hold Points with the Engineer or Construction Manager such that the Construction Manager or Engineer may observe Contractor's inspections on a scheduled basis. The Contractor shall provide the Construction Manager or Engineer

a minimum of 1 days' notice prior to conducting Hold Point Inspections. The Hold Points shall be as follows:

a. Environment and Site Conditions. Prior to commencing an activity associated with coating system installation, the Contractor shall measure, record, and confirm acceptability of ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. The acceptability of the weather and/or environmental conditions within the structure shall be determined by the requirements specified by the CSM of the coating system being used and identified and accepted as part of the coating submittal in accordance with this specification.

b. Conditions Prior to Surface Preparation. Prior to commencing surface preparation, the Contractor shall perform cleaning to remove all oil, grease, dirt, soluble salts, and all other foreign contaminants from the surface.

c. Monitoring of Surface Preparation. Spot checking of degree of cleanliness, surface profile, and surface pH testing, as required. In addition, the compressed air used for surface preparation or blow down cleaning shall be checked to confirm it is free from oil and moisture.

d. Post Surface Preparation. Upon completion of the surface preparation, the Contractor shall measure and inspect for proper degree of cleanliness and surface profile as specified in this Section 09 90 00 and in the CSM's written instructions.

e. Monitoring of Coatings Application. The Contractor shall inspect, measure, and record the WFT and general film quality (visual inspection) for lack of runs, sags, pinholes, holidays, etc. as the application work proceeds.

f. Post Application Inspection. The Contractor shall identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness, and other problems as may be observed.

g. Post Cure Evaluation. The Contractor shall measure and inspect the overall DFT. The Contractor shall conduct a DFT survey, as well as perform adhesion testing, holiday detection, or cure testing as required based on the type of project and the specific requirements in this Section 09 90 00 and/or in the CSM's written instructions.

h. Follow-up to Corrective Actions and Final Inspection. The Contractor shall measure and reinspect corrective coating work performed to repair defects identified at prior Hold Points. This activity also includes final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

D. Responsibilities of the CTR:

1. General:

a. The Contractor shall retain or obtain and schedule the services of the CTR to be on site to routinely verify in writing that the application personnel have successfully performed representative portions of the surface preparation, filler/surface application, coating system application, and QC Inspection in accordance with this Section 09 90 00. This must include testing or witnessing the contractors testing for the required degree of cleanliness, surface pH for concrete substrates, surface profile of substrates, proper mixing of coating materials, application (including checking the wet and DFT of the coating

systems), proper cure of the coating systems, and proper treatment of coating systems at terminations, transitions, and joints and cracks in substrates. These inspections are not expected to be full-time, but rather to assure that inspections by the CTR are performed on representative portions of all major steps of the coating work to ensure the CSM approves those representative portions of the work to be in compliance with the CSM's recommendations and instructions. This inspection is in addition to the inspection performed by the Contractor in accordance with paragraph 1.05C of this section. The CTR shall provide a reasonable level of oversight of the contractor's QC processes to be representative of key steps in the work, at their discretion, to provide a final sign-off certification that the CSM's products have been properly installed.

2. Coating System Inspection:
   a. While on site to verify or witness the QC processes of the contractor, the CTR shall verify representative steps of the coating work are performed properly per the manufacturer's instructions; the CTR shall coordinate and confirm the planned inspections by the Contractor's QCP are being performed per the QCTIP to assure quality of the work meets the requirements of both these specifications and any additional manufacturer's requirements; and the CTR shall verify or witness the contractors QC processes of the following QC steps at their discretion:
      1) Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.
      2) Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.
      3) Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, and other terminations at different substrates).
      4) Inspect application of the filler/surface materials for concrete and masonry substrates.
      5) Inspect application of the primers and finish coats including WFT and DFT of the coatings.
      6) Inspect coating systems for cure.
      7) Review adhesion testing of the cured coating systems for conformance to specified criteria.
      8) Inspect and record representative localized repairs made to discontinuities identified via continuity testing.
      9) Conduct a final review of completed coating system installation for conformance to the specifications.
      10) CTR shall prepare and submit a site visit report following each site visit that documents the acceptability of the coating work in accordance with the CSM's recommendations.
3. Final Report:
   a. Upon completion of coating work for the project, the CTR shall prepare a letter summarizing the inspection findings and shall attach the site visit reports required in 1.05 D.2. a.10. Include a statement that the completed work was performed in accordance with the requirements of this Section 09 90 00 and the CSM's recommendations based on the inspections performed by the CTR.

## 1.06 DELIVERY AND STORAGE

A. General:
   1. Materials shall be delivered to the job site in their original, unopened containers. Each container shall be properly labeled. Materials shall be handled and stored to prevent damage to or loss of label, meeting the project requirements or the CSM's if more stringent.
   2. Labels on material containers shall show the following information:
      a. Name or title of product
      b. CSM's batch number
      c. CSM's name
      d. Generic type of material
      e. Application and mixing instructions
      f. Hazardous material identification label
      g. Shelf-life expiration date
   3. Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold in accordance with the CSM's recommendations. Flammable materials shall be stored in accordance with state and local requirements.
   4. Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.
   5. Safety Data Sheets (SDS) for each material shall be provided to the Construction Manager.
   6. The Contractor shall store and dispose of hazardous waste according to federal, state and local requirements. This requirement specifically addresses waste solvents and coatings.



## 1.07 SUBMITTALS:

A. Action Submittals:
   1. Provide in accordance with Section 01 33 00:
      a. A copy of this specification section, with addendum updates included, and referenced and applicable sections, with addendum updates included, with each paragraph check-marked (☑) to indicate specification compliance or marked to indicate requested deviations from specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, and referenced in a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections along with justification(s) for requested deviations to the specification requirements shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

b. CSM's current printed recommendations and product data sheets for coating systems including:
   1) VOC data
   2) Surface preparation recommendations
   3) Primer type, where required
   4) Maximum dry and wet film mil thickness per coat
   5) Minimum and maximum curing time between coats, including atmospheric conditions limitations for each (temperature, dewpoint difference from temperature, etc.)
   6) Curing time before exposure to elements
   7) Thinner to be used with each coating
   8) Ventilation requirements
   9) Minimum atmospheric conditions during which the paint shall be applied
   10) Allowable application methods
   11) Maximum allowable moisture content
   12) Maximum shelf life
c. Affidavits signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements.
d. QP3 certification for shop applying coatings facility.
e. Safety Data Sheets (SDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.
f. List of cleaning and thinner solutions allowed by the CSMs.
g. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.
h. CSM's detailed written instructions for coating system treatment and graphic details for coating system terminations in the structures to be coated including, but not limited to, pipe penetrations, metal embedments, and other terminations to be determined from the contract drawings. This information shall also include detailed treatment for coating system at joints/terminations in concrete and concrete masonry unit assemblies.
i. CSM's detailed maximum chloride level tolerance for all coatings to be applied on metallic surfaces.
j. The Contractor and CSA shall provide a minimum of 5 project references each including contact name, address, and telephone number where similar coating work has been performed by their companies in the past 5 years.
k. The Contractor shall submit the QCITP as specified in 1.02 C.9. of this Section and shall include the QC Inspection Forms to be provided. The QCTIP must meet all pertinent QC requirements covered in the Quality Control Table 09 90 00 – 1 found under Part 4 of this Section. The QCTIP must also list who is responsible for performing all QC tests and inspection tasks and documentation of such tests and tasks.
l. Shop primer product data sheet and letter stating that shop primer is compatible with the field applied topcoats for all equipment on other items.
m. The Contractor's QCP shall submit a daily QC inspection report that will document all QC tests and inspections performed on any given day of the work including

test and inspection results. All non-compliant work shall be documented for coating repair. This report must be coordinated with the QCTIP provided per 1.05 C.9. QC reports shall be delivered electronically to the Construction Manager and Engineer the morning of the following day.

n. The contractors QCP shall identify immediately any items or issues that require immediate attention to the project Engineer in the form of a Flash Report (see definitions section for Flash Report definition)

o. Letter from CTR confirming that Contractor's coating application personnel to perform coating work have been trained or have appropriate experience to perform the work covered by this Section.

p. Resume of the Contractor's QCP responsible for performing the QC Testing and Inspection tasks delineated in the Contractor's Inspection and Testing Plan.

B. Product substitution requests:

1. Refer to the General Conditions and/or General Requirements for substitution requests procedures for materials or requests to substitute other specification requirements, which are handled differently than the normal project submittal procedures.



## PART 2 PRODUCTS

### 2.01 MATERIALS

A. General:

1. Notwithstanding the listing of product names in this Section 09 90 00, the Contractor shall provide affidavits, signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements. See Section 1.05 for detailed QC requirements required by the contractor. No coatings shall be applied to a surface until the specified affidavits have been submitted and have been reviewed and accepted. Failure to comply with this requirement shall be cause for rejection and removal of such materials from the site.

2. The following list specifies the material requirements for coating systems. Coating systems are categorized by generic name followed by an identifying abbreviation. If an abbreviation has a suffix number, it is for identifying subgroups within the coating system.

**Material Requirements for Coating Systems: All of the United States including California Except SCAQMD**

| Coating System | CSM | First Coat(s) | Finish Coat(s) |
|---|---|---|---|
| Epoxy Coatings | | | |
| E-1 | AkzoNobel | Interseal 670HS | Interseal 670HS |
| | Carboline | Carboguard 890 | Carboguard 890 |
| | PPG | Amerlock 2/400 Series | Amerlock 2/400 Series |
| | Sherwin Williams | Macropoxy 646 FC | Macropoxy 646 FC |
| | Tnemec | Series V69 | Series V69 |

**Material Requirements for Coating Systems: All of the United States including California Except SCAQMD**

| | | | | |
|---|---|---|---|---|
| E-2 | AkzoNobel | Interseal 670HS | | Interseal 670HS |
| | Carboline | Carboguard 890 series | | Carboguard 890 series |
| | PPG | Amerlock 2/400 Series | | Amerlock 2/400 Series |
| | Sherwin Williams | Dura-Plate 235 | | Dura-Plate 235 |
| | Tnemec | Series V69 | | Series V69 |
| E-3 | AkzoNobel | Interseal 670HS | | Interseal 670HS |
| | Carboline | Carboguard 890 series | | Carboguard 890 series |
| | PPG | Amerlock 2/400 Series | | Amerlock 2/400 Series |
| | Sherwin Williams | Dura-Plate 235 | | Dura-Plate 235 |
| | Tnemec | Series V69 | | Series V69 |
| **Coating System** | **CSM** | **First Coat(s)** | **Second Coat(s)** | **Finish Coat** |
| Epoxy Polyurethane | | | | |
| EU-1 | AkzoNobel | Interzinc 52 Series | Intergard 251HS | Interthane 990 Series |
| | PPG | Amercoat 68 HS | Amerlock 2/400 Series | Pithane Ultra |
| | Carboline | Carbozinc 859 series | Carboguard 890 | Carbothane 134 series |
| | Sherwin Williams | Galvapac 1K Zinc | Macropoxy 646FC | Hi Solids Polyurethane 250 |
| | Tnemec | Tneme-Zinc 90G-1K97 | Series V69 | Series 1094 |
| Flooring Systems | | | | |
| EFL-1 | PPG | PPG Flooring 912LV – 8-10 mils | PPG Novaguard 5041 –12-15 Mils with 20/40 Mesh Aggregate Broadcast | PPG Novaguard 5041 – 12-15 Mils |
| | Sherwin Williams | Resuprime 3579 –8-10 mils | Resufloor 3741 – 12-15 Mils with 20/40 Mesh Aggregate Broadcast | Resufloor 3741 – 12-15 mils |
| | Tnemec | Chemtread 239 – 8-10 Mils | Chemtread 239 – 12-15 mils with 50/70 Mesh Aggregate Broadcast | Tneme-Glaze 282 – 12-15 Mils |
| EFL-2 | PPG | PPG Flooring 912LV – 8-10 mils | PPG Flooring 610SL –12-15 mils with 20/40 Mesh Aggregate Broadcast | PPG Flooring 610SL – 12-15 mils |
| | Sherwin WIlliams | Resuprime 3579 –8-10 mils | Resufloor 3746 – 12-15 mils with 20/40 Mesh Aggregate Broadcast | Resufloor 3746 – 12-15 mils |
| | Tnemec | Power-Tread 237-8-10 mils | Power-Tread 237- 12-15 mils with 50/70 Mesh Aggregate Broadcast | Tneme-Glaze 280 –12-15 Mils |
| **Coating System** | **CSM** | **First Coat(s)** | | **Finish Coat(s)** |
| Grease | | | | |
| G | Texaco | N/A | | Rust Inhibitive Grease |
| | Chevron | N/A | | E.P. Roller Grease |

| Material Requirements for Coating Systems: All of the United States including California Except SCAQMD | | | |
|---|---|---|---|
| High Heat | | | |
| HH-1 (Various silicone & epoxy hybrid products up to 400F) | AkzoNobel | Interbond 2340UPC | Interbond 2340UPC |
| | PPG | Amerlock 2/400GF | Amerlock 2/400GF |
| | Carboline | Carbozinc 11 series | Thermaline 4000 |
| | Sherwin Williams | Hi Temp Heat Flex 1000 | Hi Temp Heat Flex 1000 |
| HH-2 (TMIC – Titanium Modified Inorganic Co-Polymer up to 1200F) | AkzoNobel | Interbond 1202UPC | Interbond 1202UPC |
| | PPG | Hi-Temp 1027 Series | Hi-Temp 1027 Series |
| | Carboline | Thermaline Heat Shield | Thermaline Heat Shield |
| | Sherwin Williams | Heat Flex High Temp 1200 | Heat Flex High Temp 1200 |
| Latex Acrylic | | | |
| L-1 | Benjamin Moore | SuperKote 3000 Primer | Corotech V331 Acrylic |
| | Carboline | Sanitile 120 | Carbocrylic 3359 MC |
| | PPG | Pitt-Tech Plus 4020 PF | Pitt-Tech Plus 4216 |
| | Sherwin Williams | Loxon Acrylic Primer | Sher-Cryl HPA |
| | Tnemec | Series 1028 or 1029 | Series 1028 or 1029 |
| L-2 | Benjamin Moore | Series 110 Stix Primer | Corotech V331 DTM Acrylic |
| | Carboline | Sanitile 120 | Carbocrylic 3359 MC |
| | PPG | Pitt-Tech Plus 4020 PF | Pitt-Tech Plus 4216 |
| | Sherwin Williams | Pro-Cryl Primer | Sher-Cryl HPA |
| | Tnemec | Series 1028 or 1029 | Series 1028 or 1029 |
| Miscellaneous | | | |
| M-1 | Carboline | Carbowrap Tape series Paste | Carbowrap series Petrolatum Tape |
| | Denso | Denso Paste | Densyl Tape |
| | Trenton | Waxtape Primer | #1 Wax Tape |
| M-2 | AkzoNobel | Interseal 670HS | Interseal 670HS |
| | Carboline | Carbomastic 615 | Carbomastic 615 |
| | PPG | Amerlock 2/400 Series | Amerlock 2/400 Series |
| | Sherwin Williams | Tank Clad HS | Tank Clad HS |
| | Tnemec | Series 135 | Series 135 |
| Penetrating Stain | | | |
| S-2 | Curecrete Chemical Company | N/A | Ashford Formula |
| | Sherwin Williams | N/A | Conflex 7% Silane Sealer |
| | PPG | Permacrete 4-6100C | Permacrete 4-6100C |
| | Tnemec | N/A | Series 633 Prime-A-Pell H20 |
| S-3 | Sherwin Williams | N/A | Conflex 7% Siloxane |

| Material Requirements for Coating Systems: All of the United States including California Except SCAQMD | | | |
|---|---|---|---|
| | PPG | Permacrete 4-6100C | Permacrete 4-6100C |
| | Tnemec | N/A | Series 633 Prime-A-Pell H2O |

**See CSM's Product Data Sheets for acceptable thinners for VOC compliance or do not thin.*

## PART 3 EXECUTION

### 3.01 COATINGS

A. General:

1. Coating products shall not be used until the Engineer, Construction Manager, Owner, or Owner's Representative has accepted the affidavits specified in paragraphs 1.07 and 2.01 and the CTR has trained the Contractor and CSA in the surface preparation, mixing, and application of each coating system.
2. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.
3. Only use primers accepted as part of the coating submittal for the specific project components, including for shop applied primers.

B. Shop and Field Coats:

1. Shop Applied Prime Coat: Except as otherwise specified, prime coats may be shop-applied or field-applied. Shop-applied primer shall only be that which has been identified and accepted as part of the coating submittal. It must be compatible with the specified coating system and shall be applied at the minimum DFT recommended by the CSM. Data sheets identifying the shop primer used shall be provided to the Engineer as a Submittal for Approval as required in Submittals, 1.07. All requirements for surface preparation, inspections and testing, and documentation apply to shop applied primers. Adhesion tests shall be performed on the shop primer as specified in paragraph 3.01 B.3. Adhesion Confirmation. Damaged, deteriorated and poorly applied shop coatings that do not meet the requirements of this Section 09 90 00 shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section 09 90 00, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.
2. Field Coats: Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified coating system DFT. Unless otherwise specified, finish coats shall not be applied until other work in the area is complete and until previous coats have been inspected.
3. Adhesion Confirmation: The Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) the shop applied prime coat adheres to the substrate and (2) the specified field coatings adhere to the shop applied coat. Test results showing an adhesion rating of 4A or better on surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils.
4. Compatibility of coatings applied over existing coatings of different generic chemistry shall be tested for compatibility through test patches applied and provided time for

cure. After suitable cure time as per the CSM, perform adhesion testing as per 3.01.B.3 prior to proceeding.

C. Application Location Requirements:

1. Equipment, non-immersed, non-corrosive atmosphere: Items of equipment, or parts of equipment that are not immersed in service, shall be shop primed and then finish coated in the field after installation with the specified or acceptable color. If the shop primer requires top coating within a specified period, the equipment shall be finish coated in the shop and then touch-up painted after installation in the field. If equipment removal and reinstallation is required for the project, touch-up coating work shall be performed in the field following reinstallation. [For equipment exposed to corrosive atmosphere or immersion, refer to specification 09 96 00.]
2. For equipment that is partially or totally immersed, refer to specification 09 96 00 High Performance Coatings for requirements for coatings.

## 3.02 PREPARATION

A. General:

1. Surface preparations for each type of surface shall be in accordance with the specific requirements of each coating specification sheet (COATSPEC) and the following. In the event of a conflict, the more stringent requirements shall take precedence.
2. Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, mill scale, old, weathered coatings, and other foreign substances shall be removed. Oil and grease must be removed before mechanical cleaning is started. Where testing reveals chloride contamination, chlorides shall be removed prior to blast cleaning or other mechanical surface preparation methods. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded, and free from contaminants that might interfere with the adhesion of the coatings. The air used for blast cleaning shall be free of oil and moisture so as not to cause detrimental contamination of the surfaces to be coated.
3. Protect all surfaces and equipment not to be coated from dust and overspray. Cleaning and coating shall be scheduled so that dust and spray from the cleaning process shall not fall on wet, newly coated surfaces. Hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with coated surfaces shall be removed or masked prior to surface preparation and coating operations. Following completion of coating, removed items shall be reinstalled. Equipment adjacent to walls shall be disconnected and moved to permit cleaning and coating of equipment and walls and, following coating, shall be replaced and reconnected.

B. Blast Cleaning:

1. When abrasive blast cleaning is required to achieve the specified surface preparation, the following requirements for blast cleaning materials and equipment shall be met:
   a. Used or spent blast abrasive shall not be reused on this project. No silica sand shall be used for this abrasive blast cleaning work. The blast abrasive media used shall provide the most efficient cutting action to achieve the profile and degree of cleanliness specified.

b. The compressed air used for blast cleaning shall be filtered and shall contain no condensed water and no oil. Moisture traps shall be cleaned at least once every 4 hours or more frequently as required to prevent moisture from entering the supply air to the abrasive blasting equipment.

c. Oil separators shall be installed just downstream of compressor discharge valves and at the discharge of the blast pot discharges. These shall be checked on the same frequency as the moisture traps as defined above.

d. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles at all times during this work.

e. An air dryer or desiccant filter drying unit shall be installed which dries the compressed air prior to blast pot connections. This dryer shall be used and maintained for the duration of surface preparation work.

f. The abrasive blast nozzles used shall be of the venturi or other high velocity type supplied with a minimum of 100 pounds per square in gauge (psig) air pressure and sufficient volume to obtain the blast cleaning production rates and cleanliness specified.

g. The Contractor shall provide ventilation for airborne particulate evacuation (meeting pertinent safety standards) to optimize visibility for both blast cleaning and inspection of the substrate during surface preparation work.

h. If, between final surface preparation work and coating system application, contamination of prepared and cleaned metallic substrates occurs, or if the prepared substrates' appearance darkens or changes color, recleaning by water jetting and/or abrasive blast cleaning shall be required until the specified degree of cleanliness is reclaimed.

i. The Contractor is responsible for dust control and for protection of mechanical, electrical, and other equipment adjacent to and surrounding the work area.

C. Solvent Cleaning:

1. Any solvent wash, solvent wipe, or cleaner used, including but not limited to those used for surface preparation in accordance with SSPC-SP 1 Solvent Cleaning, shall be of the emulsifying type which emits no more than 340 g/l VOCs for AIM regions, 250 g/l for CARB regions, and 100 g/l for SCAQMD regions, contains no phosphates, is biodegradable and is compatible with the specified primer.
2. Clean white cloths and clean fluids only shall be used in solvent cleaning.

D. Metallic Surfaces:

1. Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Society for Protective Coatings (SSPC) and NACE International (NACE) specified for each coating system. See Coat Spec for each coating system in this Section 09 90 00. The profile depth of the surface to be coated shall be in accordance with the COATSPEC requirements in this Section measured by Method C of ASTM D4417. Blast particle size shall be selected by the Contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the CSM.
2. If soluble chloride contamination is suspected or is possible/plausible, the following steps should be taken. Following initial blast cleaning of steel substrates, test for the presence of soluble chlorides using the retrieval and analysis method designated as Method 4.2.2. Adhesively Bonded Latex Patch or Cell as described in SSPC-TG15 . Testing shall be in accordance with ISO 8502-6/8502-9 at the rate of 4 tests per

1,000 sq. ft. of steel surface area to be coated, but no less than a total of 4 tests per component. The target threshold or tolerance conductivity level for soluble chloride contamination shall be approved in writing by the CSM's CTR for each product that is part of the application.

3. Preparation of metallic surfaces shall be based upon comparison with SSPC-VIS1-89 (ASTM D2200) and as described in the Coat Spec for each coating system. If dry abrasive blast cleaning is selected and to facilitate inspection, the Contractor shall, on the first day of cleaning operations, abrasive blast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and the Construction Manager and coated with a clear non-yellowing finish. One of these panels shall be prepared for each type of abrasive blasting and shall be used as the comparison standard throughout the project.
4. Blast cleaning requirements for steel, ductile iron, and stainless steel substrates are as follows:
   a. Steel piping shall be prepared in accordance with SSPC-SP 6/NACE#3 (Commercial Blast Cleaning) and primed before installation. Ductile iron piping surfaces including fittings shall be prepared in accordance with NAPF 500-03, NAPF 500-03-04, and NAPF 500-03-05.
   b. Stainless steel surfaces shall be abrasive blast cleaned in accordance with SSPC-SP 16 to leave a clean uniform appearance with a minimum surface profile of 1.5 to 2.5 mils that is uniform, unless required to be greater by the CSM.
   c. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products, or embedded abrasive from substrate by vacuum-cleaning prior to coating application. Blow-down cleaning with compressed air shall not be permitted.
   d. Care must be taken to prevent contamination of the surface after blasting from worker's fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions.
   e. Ambient environmental conditions in the enclosure must be constantly monitored and maintained to ensure the degree of cleanliness is held and no "rust back" occurs prior to coating material application.
5. Galvanized steel surfaces shall be abrasive blast cleaned per SSPC SP 16 to produce a minimum surface profile of 1.0 to 1.5-mil profile and to remove all corrosion products. Caution–follow CSM's specific recommendations for surface prep, including abrasive blast cleaning.

E. Concrete Surfaces:
   1. Inspection of concrete surfaces prior to surface preparation and surface preparation of concrete surfaces shall be performed in accordance with SSPC-SP 13/SP CAB/NACE #6 (also called NACE 6).
   2. Prepare substrate cracks and areas requiring resurfacing and perform detail treatment including but not limited to, terminating edges per CSM recommendations. This shall precede surface preparation for degree of cleanliness and profile.
   3. The surface profile for prepared concrete surfaces to be coated shall be evaluated by comparing the profile of the prepared concrete with the profile of the ICRI 310.2 (molded surface profile replicas). Surface profile requirements shall be in accordance with the Coat Spec requirements and the CSM's recommendations.

4. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to making repairs or applying a coat in the coating system. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness prior to application of the coating system.
5. Surface preparation of concrete substrates shall be accomplished using methods such as dry abrasive blast cleaning, high, or ultra-high-pressure water jetting in accordance with SSPC-SP 13 /SP CAB /NACE #6. The selected cleaning method shall produce the requirements set forth below.
    a. A clean substrate that is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances shall be achieved. Blast cleaning and other means necessary shall be used to open up air voids or bugholes to expose their complete perimeter. Leaving shelled over, hidden air voids beneath the exposed concrete surface is not acceptable. Concrete substrate must be dry prior to the application of repair mortars, filler/surfaces, or coating system materials.
    b. Acceptable surface preparation must produce a concrete surface with a minimum pH of 9.0 to be confirmed by surface pH testing. If after surface preparation, the surface pH remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.
    c. Following inspection by the Contractor of the concrete surface preparation, thoroughly vacuum clean concrete surfaces to be coated to remove loose dirt, and spent abrasive (if dry blast cleaning is used) leaving a dust free, sound concrete substrate. Debris produced by blast cleaning shall be removed from the structures to be coated and disposed of legally off site by the Contractor.
6. Should abrasive blast cleaning or high or ultrahigh pressure water jetting not remove degraded concrete, chipping or other appropriate tools shall be used to remove the deteriorated concrete until a sound, clean substrate is achieved which is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances. Do not use equipment that will damage the underlying sound concrete. This includes not using pneumatic or electric chipping tools which will bruise or cause micro-cracking of the concrete substrate. Concrete substrates must be dry prior to the application of polymer based or mortars or filler/surfacers coating system materials.
7. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to application of coating materials. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness and required surface profile prior to application of the coating system.
8. Moisture content of concrete to be coated shall be tested in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method. The ASTM D4263 plastic sheet test shall be conducted at least once for every 500 sq. ft. of surface area to be coated. The presence of any moisture on plastic sheet following test period constitutes a non-acceptable test.
9. If moisture is detected, the CSA in cooperation with the CTR shall perform additional moisture testing vis ASTM F1869 or ASTM F2170 to determine the extent of the moisture vapor transmission. The acceptable limit for the application of barrier coatings for ASTM F1869 is < 3lbs/1,000 sq ft/24 hours. The acceptable limit as per ASTM F2170 is an RH value <70 percent.

F. Masonry Surfaces:

1. Prepare masonry surfaces such as Concrete Masonry Units (CMU) to remove chalk, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
2. Be certain masonry surfaces are dry prior to coating application. If pressure washing or low-pressure water blast cleaning or water jetting is used for preparation, allow the masonry to dry. Allowable moisture content will be assessed by the CTR to ensure moisture levels are in tolerance ranges to the coating system being applied prior to coating application work proceeding. Results and CTR instructions shall be provided to the Engineer or Construction Manager in writing from the CTR before proceeding with application.

G. Fiberglass Reinforced Plastic (FRP) Surfaces:

1. Prepare FRP surfaces by sanding to establish uniform surface roughness without any gloss remaining while minimizing any excessive removal of resin material. Next, vacuum clean to remove loose FRP dust, dirt, and other materials. Do not use compressed air. Next, solvent clean using clean white rags and allow solvent to evaporate completely before application of coating materials.



## 3.03 APPLICATION

A. Workmanship:

1. Coated surfaces shall be free from runs, drips, sags, ridges, waves, laps, and brush marks. Coats shall be applied to produce an even film of uniform thickness completely coating corners and crevices.
2. The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. A paper blotter test shall be performed by the Contractor when requested by the Construction Manager or Engineer to determine if the air is sufficiently free of oil and moisture so as not to produce deteriorating effects on the coating system. The amount of oil and moisture in spray air shall be less than the amount recommended by the CSM. Spray equipment shall be equipped with mechanical agitators, pressure gages, pressure regulators, and spray nozzles of the proper sizes.
3. Each coat of coating material shall be applied evenly and sharply cut to line. Care shall be exercised to avoid over-spraying or spattering paint on surfaces not to be coated. Glass, hardware, floors, roofs, equipment, and all other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable masking measures.
4. Coating applications method shall be conventional or airless spray, plural component spray, brush or roller, or trowel as recommended by CSM.
5. Allow each coat to cure or dry thoroughly, according to CSM’s printed instructions, prior to recoating.
6. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Vary color for each successive coats for coating systems wherever possible to provide visual confirmation of coverage.
7. When coating complex steel shapes, prior to overall coating system application, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces as per SSPC PA Guide 11. This involves applying a

separate coat using brushes or rollers to ensure proper coverage. Stripe coat via spray application is not permitted. Stripe coating shall be applied with primer and intermediate coats but not to finish coats.

B. Coating Properties, Mixing and Thinning:
   1. Coatings, when applied, shall provide a satisfactory film and smooth even surface. Coating materials shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of 2 or more components shall be mixed in accordance with the CSM's instructions. Where necessary to suit the conditions of the surface, temperature, weather, and method of application, the coating may be thinned but only as recommended by the CSM. The VOC of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, coatings shall not be reduced more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the CSM.

C. Atmospheric Conditions:
   1. Coatings shall be applied only to surfaces that are dry and only under conditions of evaporation rather than condensation. Coating systems shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. During damp weather, when the temperature of the surface to be coated is within 10 degrees F of the dew point, forced dehumidification equipment may be used to maintain a temperature of minimum 40 degrees F and 10 degrees F above the dew point for the surfaces to be coated, the coated surface, and the atmosphere in contact with the surface. These conditions shall be maintained for a period of at least 8 hours or as recommended by the CSM. Where conditions causing condensation are severe, dehumidification equipment, fans, and/or heaters shall be used inside enclosed areas to maintain the required atmospheric and surface temperature requirements for proper coating application and cure at no additional cost to the Owner.

D. Concrete Substrate Temperatures and Detail Treatment:
   1. When the surface temperatures of the concrete substrates to be coated are rising or when these substrates are in direct sunlight, outgassing of air from the concrete may result in bubbling, pinhole formations, and/or blistering in the coating system. The application of the filler/surface and the coating system will only be allowed during periods of falling temperature. This will require that application of the filler/surface and coating system shall only occur during the cooler evening hours. Contractor shall include any cost for working outside of normal hours in the bid.
   2. Should bubbles, fish eyes, pinholes, or other discontinuities form in the applied coating system material, they shall be repaired as recommended by the CSM. Should pinholes develop in the filler/surfacer material or in the first coat of the coating material, the pinholes shall be repaired in accordance with the CSM's recommendations prior to application of the next coat of material. Whenever pinholes occur, the air void behind or beneath the pinhole shall be opened up completely and then completely filled with the specified filler/surfacer/coating material. Next, the coated area around the pinhole repair shall be abraded and the coating reapplied over that area.
   3. Perform application detail work per CSM's current written recommendations and/or drawings.

E. Protection of Coated Surfaces:

1. Items that have been coated shall not be handled, worked on, or otherwise disturbed, until the coating is completely dry and hard. After delivery at the site, and upon permanent erection or installation, shop-coated metalwork shall be recoated or retouched with specified coating when it is necessary to maintain the integrity of the film.

F. Method of Coating Application:

1. Where 2 or more coats are required, alternate coats shall contain sufficient compatible color additive to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Color additives shall not contain lead, or lead compounds, which may be destroyed or affected by hydrogen sulfide or other corrosive gas, and/or chromium.
2. Mechanical equipment, on which the equipment manufacturer's coating is acceptable, shall be touch-up primed and coated with 2 coats of the specified coating system to match the color scheduled. Electrical and instrumentation equipment specified in Divisions 26 and 40 shall be coated as specified in paragraph 3.03 Electrical and Instrumentation Equipment and Materials.
3. Coatings shall not be applied to a surface until it has been prepared as specified. The primer or first coat shall be applied by brush to ferrous surfaces that are not blast cleaned. Coats for blast-cleaned ferrous surfaces and subsequent coats for non-blast cleaned ferrous surfaces may be either brush or spray applied. After the prime coat is dry, all surfaces shall be visually inspected, and any visible pinholes and/or and holidays shall be marked, repaired in accordance with CSM's recommendations, and reinspected visually before succeeding coats are applied. Unless otherwise specified, coats for concrete and masonry shall be brushed, rolled, or troweled.

G. Film Thickness and Continuity:

1. WFT testing and documentation of the first coat of the coating system and subsequent coats shall be verified by the Contractor, following application of each coat.
2. The surface area covered per gallon of coating for various types of surfaces shall not exceed those recommended by the CSM. The first coat, referred to as the prime coat, on metal surfaces refers to the first full paint coat and not to solvent wash, grease emulsifiers, or other pretreatment applications. Coatings shall be applied to the thickness specified and in accordance with these specifications.
3. Visual observations of continuity of coating film quality about welds, projections (such as bolts and nuts), and crevices, the Contractor’s QC Inspector shall assure no holidays exist where the dry-mil thickness has been accepted. This continuity shall be the minimum required for these rough or irregular areas. Pinholes and holidays shall be recoated to the required coverage.
4. The ability to obtain specified film thickness is generally compromised when brush or roller application methods are used and, therefore, more coats may need to be applied to achieve the specified DFT.
5. For concrete substrates, the Contractor shall apply a complete skim coat of the specified filler/surfacer material over the entire substrate prior to application of the coating system as required in the COATSPEC for the specific coating system. This material shall be applied such that all open air voids and bugholes in the concrete substrate are completely filled prior to coating application. This skim or parge coat

shall be applied to the thickness recommended by the CSM and shall produce, when finished, a relatively flat, continuous coatable surface.

H. Special Requirements:

1. Before erection, the Contractor shall apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces that are inaccessible after assembly. The final coat shall be applied after erection. Structural friction connections and high tensile bolts and nuts shall be coated after erection. Areas damaged during erection shall be hand-cleaned or power-tool cleaned and recoated with primer coat prior to the application of subsequent coats. Touch-up of surfaces shall be performed after installation. Surfaces to be coated shall be clean and dry at the time of application.
2. Except for those to be filled with epoxy grout, the underside of equipment bases and supports that have not been galvanized shall be coated with at least 2 coats of primer specified for system E-2 prior to setting the equipment in place. Provide coating system terminations at leading edges and transitions to other substrates in accordance with the CSM's recommendations or detail drawings.

I. Electrical and Instrumentation Equipment and Materials:

1. Electrical and instrumentation equipment and materials shall be coated by the equipment manufacturer as specified below.
   a. Finish: Electrical equipment shall be treated with zinc phosphate, bonderized, or otherwise given a rust-preventive treatment. Equipment shall be primed, coated with enamel, and baked. Minimum DFT shall be 3 mils.
      1) Unless otherwise specified, instrumentation panels shall be coated with system E-1 for indoor mounting and system EU-1 for outdoor mounting.
      2) Before final acceptance, the Contractor shall touch up scratches on equipment with identical color coating. Finish shall be smooth, free of runs, and match existing finish. Prior to touching up scratches, Contractor shall fill them with an appropriate filler material approved by the CSM so evidence of prior scratches is not visible in the finish surface.
   b. Color: Exterior color of electrical equipment shall be FS 26463 (ANSI/NSF 61) light gray. Interior shall be painted FS 27880 white. Nonmetallic electrical enclosures and equipment shall be the equipment manufacturer's standard grey color.
      1) Exterior color of instrumentation panels and cabinets mounted indoors shall be FS 26463 light gray; unless otherwise specified, exterior color for cabinets mounted outdoors shall be FS 27722, white. Cabinet interiors shall be FS 27880, white.



## 3.04 CLEANUP

A. General:

1. Upon completion of coating, the Contractor shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean surfaces and repair overspray or other coating-related damage.

## 3.05 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

A. General:

1. Coating systems for different types of surfaces and general service conditions for which these systems are normally applied are specified on the following COATSPEC sheets. Surfaces shall be coated in accordance with the COATSPEC to the system thickness specified. Coating systems shall be as specified in paragraph 3.06. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.
2. Coating Specification Sheets included in Table A are included this paragraph 3.05.

**Table A Coating Specification Sheets**

| Coating System ID | Coating Material | Surface | Service Condition |
|---|---|---|---|
| E-1 | Epoxy | Metal | Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure. |
| E-2 | Epoxy | Metal | Exposed to high humidity, condensing conditions moderately corrosive vapors. |
| E-3 | Epoxy | Concrete or masonry | Non-immersed, moderately corrosive vapor environments, color required. |
| EU-1 | Zinc-epoxy-polyurethane system | Ferrous Metal | Exterior, exposed to direct sunlight, moderately corrosive non-immersed – vapor exposure. |
| EFL-1 | Chemical Resistant Novolac Epoxy Flooring with Anti-Slip Broadcast | Concrete | Interior areas subjected to chemical splash and spill. (NOT SECONDARY CONTAINMENT) for Secondary Containment see 09600 |
| EFL-2 | Epoxy Flooring with Anti-Slip Broadcast | Concrete | Interior areas such as electrical Rooms, mechanical rooms, storage rooms, washrooms and other common Areas of foot or light cart traffic. Not subjected to chemical or UV exposure. |
| G | Grease | Metal | Ferrous Metal: Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 1 (Solvent Cleaning.) |
| HH-1 | Next Generation Epoxy Phenolic | Metal | Temperature to 400 degrees F. |
| HH-2 | TMIC – Titanium Modified Inorganic Co-polymer | Metal | Temperature to 1200 degrees F. |
| L-1 | 100% Acrylic Latex | Concrete, masonry, plaster, gypsum board | Interior including existing coated concrete. |
| L-2 | 100% Acrylic Latex | PVC and CPVC pipe | Exterior, direct sunlight exposure. |
| M-1 | Petrolatum based mastic or wax based wrapping tapes | Metal | Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel. |
| M-2 | Epoxy mastic or equal | Ferrous Metal | Interior moderately, corrosive environment, confined enclosures, where minimal surface preparation is possible. Non-immersed. |
| S-2 | Silane or Siloxane or Blended Siloxane & Silane Sealer | Concrete Floors | Non-immersed, non-corrosive. Interior or exterior for waterproofing. |
| S-3 | Silane or Siloxane or Blended Siloxane & Silane Sealer | Concrete or Masonry Walls | Exterior or Interior – Weathering Exposure, Non-Corrosive. |

## Coating System Specification Sheets (COATSPEC)

### Coating System Identification: E-1

| | | |
|---|---|---|
| 1. | Coating Material: | Epoxy |
| 2. | Surface: | Metal |
| 3. | Service Condition: | Interior; exterior, covered, not exposed to direct sunlight, non-corrosive exposure. |
| 4. | Surface Preparation: | |
| a. | General: | Shop primed surfaces which are to be incorporated in the work where recoat times have been exceeded shall be prepared in the field by cleaning surfaces by sanding to produce uniform profile of .5 to 1.0 mils and solvent cleaned per SSPC-SP 1. Damaged shop coated areas shall be cleaned in accordance with SSPC-SP6/NACE #3 Commercial Abrasive Blast Cleaning or SSPC-SP 11 to achieve a uniform surface profile of 2.0 to 2.5 mils in the metal substrate and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive sanding and vacuum cleaning prior to receiving finish coats. |
| b. | Ferrous Metal: | Bare ferrous metal surfaces shall be prepared in accordance with SSPC-SP 6/NACE#3 (Commercial Blast Cleaning) to achieve a uniform, surface profile of 2.0 to 2.5 mils. |
| c. | Nonferrous and Galvanized Metal: | Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP 1. Areas of rust penetration shall be spot blasted to SSPC-SP6/NACE#3 Commercial blast (to achieve the 2.0- to 2.5-mil surface profile) and spot primed with the specified primer. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces. |
| 5. | Application | Field |
| a. | General: | Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations. |
| b. | Ferrous Metal: | Prime coats shall be an epoxy primer compatible with the specified finish coats and applied in accordance with the written instructions of the CSM. |
| c. | Nonferrous and Galvanized Metal: | Nonferrous and galvanized metal shall be cleaned prior to the application of the prime coat in accordance with SSPC-SP 1 (Solvent Cleaning). |
| 6. | System Thickness: | 10 mils dry film. |
| 7. | Coatings: | |
| a. | Primer: | One coat at CSM's recommended DFT. |
| b. | Finish: | One or more coats at CSM's recommended DFT per coat to achieve the specified system thickness. |

### Coating System Identification: E-2

| | | |
|---|---|---|
| 1. | Coating Material: | Epoxy |
| 2. | Surface: | Metal |
| 3. | Service Condition: | Non-immersed, moderately corrosive environment, color required. |
| 4. | Surface Preparation: | |
| a. | Ferrous Metal: | Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 5 (White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils. |
| | | Damaged shop coating shall be cleaned in accordance with SSPC-SP6/NACE #3 Commercial Blast Cleaning or SSPC-SP 11 and vacuum cleaning and spot primed with the primer specified. Shop epoxy primed surfaces shall require light abrasive blasting or abrading prior to receiving finish coats if the maximum recoat time for the primer has been exceeded. This cleaning must produce a uniform 1.0- to 1.5-mil profile in the intact |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| | shop primer. For ductile iron surfaces, refer to the requirements in paragraph 3.02 Metallic Surfaces. |
| b. Nonferrous and Galvanized Metal: | Nonferrous and galvanized metal shall be prepared in accordance with SSPC-SP 16 to achieve a uniform surface profile of 1.0 to 1.5 mils. Galvanized steel with this E-2 coating system shall not be used in routinely wet exposures. |
| 5. Application: | Field |
| a. General: | Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations. |
| b. Ferrous Metal: | Prime coat shall be an epoxy primer compatible with the specified finish coats. |
| c. Nonferrous and Galvanized Metal: | Nonferrous and galvanized metal, non-immersed, shall be coated prior to the application of the prime coat with a grease emulsifying agent in accordance with the CSM's written instructions. Nonferrous metal to be immersed shall not be painted. Galvanized metal shall not be immersed even if it is painted. If non-ferrous metals are not to be immersed, prepare in accordance with SSPC-SP 16. |
| 6. System Thickness: | 16 mils dry film. |
| 7. Coatings: | |
| a. Primer: | One coat at CSM's recommended DFT. |
| b. Finish: | Two or more coats at CSM's recommended DFT per coat to the specified system thickness. |
| **Coating System Identification: E-3** | |
| 1. Coating Material: | Epoxy |
| 2. Surface: | Concrete or masonry |
| 3. Service Condition: | Non-immersed, moderately corrosive vapor environment, color required. |
| 4. Surface Preparation: | |
| a. Concrete: | Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM before coating work proceeds. Moisture testing shall be performed in accordance with ASTM D4263, Moisture by Plastic Sheet Test. Any moisture on back of plastic sheet means coating application cannot proceed until the concrete or masonry has dried out. See section 3.02 for further testing requirements. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting and chipping, and voids and cracks shall be repaired as specified in Section 03 30 00. Surface preparation can be performed by abrasive blast cleaning as per SSPC-SP 13/NACE #6 and SSPC SP CAB 1 or high pressure water jet cleaning and must achieve a uniform concrete surface profile of CSP 3 in accordance with ICRI 310.2. After cleaning, air voids or bugholes in the concrete shall be filled with a surfacer or block filler compatible with the specified primer and finish coats. |
| b. Masonry: | Masonry surfaces shall be allowed to cure for at least 28 days after being constructed and be allowed to dry to the moisture content recommended by the CSM. Holes or other joint defects shall be filled with a material compatible with the primers and finish coats or shall be filled with masonry mortar that shall cure for at least 28 days. Loose or splattered mortar shall be removed by scraping and chipping. |
| | Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign, loose, and deleterious substances. |
| | Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| | primer. |
| 5. Application: | Field |
| a. General: | Apply filler/surfacer as recommended by CSM to fill bugholes and air voids or block texture, etc. leaving a uniformly filled surface that does not produce blowholes or outgassing causing pinholing of the coating system. Filler/surfacers shall dry a minimum of 48 hours prior to application of prime coat or as required by the CSM. |
| | Prime coat shall be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control regulations. |
| | Drying time between coats shall be as recommended by CSM. |
| 6. System Thickness: | 15 mils dry film. |
| 7. Coatings: | |
| a. Primer: | One coat at CSM's recommended DFT. |
| b. Finish: | Two or more coats at CSM's recommended DFT per coat to the specified system thickness. |
| **Coating System Identification: EU-1** | |
| 1. Coating Material: | Zinc-Epoxy-Polyurethane System |
| 2. Surface: | Ferrous Metal |
| 3. Service Condition: | Exterior, exposed to direct sunlight, moderately corrosive, non-immersed. |
| 4. Surface Preparation: | |
| a. General: | Undamaged shop primed surfaces which have exceeded recoat times which are to be incorporated in the work shall be prepared in the field by sanding to produce a uniform surface profile followed by Solvent Cleaning per SSPC-SP 1. Damaged shop coated areas shall be cleaned in accordance with SSPC-SP 11 and recoated with the primer specified. |
| b. Ferrous Metal: | Bare ferrous metal surfaces shall be prepared in accordance with SSPC-SP 6 (Commercial Blast Cleaning) 2.0–2.5 mils. Ductile iron surfaces to be coated shall be abrasive blast cleaned in accordance with paragraph 3.02 Metallic Surfaces. |
| | Ferrous metal with rust bleeding shall be cleaned in accordance with SSPC-SP 11 (Power Tool Cleaning to Bare Metal). Areas of rust penetration shall be spot blasted to SSPC-SP 6/NACE #3 10 (Commercial Near White Blast Cleaning) and spot primed with the specified primer. |
| c. Galvanized Metal: | Damaged galvanized steel areas with exposed ferrous metal and/or rusted shall be cleaned in accordance with SSPC-SP 165 (White Metal Brush Off Abrasive Blast Cleaning for Galvanized and Non-Ferrous metal) or Power Tool Cleaned to Bare Metal in accordance with SSPC-SP 11 to achieve a uniform 1.0- to 1.5-mil profile. The zinc primer is NOT used on galvanized steel but is spot primed with the primer specified for galvanized metal as recommended by the CSM. |
| | Nonferrous and galvanized metal shall be prepared in accordance with SSPC-SP 16 (Brush Off Abrasive Blast Cleaning for Galvanized and Non-Ferrous metal) to impart a 1.0- to 2.0-mil profile to the galvanized or non-ferrous steel surfaces. Where this cannot be performed, prepare by abrading in accordance with SSPC-SP 113, Power Tool Cleaning to bare metal to impart a 1.0- to 1.5-mil profile uniformly to the galvanized steel surfaces. |
| | For EU-1 over galvanized steel, **DELETE the zinc rich primer**. |
| 5. Application: | Field |
| a. General: | Prime coat may be thinned and applied as recommended by the CSM, provided the coating as applied complies with prevailing air pollution control |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| | regulations. |
| b. Ferrous Metal: | Prime coats shall be a zinc rich epoxy or polyurethane primer compatible for use with urethane finish coats and applied in accordance with written instructions of the CSM or in the case of CARB or SCAQMD applications, prime with specified primer that is not zinc rich. In these cases, only a 2-coat system is applied. |
| 6. System Thickness: | 3-4 mils of zinc rich primer, one intermediate or primer epoxy coat at 5-6 mils and one finish coat of polyurethane at 2-3 mils DFT. |
| 7. Coatings: | |
| a. Primer: | One coat at CSM's recommended DFT |
| b. Intermediate: | One coat at CSM's recommended DFT |
| c. Finish: | One coat at CSM's recommended DFT per coat to meet the specified system thickness |
| **Coating System Identification: EFL-1** | |
| 1. Coating Material: | 100% Solids Chemical Resistant Novolac Epoxy with Anti-Slip Aggregate Broadcast |
| 2. Surface | Concrete |
| 3. Service Condition | Interior areas subject to chemical splash and spill (NOT SECONDARY CONTAINMENT ) |
| 4. Surface Preparation: | |
| a. General | All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, coating terminations at metal embedment's in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the Owner, the Engineer, or any other party. |
| b. Concrete | Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content shall be tested per ASTM D4263, Moisture by Plastic Sheet Test. Any moisture on back of plastic sheet means coating cannot proceed until the concrete has dried out. See section 3.02 for further testing requirements. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces. Prepare all surfaces by shot blasting as per SSPC SP-13/NACE#6 M-SB. Filling materials may be required to provide the best aesthetic appeal. If abrasive blasting, the concrete shall be abraded to achieve a uniform minimum concrete surface profile of CSP 3 in accordance with ICRI 310.2. unless otherwise directed by the CSM. |
| 5. Application | Field |
| a. General | Surfacers, fillers or leveling/sloping materials can be applied with these coating systems per CSM's recommendations prior to application of prime coat to fill voids, holes or to appropriately slope or level the floors. These materials must be compatible with primers and finish coats. All cementitious products shall be applied to surfaces in an SSD condition. |
| | All materials shall be applied as per the strict instructions of the CSM. |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| 6. System Thickness | 26-40 mils (Varies Depending on CSM) The various CSM's have different approaches and film thickness requirements for the system. The CSA shall consult the CSM for total film thickness requirements |
| 7. Coatings | |
| a. Primer | One Coat at 8-10 mils |
| b. Body Coat | One Coat at 12-15 mils with 20/40 mesh Anti-Slip Aggregate Broadcast into the wet coating at sufficient volume to provide the desired anti-slip profile through the topcoat. A mockup of the level of anti-slip must be performed to ensure the level of anti-slip is acceptable to the owner. Overly aggressive anti-slip aggregate can make cleaning the floor difficult. When the anti-slip aggregate is added by broadcast the CSA shall backroll the material to ensure encapsulation of the aggregate into the material. The Tnemec system uses 50/70 mesh aggregate rather than the 20/40 mesh aggregate used by PPG and Sherwin Williams. |
| c. Finish | 6-15 mils (Varies Depending on CSM) The various CSM's have different approaches and film thickness requirements for the topcoat. The CSA shall consult the CSM for topcoat film thickness requirements. |
| 8. Testing | Visual inspection shall be performed over 100 percent of the coated surface area to identify any holidays or pinholes that must be repaired.<br>Visual inspection to ensure proper application and film quality and level of acceptable anti-slip agreed upon in the mockup. |
| 9. Pinhole and Holiday Repair Procedure: | Pinholes, holidays and other film defects identified by visual inspection shall be repaired per the CSM's recommendations. |
| **Coating System Identification: EFL-2** | |
| 1. Coating Material | 100% Solids Epoxy Floor Coating |
| 2. Surface | Concrete |
| 3. Service Conditions | Interior Floors in Common Areas not subjected to chemical exposure or UV. |
| 4. Surface Preparation | |
| a. General | All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, coating terminations at metal embedment's in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the Owner, the Engineer, or any other party. |
| b. Concrete | Concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content shall be tested per ASTM D4263, Moisture by Plastic Sheet Test. Any moisture on back of plastic sheet means coating cannot proceed until the concrete has dried out. See section 3.02 for further testing requirements. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces. Prepare all surfaces by shot blasting as per SSPC SP-13/NACE#6 M-SB. Filling materials may be required to provide the best aesthetic appeal. If abrasive blasting, the concrete shall be abraded to achieve a uniform minimum concrete surface profile of CSP 3 in accordance with ICRI 310.2. unless otherwise directed by the CSM. |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| 5. Application | Field |
| a. General | Surfacers, fillers or leveling/sloping materials can be applied with these coating systems per CSM's recommendations prior to application of prime coat to fill voids, holes or to appropriately slope or level the floors. These materials must be compatible with primers and finish coats. All cementitious products shall be applied to surfaces in an SSD condition. |
| | All materials shall be applied as per the strict instructions of the CSM. |
| 6. System Thickness | 26-40 mils (Varies Depending on CSM) The various CSM's have different approaches and film thickness requirements for the system. The CSA shall consult the CSM for total film thickness requirements |
| 7. Coatings | |
| a. Primer | One Coat at 8-10 mils |
| b. Body Coat | One Coat at 12-15 mils with 20/40 mesh Anti-Slip Aggregate Broadcast into the wet coating at sufficient volume to provide the desired anti-slip profile through the topcoat. A mockup of the level of anti-slip must be performed to ensure the level of anti-slip is acceptable to the owner. Overly aggressive anti-slip aggregate can make cleaning the floor difficult. When the anti-slip aggregate is added by broadcasting, the CSA shall backroll the material to ensure encapsulation of the aggregate into the material. The Tnemec system uses 50/70 mesh aggregate rather than the 20/40 mesh aggregate used by PPG and Sherwin Williams. |
| c. FInish | One Coat at 6-15 mils (Varies Depending on CSM) The various CSM's have different approaches and film thickness requirements for the topcoat. The CSA shall consult the CSM for topcoat film thickness requirements. |
| 8. Testing | Visual inspection shall be performed over 100 percent of the coated surface area to identify any holidays or pinholes that must be repaired.<br>Visual inspection to ensure proper application and film quality and level of acceptable anti-slip agreed upon in the mockup. |
| 9. Pinhole and Holiday Repair Procedure. | Pinholes, holidays and other film defects identified by visual inspection sahll be repaired per the CSM's recommendations. |
| **Coating System Identification: G** | |
| 1. Coating Material: | Grease |
| 2. Surface: | Metal |
| 3. Surface Preparation: | |
| a. Ferrous Metal: | Ferrous metal surfaces shall be prepared in accordance with SSPC-SP 1 (Solvent Cleaning). |
| 4. Application: | Field |
| | Coating shall be applied with stiff brush, hand swab, or airless spray gun. |
| 5. System Thickness: | 50 square feet per gallon. |
| 6. Coating: | One coat of grease coating. |
| **Coating System Identification: HH-1** | |
| 1. Coating Material: | Formulations vary by manufacturer. |
| 2. Surface: | Metal |
| 3. Service Condition: | Temperature to 400 degrees F. |
| 4. Surface Preparation: | Metal surfaces shall be prepared in accordance with SSPC-SP 10 (Near White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils. |
| | Field |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| 5. Application: | Curing as required by CSM. |
| 6. System Thickness: | 6.5 to 10 mils dry film varies by manufacturer. |
| 7. Coating: | DFT varies by manufacturer. |
| **Coating System Identification: HH-2** | |
| 1. Coating Material: | Formulations vary by manufacturer. |
| | TMIC – Titanium Modified Inorganic Co-polymer. |
| 2. Surface: | Metal |
| 3. Service Condition: | Temperature to 1200 degrees F |
| 4. Surface Preparation: | Metal surfaces shall be prepared in accordance with SSPC-SP 10 (Near White Metal Blast Cleaning) to achieve a uniform surface profile of 2.0 to 2.5 mils. |
| 5. Application: | Field |
| | Curing as required by CSM. |
| 6. System Thickness: | 6.5 to 10 mils dry film varies by manufacturer. |
| 7. Coating: | DFT varies by manufacturer. |
| **Coating System Identification: L-1** | |
| 1. Coating Material: | 100 percent Acrylic Latex. |
| 2. Surfaces: | Concrete, masonry, plaster, gypsum board. |
| 3. Service Condition: | Interior including existing coated concrete. |
| 4. Surface Preparation: | |
| a. Concrete: | Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content of gypsum and plaster surfaces shall be tested with a Delmhorst Instrument Company moisture detector, or equal. Moisture levels of concrete and masonry shall be tested as per ASTM D4263, Plastic Sheet Method and section 3.02. Moisture content must meet CSM's recommendation for coating work to proceed. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00. |
| b. Existing Coated Concrete: | Remove all loose coating down to a sound substrate or intact, well-adhered existing coating by scraping or other means. Then, abrade all surfaces to achieve a 0.5 to 1.5-mil uniform profile and vacuum clean to remove all loose dirt, paint chips, and dirt. |
| c. Masonry: | Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be filled with block filler compatible with the specified primer. |
| d. Plaster: | Plaster surfaces shall be dry, clean, and free from grit, loose plaster, and surface irregularities. Cracks and holes shall be repaired with acceptable patching materials, keyed to existing surfaces, and sandpapered smooth. Surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. After cleaning, surfaces shall be sealed with a compatible sealer. |
| e. Gypsum Wallboard: | Tape joints and spackled nail heads shall be sanded smooth and dusted. Seal with PVA sealer for interior uses only. |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| 5. Application: | Field |
| a. General: | Sealer or filler shall dry a minimum of 48 hours prior to primer application. |
| | Drying time between coats shall be as recommended by CSM. |
| 6. System Thickness: | 4 mils dry film. |
| 7. Coatings: | |
| a. Primer: | One coat at CSM's recommended DFT. |
| b. Finish: | Two or more coats at CSM's recommended DFT per coat to the specified system thickness. |
| **Coating System Identification: L-2** | |
| 1. Coating Material: | 100 percent Acrylic Latex. |
| 2. Surface: | PVC and CPVC pipe. |
| 3. Service Condition: | Interior and Exterior non-corrosive to mildly corrosive atmospheres suitable for direct sunlight exposure. |
| 4. Surface Preparation: | Plastic pipe shall be cleaned with solvent compatible with the specified primer and sanded to roughen surfaces to achieve a uniform surface profile of 1.0 to 1.5 mils. Vacuum clean or wipe with a damp rag after sanding to remove all loose dust, plastic particles, and dirt. |
| 5. Application: | Field |
| 6. System Thickness: | 3 mils dry film. |
| 7. Coatings: | |
| a. Primer: | One coat at CSM's recommended DFT. |
| b. Finish: | One or more coats at CSM's recommended DFT per coat to the specified system thickness. |
| **Coating System Identification: M-1** | |
| 1. Coating Material: | Petrolatum based mastic or wax based wrapping tapes. |
| 2. Surfaces: | Metal |
| 3. Service Condition: | Below grade (buried) or where little to no surface preparation can be performed on piping or structural steel. |
| 4. Surface Preparation: | Remove loose scale, rust, dirt, excessive moisture, or frost from the surface in accordance with SSPC-SP 2 (Hand Tool Cleaning). |
| 5. Application: | All surfaces shall be hand rubbed or brushed with a priming paste recommended by the CSM. Sharp projections such as threads, irregular contours, or badly pitted areas shall receive a liberal amount of priming paste to ensure maximum protection of metal throughout. |
| | On irregular shaped surfaces, (i.e., nuts, bolts, flanges, valves, etc.) the Contractor shall use either of the following systems recommended by the CSM. |
| | **A.** Apply recommended mastic by hand in sufficient quantity to build an even contour over entire surface. The Contractor shall pay particular attention to ensure that folds and air pockets within the mastic layer are thoroughly pressed out prior to subsequent application of tape. |
| | **OR:** |
| | **B.** An extra layer of tape shall be cut and carefully molded around sharp projections, nuts, bolts, etc., before final application of tape, in order to meet specified system thickness. |
| | Tape shall be spirally wrapped with a 55-percent overlap and sufficient tension and pressure to provide continuous adhesion without stretching the tape. Edges of tape must be continuously smoothed and sealed by hand |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| | during wrapping. On vertical application, contractor shall begin at bottom and proceed upward creating a weatherboard overlap. |
| 6. System Thickness: | Smooth contours shall have a minimum thickness of 50 mils while nuts, bolts, and sharp projections shall be 100 mils. |
| 7. Tape: | Number and types of tape wraps shall be in accordance with the CSM's written instructions. |
| **Coating System Identification: M-2** | |
| 1. Coating Material: | Epoxy mastic or equal |
| 2. Surface: | Ferrous Metal |
| 3. Service Condition: | Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible. |
| 4. Surface Preparation: | |
| a. Ferrous Metal: | All uncoated ferrous metal surfaces shall be prepared in accordance with SSPC-SP 3 (Power Tool Cleaning), or SSPC-SP 11 (Power to Cleaning to Bare Metal) and SSPC Hand Tool Cleanings prior to assembly. Surface preparation to achieve a uniform surface profile of 2.0 to 2.5 mils. Shop primed ferrous metal surfaces and fabricated assemblies shall be clean and dry prior to the application of field coats. Following assembly, the Contractor shall smooth welds and prominences using power tools prior to the application of the field applied coatings. |
| 5. Application: | Field |
| a. General: | Prior to the application of field applied coatings, welds, back-to-back angles, sharp or rough edges and weld splatter shall be brushed with the specified prime coat and allowed to cure overnight. |
| 6. System Thickness: | 10-15 mils dry film. |
| 7. Coatings: | |
| a. Prime: | One coat of the CSM's recommended DFT. |
| b. Finish: | One or more coats of CSM's recommended DFT per coat to the specified system thickness. |
| **Coating System Identification: S-2** | |
| 1. Coating Material: | Penetrating Water Repellent (Clear and Non-Film Building). |
| 2. Surface: | Concrete Floors |
| 3. Service Condition: | Exterior and Interior |
| 4. Surface Preparation: | Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by low pressure water cleaning (LPWC at pressures <5000 psi) and/or chemical cleaners or other preparation as approved by the CSM. |
| a. Concrete | Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content shall be tested with a Delmhorst Instrument Company moisture detector or equal. Acceptable content for coating application to be recommended by CSM. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00. |
| 5. Application: | |
| a. General: | As per CSM's instructions. Drying time before placing into service shall be as recommended by the CSM for site conditions. |
| 6. System Coverage: | Follow CSM's recommendations. |
| 7. Color Selection: | Clear |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| **Coating System Identification: S-3** | |
| 1. Coating Material: | Penetrating Water Repellent (Clear & Non-Film Building). |
| 2. Surface: | Concrete and Masonry Walls |
| 3. Service Condition: | Exterior and Interior |
| 4. Surface Preparation: | Clean surfaces of all traces of dirt, dust, efflorescence, mold, salt, grease, oil, asphalt, laitance, curing compounds, paint, coatings, and other foreign materials by brush-off blast, low pressure water cleaning (LPWC at pressures <5000 psi) and/or chemical cleaners or other preparation as approved by the CSM. |
| a. Concrete | Concrete surfaces shall be allowed to age for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content shall be tested with a Delmhorst Instrument Company moisture detector or equal. Acceptable moisture content to be as recommended by the CSM. Loose concrete and laitance shall be removed from surfaces, and voids and cracks shall be repaired as specified in Section 03 30 00. |
| b. Masonry: | Masonry surfaces shall be allowed to age for at least 28 days. Holes or other joint defects shall be filled with mortar and repointed. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. |
| 5. Application: | |
| a. General: | Drying time before placing into service shall be as recommended by the CSM for site conditions. |
| 6. System Coverage: | Follow CSM's recommendations. |
| 7. Color Selection: | Clear |



## 3.06 COATING SYSTEMS SCHEDULE (FINISH SCHEDULE)

A. General:

1. Specific coating systems, colors, and finishes for rooms, galleries, piping, equipment, and other items that are coated are specified in the following coating system schedule. Unless otherwise specified in the coating system schedule, the word "interior" shall mean the inside of a building or structure, and the word "exterior" shall mean outside exposure to weather elements.

| Coating Systems Schedule (Finish Schedule) | | |
|---|---|---|
| **Location/Surface** | **Coating System Identification** | **Standard Color** |
| **General: All Surfaces not Specified by Area or Structure** | | |
| 1. Structural Steel, Metal Decking, and Galvanized Acoustical Decking | Uncoated or E-2 | |
| 2. Equipment and Metal Appurtenances | | |
| a. Equipment, non-immersed, unless otherwise specified | | |
| 1) Interior | E-1 | Note 2 |
| 2) Exterior | EU-1 | Note 2 |
| b. High temperature equipment operable at | | |
| 1) 200 to 400 degrees F | HH-1 | Note 2 |
| 2) above 400 degrees F to 1200 degrees F | HH-2 | Aluminum or Black |

## Coating Systems Schedule (Finish Schedule)

| Location/Surface | Coating System Identification | Standard Color |
|---|---|---|
| c. Existing equipment | | |
| 1) Not damaged nor modified by work in this contract | Uncoated | -- |
| 2) Damaged, exposed, or modified by work in this contract | | Note 3 |
| a) Interior | E-1 | Note 3, Match existing color |
| b) Exterior | EU-1 without primer | Note 3, Match existing color |
| d. Diffusers and grilles on coated surfaces, unless otherwise specified | | |
| 1) Interior | E-1 | Match background color |
| 2) Exterior | EU-1 | Match background color |
| e. Diffusers and grilles on uncoated surfaces, unless otherwise specified | | |
| 1) Interior | E-1 | Match background color |
| 2) Exterior | EU-1 | Match background color |
| f. Existing diffusers and grilles | | |
| 1) Not damaged not modified by work in this contract | Uncoated | -- |
| 2) Damaged, exposed, or modified by work in this contract | | |
| a) Interior | E-1 | Match existing color |
| b) Exterior | EU-1 without primer | Match existing color |
| g. Electrical switchgear panels, unit substations, motor control centers, power transformers, distribution centers, and relay panels; interior and exterior | See paragraph 3.03 Electrical and Instrumentation Equipment and Materials | ANSI 61 Grey (outside)<br>FS 27880 White (inside) |
| h. Instrumentation panels, graphic indicating panels, indicating and transmitting field panels, unless otherwise specified | | |
| 1) Interior | | FS 26306 Grey (outside)<br>FS 27880 White (inside) |
| 2) Exterior | | FS 27722 White (outside)<br>FS 27880 White (inside) |
| i. Existing electrical and instrumentation panels | | |
| 1) Not damaged by work in this contract | Uncoated | -- |
| 2) Damaged or exposed to outside surfaces by work in this contract | | |
| a) Interior | E-1 | FS 26306 Grey |

## Coating Systems Schedule (Finish Schedule)

| Location/Surface | Coating System Identification | Standard Color |
|---|---|---|
| b) Exterior | EU-1 without primer | FS 26306 Grey (Electrical)<br>FS 27722 White (Instrumentation) |
| 3. Conduit, Piping and Ductwork | | |
| a. Ferrous, non-ferrous and galvanized piping, and appurtenant hangers and supports, non-immersed, unless otherwise specified. | | |
| 1) Interior – noncorrosive | E-1 | Refer to 40 05 02 |
| 2) Exterior – noncorrosive | EU-1 | Refer to 40 05 02, Note 2 |
| 3) Buried piping | M-1 or M-2 | Refer to 40 05 02 |
| b. Ferrous piping, appurtenant and supports, non-immersed | E-2 | Note 2 |
| c. Conduit, outlet and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports on coated surfaces, unless otherwise specified. | | |
| 1) Interior | E-1 | Match background color |
| 2) Exterior | E-2 | Match background color |
| d. Conduit, outlets and junction boxes, lighting transformers, lighting, communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps and supports on uncoated surfaces, unless otherwise specified. | | |
| 1) Interior | E-1 | Note 2 |
| 2) Exterior | EU-1 | Note 2 |
| e. Existing conduit, outlet and junction boxes, lighting transformers, lighting communication and small power panels, control stations, piping, lagged ductwork, appurtenant hangers, clamps, and supports | | |
| 1) Not damaged nor modified by work in this contract | Uncoated | -- |
| 2) Damaged, exposed, or modified by work in this contract | | |
| a) Interior | E-1 | Match existing color |
| b) Exterior | EU-1 | Match existing color |
| f. Racked conduits and cable trays | Uncoated | -- |
| g. Insulated pipe jacketing | Uncoated | -- |
| h. Plastic, fiberglass and flexible conduit and piping | | |
| 1) Unless otherwise specified | Uncoated | -- |
| 2) PVC and CPVC Piping | L-2 | Refer to 40 05 02 |
| a) Exposed to direct sunlight | L-2 | Refer to 40 05 02 |
| b) Not exposed to direct sunlight | L-2 | Refer to 40 05 02 |
| i. High temperature piping operable at | | |
| 1) 200 to 750 degrees F | HH-1 | Refer to 40 05 02 |

## Coating Systems Schedule (Finish Schedule)

| Location/Surface | Coating System Identification | Standard Color |
|---|---|---|
| 2) Above 750 degrees F to 1,200 degrees F | HH-2 | Refer to 40 05 02 |
| j. Exposed ductwork, unless otherwise specified | Uncoated | -- |
| 4. Concrete, Grout, Masonry and Plaster | | |
| a. Immersed tank and channel walls and bottoms unless otherwise specified in 09 96 00. | Uncoated | -- |
| b. Outside concrete walls below grade common with dry area or room | In accordance with Section 07 10 00 | -- |
| c. Walls and ceilings | | |
| 1) Precast concrete or colored masonry | Uncoated | -- |
| 2) Exterior, unless otherwise specified | Uncoated | -- |
| 3) Interior, unless otherwise specified | E-4 | Note 2 |
| d. Concrete equipment bases unless otherwise specified | E-4 | Match equipment color |
| e. Floors unless otherwise specified | S-2 | Note 2 |
| f. Existing coated surfaces. | L-1 | Match existing color |
| 5. Door and Door Frames | | |
| a. Doors unless otherwise specified | | |
| 1) Ferrous metal | | |
| a) Interior | E-1 | Note 2 |
| b) Exterior | EU-1 | Note 2 |
| 2) Aluminum | Uncoated | -- |
| 3) Existing | | |
| a) Not damaged by work in this contract | Uncoated | -- |
| b) Damaged, exposed, or modified by work in this contract | | |
| (1) Interior | E-1 (see paragraph 3.02 Masonry Surfaces) | Match existing color |
| (2) Exterior | EU-1 | Match existing color |
| b. Door frames, unless otherwise specified | | |
| 1) Adjacent wall coated | | |
| a) Interior | E-1 | Match wall color |
| b) Exterior | EU-1 | Match wall color |
| 2) Adjacent wall uncoated | | |
| a) Interior | E-1 | Note 2 |
| b) Exterior | EU-1 | Note 2 |
| 3) Aluminum | Uncoated | -- |
| 4) Existing | | |
| a) Not damaged by work in this contract | Uncoated | -- |
| b) Damaged, exposed, or modified by work in this contract | | |
| (1) Interior | E-1 | Match existing color |
| (2) Exterior | EU-1 without primer | Match existing color |

## Coating Systems Schedule (Finish Schedule)

| Location/Surface | Coating System Identification | Standard Color |
|---|---|---|
| 6. Handrails, Gratings, Floor Plates, Manhole Covers, and Hatches | | |
| a. Unless otherwise specified | Uncoated | |
| b. Existing | | |
| 1) Not damaged by work in this contract | Uncoated | -- |
| 2) Damaged, exposed, or modified by work in this contract | | |
| a) Interior | E-1 | Match existing color |
| b) Exterior | EU-1 without primer | Match existing color |
| 7. Ladders | | |
| a. Exterior | EU-1 | Note 2, Match Existing Color |
| 8. Aluminum Flashing, Light Standards, and Supports | | |
| a. Interior and exterior, unless otherwise specified | Refer to 07 62 00 | Note 2, Match Existing Color |
| 9. Precast Concrete Metalwork | | |
| a. Fasteners, anchors, supports, etc. | EU-1 | Match wall |
| 10. Other | | |
| a. Fire hydrants | EU-1 | FS 21302 Red |
| b. Flap gates | EA-1 | Beige |
| c. Aluminum slide gates | Uncoated | -- |
| d. Sluice gates | | |
| 1) Gate | -- | -- |
| 2) Stem, except potable | G | -- |
| 3) Operator | | |
| a) Interior | E-2 | Note 2 |
| b) Exterior | EU-1 | Note 2 |
| e. Pipe, ductwork, equipment and appurtenances made from fiberglass, plastic, rubber, including flexible hose, conduit, and plastic coated tubing, in areas not exposed to view (interior) (metal hangers and supports are coated with E-1) | Uncoated | -- |
| f. Buried, sleeve-type and flanged pipe, couplings, valves, mechanical and electrical penetrations | M-1 or M-2 | Manufacturer's color |
| **Fuel Storage Area (Area 05)** | | |
| 1. Slab | Uncoated | -- |
| **Fog Tanks (Area 63)** | | |
| 1. Concrete Cap (Exterior Surface) | S-2 | |
| 2. Interior of Tank | refer to 09 96 00, HP-14 | |
| **Fog Building (Area 63)** | | |
| 1. Exterior | | |
| g. Equipment on roof | EU-1 | Note 2 |
| h. Walls | Uncoated | |
| i. FRP Doors and Frame /Windows | Refer to 08 15 00 | Note 2 |
| j. Overhead Coiling Service Doors | Refer 08 33 00 | Note 2 |

**Coating Systems Schedule (Finish Schedule)**

| Location/Surface | Coating System Identification | Standard Color |
|---|---|---|
| k. Concrete Curb/Exterior Wall | S-3 | |
| 2. Interior | | |
| l. Electrical Room CMU Walls | L-1 | Note 2 |
| m. Electrical Room Concrete Floor | EFL-2 | Note 2 |
| n. Structural Steel, Metal Decking | Uncoated | Note 2 |
| o. FOG Room CMU Walls | E-3 | Note 2 |
| p. FOG Room Concrete Floor | EFL-1 | Note 2 |
| q. FRP Doors and Frame / Windows | Refer to 08 15 00 | Note 2 |
| r. Overhead Coiling Service Doors | Refer to 08 33 00 | Note 2 |

*Notes:*

1. *Owner will select color from coating manufacturer's list of EPA approved colors for potable water.*
2. *Owner to select color from coating manufacturer's full range of standard colors.*
3. *Recoat existing equipment to provide a uniform appearance. Color shall remain the same unless otherwise noted in the Contract Documents.*



## 3.07 QUALITY ASSURANCE INSPECTION

A. General:

1. Inspection by the Owner or others does not limit the Contractor's or CSA's responsibilities for quality workmanship or sole responsibility for QC as specified by this Section or as required by the CSM's instructions. Inspection by the Owner is optional and is additional to any inspection required to be performed by the Contractor.
2. The Owner may perform or contract with an inspection agency to perform, QA inspection and testing of the coating work covered by this Section. These inspections may include the following:
   a. Inspect materials upon receipt to ensure that all are supplied by the same CSM.
   b. Inspect to verify that specified storage conditions for the coating system materials, solvents, and abrasives are provided.
   c. Inspect and record findings for the degree of cleanliness of substrates.
   d. Inspect and record the pH of concrete and metal substrates.
   e. Inspect and record substrate profile (anchor pattern).
   f. Measure and record ambient air and substrate temperature.
   g. Measure and record relative humidity.
   h. Check for the presence of substrate moisture in the concrete.
   i. Inspect to verify that correct mixing of coating system materials is performed in accordance with CSM's instructions.
   j. Inspect, confirm, and record that the "pot life" of coating system materials is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
   k. Perform adhesion testing.
   l. Measure and record the thickness of the coating system.
   m. Inspect to verify proper curing of the coating system in accordance with the CSM's instructions.

n. Limited visual observations for defects.

## 3.08 FINAL INSPECTION

A. General

1. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications.
2. The Construction Manager or Owner's Representative will subsequently conduct a final observation with the Contractor to determine the work is in conformance with requirements of the contract documents.
3. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

## PART 4 PROJECT QUALITY CONTROL REQUIREMENTS

**TABLE 09 90 00 -1**

**QUALITY CONTROL INSPECTION AND TESTING REQUIREMENTS BY COATING SYSTEM**

| Standard Coating System | Air, R.H., Dew Point Temp. | Substrate and Debris Removal | Substrate Degree of Cleanliness and Profile | Substrate Moisture Testing | Coating | Standard Coating System | Air, R.H., Dew Point Temp. | Substrate and Debris Removal | Substrate Degree of Cleanliness and Profile | Substrate Moisture Testing | Coating |
|---|---|---|---|---|---|---|---|---|---|---|---|
| E-1 | Temp. plus ASTM E337 | Visual | SSPC-VIS-1 and ASTM D4417 or NAPF 500-03 | Visual | ASTM D4414 | SSPC-PA-2 | Visual No Holidays or Pinholes Acceptable | Visual No Excessive Runs or Sags Acceptable | ASTM D3359 Minimum Requirement of 4B per Scale in Standard | Solvent Rub Test | Visual |
| E-2 | Temp. plus ASTM E337 | Visual | SSPC-VIS-1 and ASTM D4417 or NAPF 500-03 | Visual | ASTM D4414 | SSPC-PA-2 | Visual No Holidays or Pinholes Acceptable | Visual No Excessive Runs or Sags Acceptable | ASTM D3359 Minimum Requirement of 4B per Scale in Standard | Solvent Rub Test | Visual |
| E-3 | Temp. plus ASTM E337 | Visual | Visual and ICRI 310.2 | ASTM D4263 | ASTM D4414 | SSPC-PA-9 | Visual No Holidays or Pinholes Acceptable | Visual No Excessive Runs or Sags Acceptable | ASTM D7234 | Solvent Rub Test | Visual |
| EU-1 | Temp Plus ASTM E337 | Visual | SSPC-VIS-1 and ASTM D4417 or NAPF 500-03 | Visual | ASTM D4414 | SSPC-PA-2 | Visual | Visual | ASTM 3359 | Solvent Rub Test | Visual |
| EU-1- FRP | Temp Plus ASTM E337 | Visual | Visual and Check Profile Tactile Inspection | Visual | ASTM D4414 | Rely on WFT | Visual | Visual | ASTM D3359 | Solvent Rub Test | Visual |
| G | Temp Plus ASTM E337 | Visual | Visual | Visual | Coverage Calculation | Rely on Coverage | Visual | Visual | N/A | N/A | Visual |
| HH-1 | Temp Plus ASTM E337 | Visual | SSPC-VIS-1 and ASTM D4417 or NAPF 500-03 | Visual | ASTM D4414 | SSPC-PA-2 | Visual | Visual | ASTM D3359 | N/A | Visual |

**TABLE 09 90 00 -1**

**QUALITY CONTROL INSPECTION AND TESTING REQUIREMENTS BY COATING SYSTEM**

| Standard Coating System | Air, R.H., Dew Point Temp. | Substrate and Debris Removal | Substrate Degree of Cleanliness and Profile | Substrate Moisture Testing | Coating | Standard Coating System | Air, R.H., Dew Point Temp. | Substrate and Debris Removal | Substrate Degree of Cleanliness and Profile | Substrate Moisture Testing | Coating |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HH-2 | Temp Plus ASTM E337 | Visual | SSPC-VIS-1 and ASTM D4417 or NAPF 500-03 | Visual | ASTM D4414 | SSPC-PA-2 | Visual | Visual | ASTM D3359 | N/A | Visual |
| L-1 | Temp Plus ASTM E337 | Visual | Visual | Moisture Meter | ASTM D4414 and Coverage Calculations | Rely on WFT and Coverage Calculations | Visual | Visual | ASTM D3359 | Visual | Visual |
| L-2 | Temp Plus ASTM E337 | Visual | Visual and Feel Surface | Visual | ASTM D4414 and Coverage Calculations | Rely on WFT and Coverage Calculations | Visual | Visual | ASTM D3359 | Visual | Visual |
| M-1 | Temp Plus ASTM E337 | Visual | SSPC-VIS-1 | Visual | Check Tape Thickness | Check | Visual | Visual | N/A | N/A | Visual |
| M-2 | Temp Plus ASTM E337 | Visual | SSPC-VIS-1 Runs ASTM D4417 or NAPF 500-03 | Visual | ASTM D4414 | SSPC-PA-2 | Visual | Visual | ASTM D3359 | Solvent Rub Test | Visual |
| S-2 | Temp Plus ASTM E337 | Visual | Visual | Moisture Meter | Check Coverage Rates | Check Coverage Rates | Visual | Visual | N/A | N/A | Visual |
| S-3 | Temp Plus ASTM E337 | Visual | Visual | Moisture Meter | Check Coverage Rates | Check Coverage Rates | Visual | Visual | N/A | N/A | Visual |

## 09 90 00-A COATING SYSTEM INSPECTION CHECKLIST

### Project Name

| | | | |
|---|---|---|---|
| **Owner** | | **Coating System Manufacturer Technical CTR** | |
| **General Contractor (GC)** | | **Coating System Applicator (CSA)** | |
| **Area or Structure** | | **Location within Structure** | |
| **Coating System (e.g., E-1)** | | **Coating Type (e.g., Epoxy, etc.)** | |

### Coating System Inspection Checklist

| Step | Description | Acceptance Criteria | Parties | Name | Signature | Date |
|---|---|---|---|---|---|---|
| 1 | Completion of cleaning and substrate decontamination prior to abrasive blast cleaning. | Visual Inspection- Contaminant Free | GC QC | | | |
| | | ASTM F22 – Concrete-Contaminant Free | CTR QC | | | |
| | | Blacklight Testing- Contaminant Free | CSA QC | | | |
| 2 | Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated. | As Per SSPC Guide 6 | GC QC | | | |
| | | As per Specification | CTR QC | | | |
| | | | CSA QC | | | |
| 3 | Ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area. | Negative Pressure in Enclosures | GC QC | | | |
| | | Testing Every 2 hrs Minimum | CTR QC | | | |
| | | Substrate temp 5° above the dewpoint and stabilized. | CSA QC | | | |
| 4 | Ensuring compressed air for abrasive blasting or coating/lining application is free of oil and moisture | ASTM D4285 Free of all oil & moisture | GC QC | | | |
| | | 1 blotter test per 2 hrs of compressed air usage | CTR QC | | | |
| | | | CSA QC | | | |
| 5 | Completion of Surface Preparation for Substrates to Be Coated. (Steel & Concrete) | Compliance with Sited SSPC/NACE Standards | GC QC | | | |
| | | Compliance with Specification | CTR QC | | | |
| | | | CSA QC | | | |
| 6 | Soluble Chloride Testing (If needed) as per SSPC-Guide 15 (Steel Only) | AS Per CTR allowable limits per product. | GC QC | | | |
| | | | CTR QC | | | |
| | | | CSA QC | | | |

| Step | Description | Acceptance Criteria | Parties | Name | Signature | Date |
|---|---|---|---|---|---|---|
| 7 | Completion of Concrete Repairs If Required and Related Surface Preparation Rework Prior to Coating System Application. | Compliance with Specification | GC QC | | | |
| | | | CTR QC | | | |
| | | | CSA QC | | | |
| 8 | Completion of Concrete Filler/ Surface Application to Concrete. | Bughole/Void Free | GC QC | | | |
| | | Flush with Existing Surface | CTR QC | | | |
| | | | CSA QC | | | |
| 9 | Completion of Primer Application. | SSPC-PA 2- Steel | GC QC | | | |
| | | SSPC-PA 9- Concrete | CTR QC | | | |
| | | Meets Specified DFT | CSA QC | | | |
| 10 | Completion of intermediate Coat Application and of Detail Treatment at Transitions or Terminations. | SSPC-PA 2- Steel | GC QC | | | |
| | | SSPC-PA 9- Concrete | CTR QC | | | |
| | | Meets Specified DFT | CSA QC | | | |
| 11 | Completion of Finish Coat Application and of Detail Treatment at Transitions and Terminations. | SSPC-PA 2- Steel | GC QC | | | |
| | | SSPC-PA 9- Concrete | CTR QC | | | |
| | | Meets Specified DFT | CSA QC | | | |
| 12 | Completion of Full and Proper Cure of Coating System. | ASTM D5402- Solvent Based Materials - No material transfer | GC QC | | | |
| | | Visual Inspection-Defect Free | CTR QC | | | |
| | | | CSA QC | | | |
| 13 | Completion of Testing of Cured Coating System including Adhesion, Holiday (Continuity) Testing and Dry Film Thickness. | ASTM D5402- Solvent Based Materials - No material transfer | GC QC | | | |
| | | Visual Inspection-Defect Free | CTR QC | | | |
| | | As per Specification | CSA QC | | | |
| 14 | Completion of Localized Repairs to Coating System Following Testing. | Visual Inspection-Defect Free | GC QC | | | |
| | | | CTR QC | | | |
| | | | CSA QC | | | |
| 15 | Final Acceptance of Coating System Installation Including Final Clean-Up Complying with Specification Requirements and the CTR's Quality Requirements. | Visual Inspection-Defect Free | GC QC | | | |
| | | | CTR QC | | | |
| | | | CSA QC | | | |



**END OF SECTION**

SECTION 09 96 00

HIGH PERFORMANCE PROTECTIVE COATINGS FOR WASTEWATER

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This Section specifies coating systems, surface preparation, and application requirements for high performance protective coating systems applied to both concrete and metal substrates.

B. This section includes:
   1. High performance coatings to be used for all interior surfaces of new FOG Receiving Tank 1 and 2 and all other significantly corrosive environments including headspace environments exposed to biogenic sulfide corrosion or to other corrosive gases or vapors, surfaces exposed to corrosive chemicals including various acids, sodium hydroxide, sodium hypochlorite, ferric chloride, hydrofluorosilicic acid, and sodium bisulfite, etc. whether vapor or immersion exposure.
   2. Immersion service of concrete and metal substrates in all wastewater treatment process areas, pump stations, and other process areas as specified.
   3. All surfaces to be coated which are exposed to atmospheric conditions, with the exception of:
      a. Protective film coatings in buildings, or non-corrosive exposure conditions which are covered under Section 09 90 00



### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 07 10 00 Damproofing and Waterproofing
   2. Section 09 90 00 General Coating Specification

### 1.03 DEFINITIONS

A. Coating terminology used in this Section is in accordance with definitions contained in ASTM D16, ASTM D3960, and the following definitions.
   1. Abrasive: Material used for blast cleaning, such as sand, grit or shot.
   2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.
   3. AMPP: Association for Materials Protection and Performance (Merger of NACE and SSPC).
   4. Anchor Pattern: Profile or texture of prepared surface(s).
   5. ANSI: American National Standards Institute.
   6. Bug Holes: Small cavities, usually not exceeding 15 millimeters in diameter, resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.

7. Biogenic Sulfide Corrosion: Sulfuric acid corrosion of metal and concrete substrates caused by the formation of sulfuric acid by the metabolic process of sulfurs oxidizing bacteria metabolizing hydrogen sulfide.
8. Coating/Paint/Lining Thickness: The total thickness of primer, intermediate and/or finish coats.
9. Coating System Applicator (CSA): A generic reference to the specialty subcontractor or subcontractors retained by the Contractor to install the coating systems specified in this Section.
10. Coating System Manufacturer (CSM): Refers to the acceptable coating system manufacturer, abbreviated as the CSM.
11. Coating System Manufacturer's Technical Representative(s) (CTR): Refers to the technical representative(s) of the acceptable Coating System Manufacturer and is abbreviated as CTR.
12. Continuous film or continuity of film: refers to coating layer/system without holidays, pinholes or other discontinuities.
13. CQC: Coating System Applicator (CSA) Quality Control.
14. Dehumidification: The removal of moisture, humidity or dampness from the air
15. Dew point: Temperature of a given air/water vapor mixture at which condensation starts.
16. Dry Film Thickness (DFT): Depth of cured film, usually expressed in mils (0.001 inch).
17. Drying/Cure Time: Time interval between application and curing of material before exposure to service conditions.
18. Dry to Recoat: Time interval between application of material and ability to receive next coat.
19. Dry to Touch: Time interval between application of material and ability to touch lightly without damage.
20. Feather Edging: Reducing the thickness of the edge of paint.
21. Feathering: Operation of tapering off the edge of a point with a comparatively dry brush.
22. Field Coat: The application or the completion of application of the coating system after installation of the surface at the site of the work.
23. Hold Point: A defined point, specified in this Section, at which work shall be halted for inspection.
24. Holiday: A discontinuity, skip, or void in coating or coating system film that exposes the substrate.
25. Honeycomb: Segregated condition of hardened concrete due to non-consolidation
26. ICRI: International Concrete Repair Institute.
27. Incompatibility: Inability of a coating to perform well over another coating because of bleeding, poor bonding, or lifting of old coating; inability of a coating to perform well on a substrate.
28. Laitance: A layer of weak, non-durable concrete containing cement fines that are brought to the surface through bleed water because of concrete finishing and/or over-finishing.
29. Mil: 0.001 inch.
30. NACE: National Association of Corrosion Engineers.
31. NSF International: National Sanitation Foundation.

32. Overspray: Dry spray, particularly such paint that failed to strike the intended surface.
33. Owner's Quality Assurance Representative: Person or persons designated by the Owner to perform QA review of the Contractor's QC reports and inspection and testing work.
34. Pinhole: A small diameter discontinuity in a coating or coating system film that is typically created by outgassing of air from a void in a concrete substrate resulting in exposure of the substrate or a void between coats.
35. Pot Life: Time interval after mixing of components during which the coating can be satisfactorily applied.
36. QCP: Quality Control Person representing the Contractor and responsible for QC Testing, Inspection and associated documentation.
37. QCTIP: Quality Control Testing and Inspection Plan..
38. QP-1 AMPP: Accredited program that evaluates the practices of field painting.
39. QP-3- AMPP: Accredited program that evaluates the practices of shop painting facilities.
40. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-base material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.
41. Shelf Life: Maximum storage time for which a material may be stored without losing its usefulness.
42. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site of the work, where the field or finishing coat is applied.
43. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
44. SSPC: The Society for Protective Coatings.
45. Stripe Coat: A separate coat of paint applied to all weld seems, pits, nuts/bolts/washers and edges by brush. This coat shall not be applied until any previous coat(s) have cured and, once applied, shall be allowed to cure prior to the application of the subsequent coat(s).
46. Surface Saturated Dry (SSD): Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.
47. Tie Coat: An intermediate coat used to bond different types of paint coats; coatings used to improve the adhesion of a succeeding coat.
48. Touch-Up Coating: The application of paint on areas of painted surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.
49. TPC: Technical Practice Committee.
50. Volatile Organic Compound (VOC) Content: The portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing, expressed in grams per liter (g/l) or pounds per gallon (lb/gal).
51. Immersion: Refers to a service condition in which the substrate is below the waterline or submerged in water or wastewater at least intermittently if not constantly.
52. Weld Spatter: Beads of metal scattered near seam during welding.
53. Wet Film Thickness (WFT): The primer or coating film's thickness immediately following application; wet film thickness is measured in mils or thousandths of an inch (0.001 inch) and is abbreviated WFT.

## 1.04 REFERENCES:

A. This section contains references to the following documents listed and described below. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed and described documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.



| References | Title |
|---|---|
| ANSI/ASC 29.4<br>Exhaust Systems | Abrasive Blasting Operations, Ventilation and Safe Practice |
| ANSI B74.18 | Grading of Certain Abrasive Grain on Coated Abrasive Material |
| ASTM C1583 | Standard Test Method For Tensile Strength Of Concrete Surfaces and The Bond Strength Or Tensile Strength Of Concrete Repair and Overlay Materials By Direct Tension (Pull-Off Method) |
| ASTM D16 | Standard Terminology for Paint, Related Coatings, Materials, and Applications |
| ASTM D2200<br>(SSPC-VIS1) | Pictorial Surface Preparation Standards for Painting Steel Surfaces |
| ASTM D3960 | Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings |
| ASTM D4262 | Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces |
| ASTM D4263 | Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method |
| ASTM D4414 | Standard Practice for Measurement of Wet Film Thickness by Notch Gages |
| ASTM D4417 | Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel |
| ASTM D4541 | Standard Test Methods for Pull-Off Strength of Coatings On Metal Substrates Using Portable Adhesion Testers |
| ASTM D4787 | Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates |
| ASTM D5162 | Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates |
| ASTM 5402 | Standard Practice for assessing the solvent resistance of organic coatings using solvent rubs |
| ASTM D7234 | Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Adhesion Testers. |
| ASTM E337 | Standard Test Method for Measuring Humidity With a Psychrometer |
| ASTM F22 | Standard Test Method for Hydrophobic Surface Films by the Water-Break Test |
| FS 595b | Federal Standard Colors |

| References | Title |
|---|---|
| ICRI 310.2R-2013 | Guideline for Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair |
| NACE Publication 6D-163 | A Manual for Painter Safety |
| NACE Publication 6F-163 | Surface Preparation of Steel or Concrete Tank/Interiors |
| NACE Publication 6G-164 A | Surface Preparation Abrasives for Industrial Maintenance Painting |
| NACE Standard RP0188 | Standard Recommended Practice – Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates |
| NACE Standard RP0288 | Standard Recommended Practice, Inspection of Linings on Steel and Concrete |
| NACE SP0178 | Design, Fabrication and Surface Finish Practices for Vessels and Tanks to Be Lined for Immersion |
| NACE Standard RP0892 | Standard Recommended Practice, Linings Over Concrete in Immersion Service |
| NACE Publication TPC2 | Coatings and Linings for Immersion Service |
| NAPF 500-03 | Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings |
| NAPF 500-03-04 | Abrasive Blast Cleaning for Ductile Iron Pipe |
| NAPF 500-03-05 | Abrasive Blast Cleaning for Cast Ductile Iron Fittings |
| OSHA 1910.144 | Safety Color Code for Marking Physical Hazards |
| OSHA 1915.35 | Standards – 29CFR – Painting |
| South Coast Air Quality Management District (SCAQMD) | Rule 1113 -Architectural Coatings |
| SSPC | Paint Application Specification No. 1. |
| SSPC-AB 1 | Mineral and Slag Abrasives |
| SSPC-PA 1 | Shop, Field, and Maintenance Painting of Steel |
| SSPC-PA 2 | Measurement of Dry Coating Thickness with Magnetic Gages |
| SSPC-PA 9 | Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages |
| SSPC Guide 15 | Field Methods for Retrieval and Analysis of Soluble Salts on Substrates. |
| SSPC-PA Guide 3 | A Guide to Safety in Paint Application |
| SSPC-PA Guide 6 | Guide for Containing Debris Generated During Paint Removal Operations |
| SSPC PA-Guide 10 | Guide to Safety and Health Requirements for Industrial Painting Projects |
| SSPC- PA Guide 11 | Guide for Stripe Coating |
| SSPC-PA Guide 12 | Guide for Illumination of Industrial Painting Project |
| SSPC SP1 | Solvent Cleaning |
| SSPC SP2 | Hand Tool Cleaning |
| SSPC SP3 | Power Tool Cleaning |
| SSPC SP5/NACE #1 | White Metal Blast Cleaning |
| SSPC SP6/NACE#3 | Commercial Blast Cleaning |
| SSPC SP7/NACE #4 | Brush-Off Blast Cleaning |
| SSPC SP10/NACE#2 | Near-White Blast Cleaning |
| SSPC SP11 | Power Tool Cleaning to Bare Metal |
| SSPC/NACE WJ 1-4 | Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultra-High Pressure Water Jetting Prior to Recoating |
| SSPC SP13/NACE#6 | Surface Preparation of Concrete |
| SSPC SP14/NACE#8 | Industrial Blast Cleaning |
| SSPC SP15 | Commercial Power Tool Cleaning |

| References | Title |
|---|---|
| SSPC SP16 | Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals |
| SSPC-TR2 | Wet Abrasive Blast Cleaning |
| SSPC-TU-3 | Overcoating |
| SSPC-TU-4 | Field Methods for Retrieval and Analysis of Soluble Salts on Substrates. |
| SSPC V2 | Systems and Specifications: Steel Structures Painting Manual, Volume 2 |
| SSPC-VIS 1 | Visual Standard for Abrasive Blast Cleaned Steel |
| SSPC-VIS 3 | Visual Standard for Power and Hand – Tool Cleaned Steel |
| SSPC-VIS 4 | Visual Standards (Waterjetting) |
| SSPC-VIS 5 | Visual Standards (Wet Abrasive Blast Cleaning) |

## 1.05 QUALITY ASSURANCE

A. General Requirements:

1. Materials and supplies provided shall be the standard products of CSMs. Materials in each coating system shall be the products of a single CSM.
2. The standard products of CSMs other than those specified may be acceptable when it is demonstrated to the Construction Manager that they are equal in composition, durability, usefulness, and convenience for the purpose intended. Requests for consideration of CSMs other than those specified in this Section will be considered in accordance with the requirements of the General Conditions and provided the following minimum conditions are met. Such requests are not a substitution for submittals after the alternative CSMs have been considered and accepted.
   a. The proposed coating system shall use an equal or greater number of separate coats to achieve the required total DFT.
   b. The proposed coating system shall use coatings of the same generic type as that specified including curing agent type.
   c. Requests for consideration of products from CSMs other than those specified in this Section shall include information listed in paragraph 1.07, demonstrating that the proposed CSM's product is equal to the specified coating system.
   d. The Contractor and the proposed alternative CSM shall provide a list of references for the proposed product where the coating of the same generic type has been applied. The reference list shall include the project name, city, state, owner, and phone number of owner; coating system reference and number from this Section 09 96 00; type of facility in which it was used, generic type, and year coating was applied.
   e. At any time when there is a conflict between the CSM's product data and the COAT SPEC requirements regarding surface preparation, material application or any other coating details that provides the more stringent requirements will take precedent.

B. Shop and Field Quality Control Requirements:

1. The Contractor is solely responsible for the workmanship and quality of the coating system installation by the CSA. Inspections by the Owner, Engineer, a Construction Manager, the CTR, or any other party will not relieve or limit the Contractor's responsibilities for the quality of the coating system.
2. The Contractor's CSA's methods shall conform to requirements of this specification and the standards referenced in this Section. Changes in the coating system

installation requirements will be allowed only with the written acceptance of the Engineer before work commences.

3. Only personnel who are trained by the CTR specifically for this contract or who are approved by the CSM specifically for this contract shall be allowed to perform the coating system installation specified in this Section.
4. All field surface preparation and coating applications shall be performed by a AMPP QP1 Certified field painting Contractor in good standing.
5. All shop surface preparation and coating applications shall be performed by a AMPP QP3 Certified blast and painting shop in good standing.
6. Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.
7. For repairs, the CSA shall provide the same products, or products recommended by the CSM, as used for the original coating.
8. The Contractor shall identify the points of access for inspection by the Owner, the Engineer, or the Owner's Representative. The Contractor shall provide ventilation, ingress and egress, and other safe means necessary for the Owner's or Engineer's personnel or designated representative to safely access the work areas.
9. The Contractor and CSA shall conduct the work so that the coating system is installed as specified and shall inspect the work continually to ensure that the coating system is installed as specified. Coating system work that does not conform to the specifications or is otherwise not acceptable shall be corrected to the as-specified requirements.
10. The CSA shall have full time inspection and shall have trained and certified quality control (QC) inspectors performing all QC procedures. All persons performing QC duties shall be a minimum AMPP Basic Coating Inspector (NACE/SSPC Level 1) with a minimum of 3 years' experience in QC processes is acceptable, providing they are under the direct supervision of a AMPP Certified Coatings Inspector (NACE/SSPC Level 2) or AMPP Senior Coatings Inspector (NACE/SSPC Level 3) in good standing, with at least 10 years of similar coatings work experience. The trained QC Program inspectors shall perform all routine QC testing and inspection tasks as the coating work proceeds in accordance with the requirements of this Section.
11. The Contractor shall submit for approval a Quality Control Testing and Inspection Plan (QCTIP) for the work covered by this Section. The QCTIP shall list all tests and inspection tasks including referenced and applicable standards to be conducted and the frequency in which these tests or tasks shall be performed. This frequency can be addressed for certain tests such as air and substrate temperature or Dew Point measurements on an hourly per shift basis. Or this frequency can be addressed on a per number of square feet basis for tests and tasks such as WFT and DFT tests or adhesion tests. The QCTIP must provide a written record which identifies when (time and date) work not conforming to the specification requirements is identified. The QCTIP must also provide a written record of the proposed corrective actions for such non-conforming work as well as a record of when that action was performed (time and date). All corrective action for non-conforming work shall be described in writing in detail with referenced digital photographs taken of that re-work.
12. The CSA's Quality Control Person (QCP) or persons shall submit a daily QC inspection report that describes and documents all QC tests and inspection tasks performed including frequency of performance and test results (including test data) and referenced standard followed for each shift the Contractor works. These reports shall be submitted on the morning of the following day the work was performed to the

Engineer . If any non-conforming work is identified, a written account of those non-conforming issues and corrective measures and annotated digital photographs of such work shall be included with the daily QC report. The Contractor shall submit a standard inspection form to be used for these reports for review by the Engineer. The approved inspection report forms shall be used by the Contractor's QC Inspector to record all QC inspection and testing throughout the performance of the coating work.

13. The CSA, with Contractor's oversite, shall complete the Coating System Quality Assurance Checklist, Form 09 96 00-A, included in 01 99 90, for coating system installations. Follow the sequential steps required for proper coating system installation as specified and as listed in the Coating System Quality Assurance Checklist. For each portion of the work, install the coating system and complete sign-offs as specified prior to proceeding with the next step. After completing each step as indicated on the Coating System Quality Assurance Checklist, the Contractor shall sign the checklist indicating that the work has been installed and inspected as specified.

C. Quality Control Minimum Inspection Processes:

1. The CSA shall conduct QC inspections during the coating system installation, including surface preparation. Results of those inspections shall be included in the Daily Inspection Reports. Sign off by all involved parties(QC, CSA, CSM) is required on the project Inspection Checklist, Form 09 97 00-A. QC inspections and testing shall be performed as often as needed to ensure full compliance to this specification. The minimum QC inspections include but are not limited to the following:
   a. Environment and Site Conditions: Prior to commencing an activity associated with coating system installation, the CSA inspector shall measure, record, and confirm acceptability of ambient air temperature and humidity as well as other conditions such as proper protective measures for surfaces not to be coated and safety requirements for personnel. The acceptability of the weather and/or environmental conditions within the structure shall be determined by the requirements specified by the CSM of the coating system being used.
   b. Conditions Prior to Surface Preparation: Prior to commencing surface preparation, the CSA inspector shall observe, record, and confirm that oil, grease, and/or soluble salts have been eliminated from the surface.
   c. Monitoring of Surface Preparation: Spot checking of degree of cleanliness, surface profile, and surface pH testing, where applicable. In addition, the compressed air used for surface preparation or vacuum or wash-down cleaning shall be checked to confirm it is free from oil and moisture.
   d. Post Surface Preparation: Upon completion of the surface preparation, the CSA shall measure and inspect for proper degree of cleanliness and surface profile as specified in this Section and in the CSM's written instructions (Product SDS).
   e. Monitoring of Coatings Application: The CSA inspector shall inspect, measure, and record the WFT and general film quality (visual inspection) for lack of runs, sags, pinholes, holidays, etc. as the application work proceeds.
   f. Post Application Inspection: The CSA shall identify defects in application work including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness, and other problems as may be observed.
   g. DFT Measurements: DFT measurements shall be taken after each coat and recorded in the daily QC inspection reports. DFT readings for steel surface shall be taken as per SSPC- PA2 using Type II Magnetic DFT Gauges for ferrous

surfaces and Type II Eddy Current Gauges for non-ferrous surfaces. DFT readings for concrete surface can be taken as per SSPC- PA9 using Ultra Sonic DFT Gauges or by proving materials usage versus square foot coverage. All gauges shall be calibrated by the manufacturer or approved agent within 1 year of use. Following SSPC- PA2 and SSPC-PA9, minimum measurement standards may not provide the QCP adequate measurement intervals to ensure full compliance to the specification. QC personnel are required to take as many measurements necessary to ensure full compliance to this specification.

h. Post Cure Evaluation: The CSA shall measure and inspect the overall DFT. The CSA shall conduct a DFT survey, as well as perform adhesion testing, holiday detection, or cure testing as required based on the type of project and the specific requirements in this Section and/or in the CSM's written instructions.

i. Follow-up to Corrective Actions and Final Inspection: The CSA shall measure and reinspect corrective coating work performed to repair defects identified at prior Hold Points. This activity also includes final visual inspection along with follow-up tests such as holiday detection, adhesion tests, and DFT surveys.

j. Post-construction Inspection: The CSA shall perform an inspection of FOG Receiving Tanks 1 & 2 after the tanks have been in service for a period of 1-year. The inspection performed shall follow the same steps performed for the post application inspection. The CSA shall coordinate with the Owner to take each tank out of service for the inspection, but the Owner cannot take both tanks offline at the same time. The Owner requires 1-day notice prior to the inspection to take a tank offline. The Owner will drain and clean each tank prior to the inspection using equipment available at the facility.

D. Quality Assurance Inspection:

1. The Owner and Engineer reserve the right to retain the services of a Quality Assurance Inspection firm to perform random audits of the CSA's QC processes and documentation at any time during the project's progress. Any inspections by the Owner, Engineer, or other owner related representatives do not relieve the Contractor from having sole responsibility for the quality of the installed coating system.
2. Quality Assurance Hold Point Inspections may include, but are not limited to the following processes:
   a. Conditions Prior to Surface Preparation
   b. Environment and Site Conditions
   c. Post Surface Preparation
   d. Post Primer Application (if Applicable)
   e. Post Intermediate Coat Application (if Applicable)
   f. Post Final Coat Application
   g. Final Cure and Testing (including Holiday Detection)
   h. Follow-up to Corrective Actions and Final Inspection
3. The Contractor/CSA shall coordinate such Hold Points with the Owner's Quality Assurance representative such that this representative may observe the CSA's QC inspections on a scheduled basis. The Contractor/CSA shall provide the Owner's Quality Assurance representative a minimum of 48 hours of notice prior to conducting Hold Point Inspections.

E. Responsibilities of the CTR:

1. General:
    a. The Contractor shall retain or obtain the services of the CTR to be on site to perform the Contractor and/or CSA application training and to routinely verify in writing that the application personnel have successfully performed representative portions of the surface preparation work, filler/surface application, coating system application, and QC Inspection in accordance with this Section. This must include testing, checking, or witnessing the contractors testing for the required degree of cleanliness, surface pH for concrete substrates, surface profile of substrates, proper mixing of coating materials, application (including checking the WFT and DFT of the coating systems), proper cure of the coating systems, and proper treatment of coating systems at terminations, transitions, and joints and cracks in substrates. Refer to paragraph 1.08.B, Coating System Installation Training. for further details on these CTR requirements. This verification is in addition to the inspection performed by the Contractor in accordance with this Section. The CTR must be a technical representative of the CSM's Technical Service Department and not a local sales representative. The CTR shall provide an adequate level of oversight of the contractor's QC processes, at their discretion, to provide sign off that the CSM's products have been properly installed.
2. Coating System Installation Training:
    a. Provide a minimum of 8 hours of classroom and off-site training for application and supervisory personnel of the Contractor (CSA). Provide training to a minimum of 2 supervisory personnel from the CSA. Alternatively, the CTR shall provide a written letter from the CSM stating that the application personnel (listed by name) who shall perform coating work are approved by the CSM without further or additional training.
    b. One CTR shall provide training for all application and supervisory personnel. The training shall include the following as a minimum:
        1) A detailed explanation of mixing, application, curing, and termination details.
        2) Hands-on demonstration of how to mix and apply the coating systems.
            a) A detailed explanation of the ambient condition requirements (temperature and humidity) and surface preparation requirements for application of the coating system as well as a detailed explanation of re-coat times, cure times, and related ambient condition requirements.
        3) When training is performed, the CTR shall provide a written letter stating that training was satisfactorily completed by the personnel listed by name in the letter.
3. Representative Coating System Inspections:
    a. While on site to verify or witness the QC processes of the contractor, the CTR shall verify representative steps of the coating work are performed properly per the manufacturer's instructions, the CTR shall coordinate and confirm the planned inspections by the Contractor's QC person are being performed per the QCTIP to assure quality of the work meets the requirements of both these specifications and any additional manufacturer's requirements, the CTR shall verify or witness the contractors QC processes of the following QC steps, at their discretion and as delineated above in 1.05.C.:
        1) Inspect ambient conditions during various coating system installation at hold points for conformance with the specified requirements.

2) Inspect the surface preparation of the substrates where the coating system will terminate or will be applied for conformance to the specified application criteria.
3) Inspect preparation and application of coating detail treatment (for example, terminations at joints, metal embedments in concrete, etc.).
4) Inspect application of the filler/surface materials for concrete and masonry substrates.
5) Inspect application of the primers and finish coats including WFT and DFT of the coatings.
6) Inspect coating systems for cure.
7) Review adhesion testing of the cured coating systems for conformance to specified criteria.
8) Review coating system discontinuity testing for conformance to specified criteria.
9) Observe adhesion testing work to assure it meets specification requirements.
10) Inspect and record representative localized repairs made to discontinuities identified via continuity testing.
11) Conduct a final review of completed coating system installation for conformance to the specifications.
12) Prepare and submit a site visit report following each site visit that documents the acceptability of the coating work observed and inspected in accordance with the CSM's Recommendations.



## 1.06 DELIVERY AND STORAGE

A. General:
1. Conform to the requirements of Section 01 66 00, Product Storage and Handling Requirements.
2. Materials shall be delivered to the job site in their original, unopened containers. Each container shall be properly labeled. Materials shall be handled and stored to prevent damage to or loss of label.
3. Labels on material containers shall show the following information:
a. Name or title of product
b. CSM's batch number
c. CSM's name
d. Generic type of material
e. Application and mixing instructions
f. Hazardous material identification label
g. Shelf life expiration date
4. Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold in accordance with the CSM’s recommendations. Flammable materials shall be stored in accordance with state and local requirements.
5. Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.

6. Safety Data Sheets (SDS) for each material shall be provided to the Construction Manager, Owner, Contractor, and CSA.
7. The Contractor/CSA shall store and dispose of hazardous waste according to federal, state and local requirements. This requirement specifically addresses waste solvents and coatings.

## 1.07 SUBMITTALS:

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, and referenced and applicable sections, with addendum updates included, with each paragraph check-marked (☐) to indicate specification compliance or marked to indicate requested deviations from specification requirements or those parts which are to be provided by the Contractor or others. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner's representative shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined shall signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations to the specification requirements, shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.
   3. CSM's current printed recommendations and product data sheets for coating systems including:
      a. Volatile organic compound (VOC) data
      b. Surface preparation recommendations
      c. Primer type, where required
      d. Maximum dry and wet-mil thickness per coat
      e. Minimum and maximum curing time between coats, including atmospheric conditions for each
      f. Curing time before submergence in liquid
      g. Thinner to be used with each coating
      h. Ventilation requirements
      i. Minimum atmospheric conditions during which the paint shall be applied
      j. Allowable application methods
      k. Maximum allowable moisture content
      l. Maximum shelf life
   4. Affidavits signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements.
   5. Safety Data Sheets (MSDS) for materials to be delivered to the job site, including coating system materials, solvents, and abrasive blast media.
   6. Written list of cleaning and thinner solutions allowed by the CSMs.

7. Storage requirements including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.
8. CSM's detailed, written instructions for coating system treatment and graphic details for coating system terminations in the structures to be coated including pipe penetrations, metal embedments, gate frames, and other terminations to be determined from the contract drawings. This information shall also include detail treatment for coating system at joints and cracks in concrete.
9. The Contractor and CSA shall provide a minimum of 5 project references each including contact name, address, and telephone number where similar coating work has been performed by their companies in the past 5 years.
10. Written certification that the Contractor's QC person for the work is a Certified SSPC or NACE Coatings Inspector who has the requisite experience identified in 1.05.B.8.
11. Written Quality Control Testing and Inspection Plan (QCTIP) for the coating work covered by the Contract for this project and as specified in this Section.
12. Sample Daily QC Inspection Report Forms to be used by the Contractor's QC person assigned to the work covered by this Section.
13. Written letter from CSM signed by a Company officer that the Contractor's personnel who will perform the coating work have successfully been trained to apply the specified and approved coating materials.
14. Signed Affidavit from CSM that all products provided for the coating work covered by this Section are compliant with applicable VOC regulations.
15. Signed and dated QA Hold Points Checklists per 1.05.C.1. of this Section.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Prior to application of coatings, submit letter(s) from the CTR(s) identifying the application personnel who have satisfactorily completed training as specified in paragraph 1.05 or a letter from the CSM stating that personnel who shall perform the work are approved by the CSM without need for further or additional training.
   3. Submit reports specified in paragraph 1.05.B Quality Control Requirements and 1.05.C Quality Assurance Hold Points when the work is underway.

C. Closeout Submittals:
   1. Procedures: Section 01 33 00.
   2. Submit the Coating System Inspection Checklists using Form 09 96 00-A, included in this Section, for the coating work.



## PART 2 PRODUCTS

### 2.01 MATERIALS

A. General:
   1. Notwithstanding the listing of product names in this Section, the Contractor shall provide affidavits, signed and sealed by an officer of the CSM's corporation, attesting to full compliance of each coating system component with current and promulgated federal, state, and local air pollution control regulations and requirements. No coatings shall be applied to a surface until the specified affidavits have been

submitted and have been reviewed and accepted. Failure to comply with this requirement shall be cause for rejection and removal of such materials from the site.

B. Description of Standard High Performance Coating Systems:

| Coating systems Designation | Description |
|---|---|
| HP-14 | High Build High Strength Semi-Structural Blended Amine Cured Epoxy for Concrete Substrates in Biogenic Sulfide and Immersion Exposure Conditions. |

C. Material Requirements for Standard High Performance Coating Systems:

**Material Requirements for Standard Coating Systems for United States and Canada, except for California SCAQMD:**

| Coating Systems Designation | CSM | Pit Filler/Mortar Repair | Primer/Intermediate Coats | Finish Coats |
|---|---|---|---|---|
| HP-14 | PPG | PPG Raven 760 EMC | Raven 175 Optional | Raven 405 |
| | Sauereisen | Series F120 or F121 | PermaPrime 500 (optional) | Series 210XHB |
| | Sherwin Williams | Dura-Plate 2300<br>AW Cook MSM | Macropoxy 5000 (optional) | Dura-Plate 6100 |



## PART 3 EXECUTION

### 3.01 COATINGS

A. General:

1. Coating products shall not be used until the Engineer or Owner's Representative has accepted the affidavits specified in paragraphs 1.07 and 2.01, and inspected the materials, and the CTR has trained the Contractor in the surface preparation, mixing, and application of each coating system.
2. Erect and maintain protective enclosures as stipulated per SSPC-Guide 6 Guide for Containing Debris Generated During Paint Removal Operations.

B. Shop and Field Coats:

1. Shop Applied Prime Coat: Except as otherwise specified, prime coats may be shop-applied or field-applied. Shop-applied primer shall be compatible with the specified coating system and shall be applied at the minimum DFT recommended by the CSM. Data sheets identifying the shop primer used shall be provided to the on-site coating application personnel. Adhesion tests shall be performed on the shop primer as specified in paragraph 3.01 B.3. Adhesion Confirmation. Damaged, deteriorated, and poorly applied shop coatings that do not meet the requirements of this Section shall be removed and the surfaces recoated. If the shop primer coat meets the requirements of this Section, the field coating may consist of touching up the shop prime coat and then applying the finish coats to achieve the specified film thickness and continuity.
2. Field Coats: Field coats shall consist of one or more prime coats and one or more finish coats to build up the coating to the specified DFT. Unless otherwise specified,

finish coats shall not be applied until other work in the area is complete and until previous coats have been inspected.

3. Adhesion Confirmation: The Contractor shall perform an adhesion test after proper cure in accordance with ASTM D3359 to demonstrate that (1) the shop applied prime coat adheres to the substrate, and (2) the specified field coatings adhere to the shop coat. Test results showing an adhesion rating of 5A on immersed surfaces and 4A or better on other surfaces shall be considered acceptable for coatings 5 mils or more in thickness (Method A). Test results showing an adhesion rating of 5B on immersed surfaces and 4B or better on other surfaces shall be considered acceptable for coating thicknesses less than 5 mils
4. The same QC and quality assurance inspection requirements are applicable for shop applications as for field applications.

C. Application Location Requirements:

1. Equipment, Non-immersed: Items of equipment, or parts of equipment that are not immersed in service, shall be shop primed and then finish coated in the field after installation with the specified or acceptable color. If the shop primer requires topcoating within a specified period, the equipment shall be finish coated in the shop and then touch-up painted after installation. If equipment removal and reinstallation is required for the project, touch-up coating work shall be performed in the field following installation.
2. Equipment, Immersed: Items of equipment, or parts and surfaces of equipment that are immersed when in service, with the exception of pumps and valves, shall have surface preparation and coating work performed in the field. Coating systems applied to immersed equipment shall be pinhole free.



## 3.02 PREPARATION

A. General:

1. Surface preparations for each type of surface shall be in accordance with the specific requirements of each coating specification sheet (COATSPEC) and the following. In the event of a conflict, the COATSPEC sheets shall take precedence.
2. Surfaces to be coated shall be clean and dry. Before applying coating or surface treatments, oil, grease, dirt, rust, loose mill scale, old weathered coatings, and other foreign substances shall be removed. Oil and grease shall be removed before mechanical cleaning is started. Where mechanical cleaning is accomplished by blast cleaning, the abrasive used shall be washed, graded, and free from contaminants that might interfere with the adhesion of the coatings. The air used for blast cleaning shall be sufficiently free of oil and moisture so as not to cause detrimental contamination of the surfaces to be coated.
3. The Contractor's QCP inspector will review surfaces to be coated before application of a coating. Surface defects identified by the inspector shall be corrected by the Contractor at no additional cost to the Owner.
4. Cleaning and coating shall be scheduled so that dust and spray from the cleaning process shall not fall on wet, newly coated surfaces. Hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with coated surfaces shall be removed or masked prior to surface preparation and coating operations. Following completion of coating, removed items shall be reinstalled. Equipment adjacent to

walls shall be disconnected and moved to permit cleaning and coating of equipment and walls and, following coating, shall be replaced and reconnected.

B. Blast Cleaning:
   1. When abrasive blast cleaning is required to achieve the specified surface preparation, the following requirements for blast cleaning materials and equipment shall be met:
      a. Used or spent blast abrasive shall not be reused on this project.
      b. The compressed air used for blast cleaning shall be filtered and shall contain no condensed water and no oil. Moisture traps shall be cleaned at least once every 4 hours or more frequently as required to prevent moisture from entering the supply air to the abrasive blasting equipment.
      c. Oil separators shall be installed just downstream of compressor discharge valves and at the discharge of the blast pot discharges. These shall be checked on the same frequency as the moisture traps as defined above.
      d. Regulators, gauges, filters, and separators shall be in use on compressor air lines to blasting nozzles at all times during this work.
      e. An air dryer or desiccant filter drying unit shall be installed which dries the compressed air prior to blast pot connections. This dryer shall be used and maintained for the duration of surface preparation work.
      f. The abrasive blast nozzles used shall be of the venturi or other high velocity type supplied with a minimum of 100 pounds per square in gauge (psig) air pressure and sufficient volume to obtain the blast cleaning production rates and cleanliness/specified.
      g. The Contractor shall provide ventilation for airborne particulate evacuation (meeting pertinent safety standards) to optimize visibility for both blast cleaning and inspection of the substrate during surface preparation work.
      h. If, between final surface preparation work and coating system application, contamination of prepared and cleaned metallic substrates occurs, or if the prepared substrate's appearance darkens or changes color, recleaning by water blasting, reblasting, and abrasive blast cleaning shall be required until the specified degree of cleanliness is reclaimed.
      i. The Contractor is responsible for dust control and for protection of mechanical, electrical, and other equipment adjacent to and surrounding the work area

C. Solvent Cleaning:
   1. Any solvent wash, solvent wipe, or cleaner used, including but not limited to those used for surface preparation in accordance with SSPC SP1 Solvent Cleaning and shall be of the emulsifying type which emits no more than 340 g/l VOCs contains no phosphates, is biodegradable, removes no zinc, and is compatible with the specified primer.
   2. Clean white cloths and clean fluids shall be used in solvent cleaning.

D. Metallic Surfaces:
   1. Metallic surfaces shall be prepared in accordance with applicable portions of surface preparation specifications of the Society for Protective Coatings (SSPC) specified for each coating system. See Coat Spec for each coating system in this Section. The profile depth of the surface to be coated shall be in accordance with the COATSPEC

requirements in this Section measured by Method C of ASTM D4417. Blast particle size shall be selected by the Contractor to produce the specified surface profile. The solvent in solvent cleaning operations shall be as recommended by the CSM.

2. Preparation of metallic surfaces for degree of cleanliness shall be based upon comparison with SSPC-VIS1-89 (ASTM D2200), and as described in the Coat Spec for each coating system. If dry abrasive blast cleaning is selected and to facilitate inspection, the Contractor shall, on the first day of cleaning operations, abrasive blast metal panels to the standards specified. Plates shall measure a minimum of 8-1/2 inches by 11 inches. Panels meeting the requirements of the specifications shall be initialed by the Contractor and coated with a clear non-yellowing finish. One of these panels shall be prepared for each type of abrasive blasting and shall be used as the comparison standard throughout the project.
3. Blast cleaning requirements for steel, ductile iron, and stainless steel substrates are as follows:
   a. External surfaces of steel piping shall be prepared in accordance with SSPC SP10 (Near White Metal Blast Cleaning) and primed before installation. Ductile iron piping surfaces including fittings shall be prepared in accordance with NAPF 500-03, NAPF 500-03-04, and NAPF 500-03-05. All other steel surfaces shall be prepared to white metal blast cleaning per SSPC SP5.
   b. Stainless steel surfaces shall be abrasive blast cleaned in accordance with SSPC SP16 to leave a clean uniform appearance with a minimum surface profile of 1.5 to 2.5 mils that is uniform.
   c. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products or embedded abrasive from substrate by vacuum cleaning prior to coating application.
   d. Care must be taken to prevent contamination of the surface after blasting from worker's fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions.
   e. Ambient environmental conditions in the enclosure must be constantly monitored and maintained to ensure the degree of cleanliness is held and no "rust back" occurs prior to coating material application.

E. Concrete Surfaces:
   1. Inspection of concrete surfaces prior to surface preparation and surface preparation of concrete surfaces shall be performed in accordance with SSPC-SP13 (also called NACE 6).
   2. Prepare substrate cracks and areas requiring resurfacing and perform detail treatment including but not limited to, terminating edges, per CSM recommendations. This shall precede surface preparation for degree of cleanliness and profile.
   3. The surface profile for prepared concrete surfaces to be coated shall be evaluated by comparing the profile of the prepared concrete with the profile of graded abrasive paper, as described in ANSI B74.18 or by comparing the profile with the ICRI 310.2 (surface profile replicas). Surface profile requirements shall be in accordance with the Coat Spec requirements and the CSM's recommendations.
   4. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to making repairs or applying a coat in the coating system. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness prior to application of the coating system.

5. Surface preparation of concrete substrates shall be accomplished using methods such as dry abrasive blast cleaning, high, or ultra high-pressure water blast cleaning in accordance with SSPC SP13. The selected cleaning method shall produce the requirements set forth below.
    a. A clean substrate that is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances shall be achieved. Blast cleaning and other means necessary shall be used to open up air voids or bugholes to expose their complete perimeter. Leaving shelled over, hidden air voids beneath the exposed concrete surface is not acceptable. Concrete substrate must be dry prior to the application of filler/surface or coating system materials.
    b. Acceptable surface preparation must produce a concrete surface with a minimum pH of 9.0 to be confirmed by surface pH testing. If after surface preparation, the surface pH remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.
    c. Following inspection by the Contractor of the concrete surface preparation, thoroughly vacuum clean concrete surfaces to be coated to remove loose dirt, and spent abrasive (if dry blast cleaning is used) leaving a dust free, sound concrete substrate. Debris produced by blast cleaning shall be removed from the structures to be coated and disposed of legally off site by the Contractor.
6. Should abrasive blast cleaning or high or ultrahigh pressure water jetting not remove degraded concrete, chipping or other abrading tools shall be used to remove the deteriorated concrete until a sound, clean substrate is achieved which is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances. Concrete substrates must be dry prior to the application of filler/surfacers or coating system materials.
7. Surface cleanliness of prepared concrete substrates shall be inspected after cleaning, preparation, and/or drying, but prior to application of coating materials. If concrete surfaces are repaired, they shall be reinspected for surface cleanliness and required surface profile prior to application of the coating system.
8. Moisture content of concrete to be coated shall be tested in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method. ASTM D4263 plastic sheet test shall be conducted at least once for every 500 sq ft of surface area to be coated or more often if required by the CSM. The presence of any moisture on plastic sheet following test period constitutes a non-acceptable test.

F. Masonry Surfaces:
1. Prepare masonry surfaces such as Concrete Masonry Units (CMU) to remove chalk, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
2. Be certain masonry surfaces are dry prior to coating application. If pressure washing or low-pressure water blast cleaning is used for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or when the minimum ambient temperature is 70 degrees F prior to coating application work.

## 3.03 APPLICATION

A. Workmanship:

1. Coated surfaces shall be free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce an even film of uniform thickness completely coating corners and crevices.
2. The Contractor's equipment shall be designed for application of the materials specified. Compressors shall have suitable traps and filters to remove water and oils from the air. A paper blotter test shall be performed by the Contractor when requested by the Construction Manager to determine if the air is sufficiently free of oil and moisture so as not to produce deteriorating effects on the coating system. The amount of oil and moisture in spray air shall be less than the amount recommended by the CSM. Spray equipment shall be equipped with mechanical agitators, pressure gages, and pressure regulators, and spray nozzles of the proper sizes.
3. Each coat of coating material shall be applied evenly and sharply cut to line. Care shall be exercised to avoid overspraying or spattering coating on surfaces not to be coated. Glass, hardware, floors, roofs, and other adjacent areas and installations shall be protected by taping, drop cloths, or other suitable measures.
4. Coating applications method shall be conventional or airless spray, brush or roller, or trowel as recommended by CSM.
5. Allow each coat to cure or dry thoroughly, according to CSM's printed instructions, prior to recoating.
6. Vary color for each successive coat for coating systems when possible.
7. When coating complex steel shapes, prior to overall coating system application, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer coat. This involves applying a separate coat using brushes or rollers to ensure proper coverage. Stripe coat via spray application is not permitted.

B. Coating Properties, Mixing and Thinning:

1. Coatings, when applied, shall provide a satisfactory film and smooth even surface. Glossy undercoats shall be lightly sanded to provide a surface suitable for the proper application and adhesion of subsequent coats. Coating materials shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings consisting of 2 or more components shall be mixed in accordance with the CSM's instructions. Where necessary to suit the conditions of the surface, temperature, weather, and method of application, the coating may be thinned as recommended by the CSM immediately prior to use. The volatile organic content (VOC) of the coating as applied shall comply with prevailing air pollution control regulations. Unless otherwise specified, coatings shall not be reduced more than necessary to obtain the proper application characteristics. Thinner shall be as recommended by the CSM.

C. Atmospheric Conditions:

1. Coatings shall be applied only to surfaces that are dry, and only under conditions of evaporation rather than condensation. Coatings systems shall not be applied during rainy, misty weather, or to surfaces upon which there is frost or moisture condensation. During damp weather, when the temperature of the surface to be coated is within 10 degrees F of the dew point, forced dehumidification equipment

may be used to maintain a temperature of minimum 40 degrees F and 10 degrees F above the dew point for the surfaces to be coated, the coated surface, and the atmosphere in contact with the surface. These conditions shall be maintained for a period of at least 8 hours or as recommended by the CSM to assure proper coating cure. Where conditions causing condensation are severe, dehumidification equipment, fans, and/or heaters shall be used inside enclosed areas to maintain the required atmospheric and surface temperature requirements for proper coating application and cure.

D. Concrete Substrate Temperatures and Detail Treatment:
   1. When the surface temperatures of the concrete substrates to be coated are rising or when these substrates are in direct sunlight, outgassing of air from the concrete may result in bubbling, pinhole formations, and/or blistering in the coating system. The application of the filler/surfacer or restoration mortar and the coating system will only be allowed during periods of falling temperature. This will require that application of the filler/surfacer and coating system shall only occur during the cooler evening hours in most cases. Contractor shall include any cost for working outside of normal hours in the bid.
   2. Should bubbles, pinholes, or discontinuities form in the applied coating system material, they shall be repaired as recommended by the CSM. Should pinholes develop in the filler/surfacer material or in the first coat of the coating material, the pinholes shall be repaired in accordance with the CSM's recommendations prior to application of the next coat of material. Whenever pinholes occur, the air void behind or beneath the pinhole shall be opened up completely and then completely filled with the specified filler/surfacer material. Next, the coated area around the pinhole repair shall be abraded and the coating reapplied over that area.
   3. Perform application detail work per CSM's current written recommendations and/or drawings.

E. Protection of Coated Surfaces:
   1. Items that have been coated shall not be handled, worked on, or otherwise disturbed until the coating is completely dry and hard. After delivery at the site, and upon permanent erection or installation, shop-coated metalwork shall be recoated or retouched with specified coating when it is necessary to maintain the integrity of the film.

F. Method of Coating Application:
   1. Where 2 or more coats are required, alternate coats shall contain sufficient compatible color additive to act as indicator of coverage, or the alternate coats shall be of contrasting colors. Color additives shall not contain lead, or lead compounds, which may be destroyed or affected by hydrogen sulfide or other corrosive gas, and/or chromium.
   2. Mechanical equipment, on which the equipment manufacturer's coating is acceptable, shall be touch-up primed and coated with 2 coats of the specified coating system to match the color scheduled.
   3. Coatings shall not be applied to a surface until it has been prepared as specified. The primer or first coat shall be applied by brush to ferrous surfaces that are not blast cleaned. Coats for blast cleaned ferrous surfaces and subsequent coats for nonblast cleaned ferrous surfaces may be either brush or spray applied. After the prime coat is dry, pinholes and holidays shall be marked, repaired in accordance with CSM's

recommendations, and retested before succeeding coats are applied. Unless otherwise specified, coats for concrete and masonry shall be brushed, rolled, or troweled.

G. Film Thickness and Continuity:
   1. WFT of the first coat of the coating system and subsequent coats shall be verified by the Contractor, following application of each coat.
   2. The surface area covered per gallon of coating for various types of surfaces shall not exceed those recommended by the CSM. The first coat, referred to as the prime coat, on metal surfaces refers to the first full paint coat and not to solvent wash, grease emulsifiers, or other pretreatment applications. Coatings shall be applied to the thickness specified, and in accordance with these specifications.
   3. The ability to obtain specified film thickness is generally compromised when brush or roller application methods are used and, therefore, more coats may need to be applied to achieve the specified DFT.
   4. For concrete substrates, the Contractor shall apply a complete skim coat of the specified filler/surfacer material over the entire substrate prior to application of the coating system. This material shall be applied such that all open air voids and bugholes in the concrete substrate are completely filled prior to coating application.

H. Special Requirements:
   1. Before erection, the Contractor shall apply all but the final finish coat to interior surfaces of steel supports, pipe hangers, piping in contact with hangers, and contact surfaces that are inaccessible after assembly. The final coat shall be applied after erection. Areas damaged during erection shall be hand-cleaned or power-tool cleaned and recoated with primer coat prior to the application of subsequent coats. Touch-up of surfaces shall be performed after installation. Surfaces to be coated shall be clean and dry at the time of application.

I. Electrical and Instrumentation Equipment and Materials:
   1. Electrical and instrumentation equipment and materials shall be coated in accordance with Section 09 90 00.



## 3.04 CLEANUP

A. General:
   1. Upon completion of coating, the Contractor shall remove surplus materials, protective coverings, and accumulated rubbish, and thoroughly clean surfaces and repair overspray or other coating-related damage.

## 3.05 FINAL INSPECTION.

A. General:
   1. Contractor shall conduct a final inspection to determine whether coating system work meets the requirements of the specifications. At least 48 hours prior to the final inspection, the Contractor shall compile a single, complete set of QC records and signoff sheets that confirm all testing was properly performed on all materials, and appropriate repairs were completed, and any final retesting was successful. These records should include a complete set of CTR records/reports as well.

2. The Engineer or Owner's Representative will subsequently conduct a final observation with the Contractor for general conformance.
3. Any rework required shall be marked. Such areas shall be recleaned and repaired as specified at no additional cost to the Owner.

## 3.06 COATING SYSTEM SPECIFICATION SHEETS (COATSPEC)

A. General:

1. Coating systems for different types of surfaces and general service conditions for which these systems are normally applied are specified on the following COATSPEC sheets. Surfaces shall be coated in accordance with the COATSPEC to the system thickness specified. Coating systems shall be as specified in paragraph 3.06. In case of conflict between the schedule and the COATSPECS, the requirements of the schedule shall prevail.
2. Coating Specification Sheets included in Table A are included this paragraph 3.06.

**Table A Coating Specification Sheets**

| Coating System ID | Coating Material | Surface | Service Condition |
|---|---|---|---|
| HP-14 | High Build High Strength Semi Structural Blended Amine Cured Epoxy System | Concrete and Concrete Block Masonry | Intermittent Immersion in Wastewater or Wastewater Sludge and Biogenic Sulfide Corrosion – Headspace Exposure and Abrasive Conditions |

**Coating System Specification Sheets (COATSPEC)**

**Coating System Identification – HP-14**

| | |
|---|---|
| 1. Coating Material: | High Build High Strength Semi Structural Blended Amine Cured Epoxy System |
| 2. Surfaces: | Concrete and Concrete Block Masonry |
| 3. Service Conditions: | Intermittent Immersion in Wastewater or Wastewater Sludge and Biogenic Sulfide Corrosion – Headspace Exposure and Abrasive Conditions |
| 4. Surface Preparation: | Confirm that the exterior of buried concrete structures will be waterproofed in accordance with Section 07 10 00 prior to application of this coating.<br>All coating termination and transition details shall be prepared in accordance with the CSM's standard detail drawings. This includes coating termination details, coating transitions at vertical and vertical to horizontal corners, coating terminations at joints, concrete crack treatment, coating terminations at metal embedments in the concrete substrate, and other details. The CSM's standard detail drawings shall be submitted for all such coating applications. If standard details are not available for a given detail treatment, the CSM shall be required to produce one at no additional cost to the Owner, the Engineer, or any other party.<br>If wet abrasive or water jetting surface preparation methods were used, the concrete substrate shall be allowed to dry under warm conditions (minimum of 75 degrees F) for at least 5 days prior to coating application. The exception to this is when filler/surfacers or mortars require pre-wetted substrates to assure proper adhesion. Following surface preparation work and dry-out, all surfaces to be coated shall be vacuum cleaned to remove all loose dirt, dust, or other loose materials.<br>Alternatively, the prepared substrate can be thoroughly washed down with potable water to remove all loose debris, dust, and other materials leaving a clean sound substrate that is dust-free. |
| a. Concrete: | New concrete surfaces shall be allowed to cure for at least 28 days and allowed to dry to the moisture content recommended by the CSM. Moisture content shall be tested as specified herein in 3.07. Except as otherwise specified, loose concrete, form oils, surface hardeners, curing compounds, and laitance shall be removed from surfaces by abrasive blasting surface or ultrahigh pressure water jetting. Large voids or spalls and cracks shall be repaired as specified in the CSM's Crack |

Coating System Identification – HP-14

| | |
|---|---|
| | Treatment Details. Surface Preparation must open up all shelled over air voids or bugholes to expose fully the void's depth, width, and length. Concrete shall be abraded to achieve a uniform minimum concrete surface profile of CSP 6 in accordance with ICRI 310.2R. Surface preparation must produce minimum concrete surface pH of 9.0. After surface preparation has been accepted, a complete skim coat of the specified filler surfacer shall be applied over all concrete surfaces and all bugholes (air voids) shall be completely filled using this same material. The filler/surfacer material shall be applied as a complete parge coat of the substrate. If the parge coat (filler/surfacer material is non-polymer modified, it must be brush blast cleaned following adequate cure per CSM's instructions to produce a uniform anchor pattern of CSP 4 in accordance with ICRI 310.2R prior to coating application. |
| b. Masonry: | Masonry surfaces shall be allowed to cure for at least 28 days after being constructed and be allowed to dry to the moisture content recommended by the CSM. Holes or other joint defects shall be filled with a material compatible with the primers and finish coats or shall be filled with masonry mortar that shall cure for at least 28 days. Loose or splattered mortar shall be removed by scraping and chipping. Masonry surfaces shall be tested for moisture content in accordance with the CSM's recommendations.<br>Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances.<br>Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer. |
| 5. Field Application: | |
| a. General: | Surfacer or filler shall be applied per CSM's recommendations prior to application of coating to fill all bugholes and voids and create a complete parge coat of the prepared substrate. This parge coat shall completely fill all bugholes and voids in the substrate and will also completely cover the substrate unless specified otherwise above such filled voids by 1/8 inch (125 mils) of thickness.<br>Drying time between coats shall be as specified by the CSM for the site conditions. If the maximum recoat time is exceeded, surface preparation shall require solvent washing, light abrasive blasting, or other procedures per CSM's instructions. |
| b. Coating System Thickness: | 100-125 mils dry film in addition to the parge coat. |
| c. Coatings: | Primer: Optional to control outgassing.<br>Finish: One coat at 125 mils. |
| d. Routine QC Inspection Tasks: | Refer to Tables in 3.07 of this Section. |
| e. Post Cure QC Testing: | Holiday Detection shall be performed over 100 percent of the coated surface area to identify any holidays or pinholes which could compromise coating system performance. Holiday testing to be performed after application and adequate cure of the spray applied epoxy coating material. Holiday detection shall be performed in accordance with ASTM D4787.<br>Acceptance Criteria for Holiday Detection is no pinholes or holidays.<br>Perform Adhesion Testing on concrete substrate after surface preparation prior to resurfacing mortar application in accordance with ASTM C1583. Perform at 10 representative locations (3 tests per location) to determine the tensile strength of the concrete substrate.<br>Acceptance Criteria shall be minimum average target pull-off tensile strength of 250 psi. Based on the average ASTM C1583 test values, the acceptance criteria for tensile pull-off strength for coating adhesion can be established. When coating system mock-up application has been performed (DO MOCK-UP of 200 sq ft for verification purposes prior to commencing with production coating work), perform adhesion testing of coating system on mock-up area (6 tests total) in accordance with ASTM D7234. The target acceptance criteria is average of pull-off values of |

| Coating System Specification Sheets (COATSPEC) | |
|---|---|
| **Coating System Identification – HP-14** | |
| | 250 psi, but actual acceptable value to be established by ASTM C1583 tests performed on substrate as required above. The coating system adhesion tests shall be performed at least at one location for every 1,000 sq ft of area to be coated and be performed at areas representative of the entire area to be coated if that is greater. The acceptance criteria for coating pull-off adhesion testing shall also be failure plane percentage of minimum of 75 percent of failure plane on back of load fixture within the concrete substrate. |
| f. Pinhole, Holiday or Defect Repair Procedure: | Pinholes and holidays identified by Holiday Detection shall be repaired as follows:<br>• Using a grinder or other suitable power tool, remove the coating system at all pinholes or holidays in an area at least 2 inches in diameter or in both dimensions around the defect back to the concrete substrate.<br>• Chip out and remove the concrete to expose the full dimensions in all 3 directions of the air void responsible for the defect.<br>• Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.<br>• Vacuum clean the prepared area to remove all dust, dirt, etc. leaving clean sound surfaces.<br>• Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.<br>• Using a putty knife or other suitable tool, fill the opened void with the approved filler/surfacer material completely and strike-off. Allow to cure per CSM's recommendations.<br>• Apply the coating system in the number of coats necessary to achieve the specified 125 mils DFT over the defect and coating removal areas and feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline. Allow to cure properly. |



## 3.07 ROUTINE QUALITY CONTROL INSPECTION/TESTING REQUIREMENTS

A. The routine QC inspection tasks and tests listed below are required for all standard High Performance Coating Systems covered in this Section. All findings to be compared for compliance with this Section and the referenced product data sheets from the CSM. All of the QC tasks/tests listed below are to be included in the Contractor's QC Testing and Inspection Plan as required in this Section and documented on Form 09 96 00A..

**Routine Quality Control Inspection/Testing Requirements Table**

| Inspection Task or Test | Referenced Standard or Practice | Acceptance Criteria | Frequency of Test or Inspection Task |
|---|---|---|---|
| Inspect compressed air to be free of oil and moisture. | ASTM D4285 | Free of Oil and Moisture | Every 2 hours per shift worked. |
| Check pressure gauge for water jetting or test pressure for abrasive blast cleaning compressed air. | Needle Gage<br>No Standard | As Specified | Every 4 hours per shift worked. |
| Measure ambient air and substrate temperature. | Electronic Hygrometer<br>Positector or Elcometer DPM | As per CSM Product data Sheets | Every 2 hours per shift worked. |
| Measure relative humidity and dew point of air in coating area. | Electronic Hygrometer<br>Positector or Elcometer DPM | Surface Temperature 5°F above the Dew Point and Stabilized | Every 2 hours per shift worked. |

## Routine Quality Control Inspection/Testing Requirements Table

| Inspection Task or Test | Referenced Standard or Practice | Acceptance Criteria | Frequency of Test or Inspection Task |
|---|---|---|---|
| Test concrete substrate for moisture. | Phase 1- ASTM D4263 (Qualitative)<br>Phase 2 (If Moisture Present) – ASTM F1869 or ASTM F2170 | ASTM F1869-<3lbs per 1000 Sq Ft/24 Hrs<br>ASTM F2170<br>70% RH or less | Twice per shift worked and prior to coating application. |
| Test moisture content in concrete block with moisture meter. | Per CSM's Recommendations | <6% Moisture Content | Every 25 sq. f.t to be coated prior to coating application. |
| Inspect steel or other ferrous metals for Degree of Cleanliness in Carbon Steels. | SSPC VIS-1<br>(ASTM D2200)<br>SSPC VIS-3<br>SSPC VIS-4<br>SSPC VIS-5 | As per the Specification | All surfaces checked prior to coating – one comparison for every 50 sq ft to be coated. |
| Inspect Concrete Surface Profile by Comparison to Replicas. | ICRI 310.2R | As per the Specification | Every 15 sq ft to be coated. |
| Inspect Concrete for Soundness with Hammer Testing | N/A | No Hollow Concrete Areas | Check for soundness visually 100% and hammer test every 10 sq ft or where cracked or loose concrete is apparent visually. |
| Inspect Surface pH of Prepared Concrete. | ASTM D4262 | Min 9 pH | Every 100 sq. ft to be coated. |
| Calculate Coverage of Filler/Surfacers or Mortars based on CSM's Coverage Robes and Measure Thickness with Needle or Calibrated Wire. | N/A | As per Specification | For all surfaces to be surfaced and filled with parge coat of mortar. |
| Moisture WFT of Coatings Over Metal. | ASTM D4414 | As per CSM Product Data Sheets | Every 10 sq ft to be coated. |
| Measure WFT of Coatings Over Parge Coats – Troweled Over Concrete or Masonry. | ASTM D4414 | As per CSM Product Data Sheets | Every 10 sq ft to be coated. |
| Visually Inspect All Coating Film for Film Quality e.g. Pinholes, Holidays, Runs, Sags, etc. | N/A | Pinhole Free surface and free of runs and sags | 100% of all surfaces to be coated. |
| | | | |
| Measure DFT of Coatings on Concrete Substrates. | SSPC PA9 Level 3 | As Specified | As prescribed by SSPC PA9 |
| | | | |
| Discontinuity Testing (Holiday Detection) on Concrete Substrates. | ASTM D4787 | Pinhole Free Surface | Addressed in Applicable COATSPECS |
| | | | |
| Adhesion Testing on Concrete Substrates. | ASTM C4583<br>ASTM D7234 | 250 Psi Min | Addressed in Applicable COATSPECS |
| Reinspect for Rework from all Non-Compliant Issues Identified from QC Inspection listed above. | N/A | Meets all Specified standards | As needed. |

## 09 96 00-A COATING SYSTEM INSPECTION CHECKLIST

### Project Name

| | | | |
|---|---|---|---|
| **Owner** | | **Coating System Manufacturer Technical CTR** | |
| **General Contractor (GC)** | | **Coating System Applicator (CSA)** | |
| **Area or Structure** | | **Location within Structure** | |
| **Coating System (e.g., E-1)** | | **Coating Type (e.g., Epoxy, etc.)** | |

### Coating System Inspection Checklist

| Step | Description | Acceptance Criteria | Parties | Name | Signature | Date |
|---|---|---|---|---|---|---|
| 1 | Completion of pre-cleaning and substrate decontamination prior to abrasive blast cleaning. (Concrete) | Surface free of all oil, grease, form release agents and all other foreign contaminants | GC QC | | | |
| | | Host Substrate Min pH9 | CTR QC | | | |
| | | ASTM F22- No Moisture Lens Formation | CSA QC | | | |
| 2 | Moisture Testing of Concrete | Step 1- Initial Testing as Per ASTM D4263- if moisture present move to step 2 | GC QC | | | |
| | | Step 2- ASTM F1869- < 3lbs/1000 sq. ft/24 hours | CTR QC | | | |
| | | Step 2 Alternate- ASTM F2170- Substrate RH 70% or less. | CSA QC | | | |
| 3 | Ensuring compressed air for abrasive blasting or coating/lining application is free of oil and moisture | ASTM D4285- Free of all oil & moisture | GC QC | | | |
| | | 1 blotter test per 2 hours of compressed air usage | CTR QC | | | |
| | | | CSA QC | | | |
| 4 | Installation of protective enclosure of structure or area and protection of adjacent surfaces or structures that are not to be coated. | Conforms to SSPC Guide 6 Guidelines and specification requirements. | GC QC | | | |
| | | | CTR QC | | | |
| | | | CSA QC | | | |
| 5 | Completion of ambient condition control in structure or building area and acceptance of ventilation methods in structure or Area. | Substrate min of 5 degrees above the dew point and stabilized. | GC QC | | | |
| | | Recording ambient conditions, a minimum of 4 times per shift/day at 2-hour intervals | CTR QC | | | |

| Step | Description | Acceptance Criteria | Parties | Name | Signature | Date |
|---|---|---|---|---|---|---|
| | | Negative pressure of enclosure. Visual inspection of enclosure tarps indicating negative pressure. | CSA QC | | | |
| 6 | Completion of Surface Preparation for concrete deep repair applications. (If required) | SSPC SP CAB 1 and SSPC-SP13/NACE #6 | GC QC | | | |
| | | Surface Profile- ICRI CSP#5 minimum | CTR QC | | | |
| | | | CSA QC | | | |
| 7 | Completion of Concrete Deep Repairs (If required) and Related Surface Preparation Rework Prior to Concrete Filler/Re-surfacer/Parge. | SSD Maintained throughout application | GC QC | | | |
| | | SSPC SP CAB 1 and SSPC-SP13/NACE #6 | CTR QC | | | |
| | | Surface Profile- ICRI CSP#5 minimum | CSA QC | | | |
| 8 | Adhesion testing of host concrete as per ASTM C1583. Conduct tests in three (3) representative locations. Three (3) tests per location. Glue failures are not considered a completed test. | Report all adhesion values measured | GC QC | | | |
| | | Report average results of test areas. | CTR QC | | | |
| | | | CSA QC | | | |
| 9 | Completion of Concrete Filler/ Re-surfacer/Parge Coat Application to Concrete Prior to Coating System Application. | SSD Maintained throughout application | GC QC | | | |
| | | Visual inspection of uniformity of fill and dispersal | CTR QC | | | |
| | | | CSA QC | | | |
| 10 | Concrete - Completion of Surface Preparation for coating & lining applications. | SSPC SP CAB 1 and SSPC-SP13/NACE #6 | GC QC | | | |
| | | Surface Profile- ICRI CSP#4 minimum | CTR QC | | | |
| | | | CSA QC | | | |
| 11 | Concrete- Adhesion testing on installed repair mortar (after min 72-hour cure) as per ASTM C1583. Conduct tests in 3 representative locations. 3 tests per location. Glue failures are not considered a completed test. | Minimum 250 psi | GC QC | | | |
| | | 75% minimum host concrete failure | CTR QC | | | |
| | | | CSA QC | | | |
| 12 | Concrete- Completion of Primer Application. (If required) | DFT meets specifications as per SSPC PA9 | GC QC | | | |
| | | Visual Inspection- Film free of | CTR QC | | | |

| Step | Description | Acceptance Criteria | Parties | Name | Signature | Date |
|---|---|---|---|---|---|---|
| | | coating defects, pinholes and debris. | CSA QC | | | |
| | | | | | | |
| 13 | Concrete- Completion of Intermediate Coat Application and of Detail Treatment at Transitions or Terminations. (Only applicable in 2 coat applications) | DFT meets specifications as per SSPC PA9 | GC QC | | | |
| | | Visual Inspection- Film free of coating defects, pinholes and debris. | CTR QC | | | |
| | | | CSA QC | | | |
| | | | | | | |
| 14 | Concrete - Completion of Finish Coat Application and of Detail Treatment at Transitions and Terminations. | DFT meets specifications as per SSPC PA9 | GC QC | | | |
| | | Visual Inspection- Film free of coating defects, pinholes and debris. | CTR QC | | | |
| | | | CSA QC | | | |
| | | | | | | |
| 15 | Completion of Full and Proper Cure of Lining System. | ASTM D5402- No material transfer | GC QC | | | |
| | | ASTM D2240- Shore D- Must match value stated on CTR PDS data. | CTR QC | | | |
| | | | CSA QC | | | |
| 16 | Concrete - Completion of Testing of Cured Lining System including Adhesion, Holiday (Continuity) Testing. | ASTM D4787- Pinhole/holiday free | GC QC | | | |
| | | ASTM D7234- TBD by results of ASTM C1583 testing of host concrete and repair mortar | CTR QC | | | |
| | | | CSA QC | | | |
| | | | | | | |
| 17 | Concrete- Completion of Localized Repairs to Lining System Following Testing. | ASTM D4787- Pinhole/holiday free | GC QC | | | |
| | | Visual inspection for film quality-no runs, sags or other defects | CTR QC | | | |
| | | | CSA QC | | | |
| | | | | | | |
| 18 | Final Acceptance of Coating/Lining System Installation Including Final Clean-Up Complying with Specification Requirements and the CTR's Quality Requirements. | Coatings/linings meet all specification requirements | GC QC | | | |
| | | | CTR QC | | | |
| | | | CSA QC | | | |



**END OF SECTION**

# DIVISION 10
# SPECIALTIES

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SECTION 10 14 00

SIGNAGE

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This section specifies informational and accident prevention signs.
   2. Provide all labor, materials, tools, equipment and specified and required to furnish and install identification signs.
   3. Extent of identification is as specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the identification signs.
   2. Coordinate adhesives and fasteners with mounting surfaces. Review other Sections in order to insure compatibility of identification sign mounting accessories for the various surfaces.
   3. Coordinate with other discipline signage for electrical, process mechanical, structural and civil.



### 1.02 QUALITY ASSURANCE

A. Identification Sign Manufacturers:
   1. Engage firms specializing in the production of the types of products specified, in compliance with specified standards, with a documented record of successful in-service performance, and who can provide sufficient production capacity to avoid delaying the Work.
   2. Submit name and experience record of manufacturers to Engineer

B. Source Quality Control:
   1. Obtain each separate type of identification sign from a single supplier and from a single manufacturer.
   2. Colors shall be brilliant, distinctive shades, matching the safety colors specified in American National Standards Institute (ANSI) Z535.1 and Occupational Safety and Health Administration (OSHA) 1910.144.

C. Performance Criteria:
   1. Details for identification signs shown on the Drawings, such as alphabet representation, letter spacing, borders designs, and other graphic features, are generic and intended to establish text, general positions and symbols only.
   2. Submit for approval complete, camera-ready, color graphic layouts based on specified requirements and recommendations from manufacturer.

D. Allowable Tolerances:

1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16-inch measured diagonally.

E. Requirements of Regulatory Agencies:

1. Permanent rooms and spaces, and directional and informational signage where specified as accessible to people with disabilities shall comply with ANSI A117.1, ADAAG and 2010 Americans with Disabilities Act 2010 Standards for Accessibility Guidelines
2. Where identification signs are specified as accessible to people with disabilities provide text, with alphabet both in English and Grade 2 Braille on each accessible room identification, informational and directional sign, and with color and contrast, mounting heights and other features as required to comply with the Americans with Disabilities Act of 1990 Appendix A to Title 28 Code of Federal Regulations Part 36 Accessibility Guidelines for Buildings and Facilities (ADAAG), latest edition.
3. All right-to-know labels, signs and tags shall use National Fire Protection Association (NFPA) 704 "Diamond" hazard identification systems and shall comply with OSHA 1910.1200 and OSHA Subpart Z.
4. All accident prevention signs and tags shall comply with OSHA 1910.145.
5. All health, safety and warning signs shall comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3 and OSHA 1910.144 and 1910.145, unless otherwise specified. The colors shall be those of opaque glossy samples as specified in Table 1 of ANSI Z535.1. Safety symbol pictograms shall be incorporated into each sign, in addition to text.
6. Vehicle Idling Restriction, U.S Code of Federal Regulation 49 CFP Park 395 and the Arizona Department of Transportation (DOT) regulation R17-5-202.

F. Codes: Comply with the current adopted building code.

G. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:

1. ASTM A 167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM E 527, Practice for Numbering Metals and Alloys (UNS).
3. ANSI A13.1 Scheme for the Identification of Piping Systems.
4. ANSI A117.1, Accessible and Usable Buildings and Facilities
5. ANSI Z535.1, Safety Color Code.
6. ANSI Z535.2, Environmental and Facility Safety Signs.
7. ANSI Z535.3, Criteria for Safety Symbols.
8. ANSI Z535.4, Product Safety Signs and Labels.
9. ANSI Z535.5, Accident Prevention Tags (for Temporary Hazards).
10. NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
11. OSHA 1970, Title 29, Code of Federal Regulations Part 1910.1200, Hazard Communication Standard.

12. OSHA 1970, Title 29, Code of Federal Regulations Part 1910, Subpart Z, Toxic and Hazardous Substances.
13. OSHA 1970, Title 29, Code of Federal Regulations Part 1910.144, Safety Color Code for Marking Physical Hazards.
14. OSHA 1970, Title 29, Code of Federal Regulations Part 1910. 145, Specification for Accident Prevention Signs and Tags.
15. Chemical Abstracts Service, CAS Registry Numbers for Specific Chemical Identity.
16. The Aluminum Association, AA SAA-46, Standards for Anodized Architectural Aluminum.
17. 2012 Texas Accessibility Standards

## 1.03 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Each color and finish of exposed materials and accessories required for identification devices
   2. Actual full-size sample of each type of permanent room and space identification sign and informational and directional sign incorporating all features specified; pipeline identification sign and mounting accessories; structure nameplate, valve tags and accessories; and right-to-know signs, labels and tags. Information on the type of coding system will be furnished to CONTRACTOR by OWNER'S REPRESENTATIVE.
   3. Actual full-size representative sample of each individual-type letter and number specified, demonstrating alphabetic style, material, color and finish specified.
   4. Engineer shall review of samples will be for color and texture only. Compliance with all other requirements is the responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Copies of manufacturer's technical data for each product specified including fabrication and erection information for all identification signs. Show anchorages and accessory items. Furnish location template drawings for items supported or anchored to permanent construction.
   3. Complete selection of each specified manufacturer's standard and custom colors, alphabetic styles, graphic layouts and pictograms. Include full-size graphic layouts for plaques, individual dimensional letters and numbers and other items where final

graphic appearance must be established prior to fabrication, incorporating all required graphic features specified or shown on the Drawings.

4. Coordinate mounting position, method, and proposed mounting accessories and fasteners with actual Project conditions. Indicate required mounting accessories on Drawings showing locations of all required exit signs based on measurements taken at the site. Show final location and identify type of mounting surface for each exit sign. Coordinate location of exit signs for noninterference with other work and as required by the OWNER'S REPRESENTATIVE.
5. Comply with the requirements of Section 01332, Shop Drawing Procedures.

## 1.04 OPERATING AND DESIGN REQUIREMENTS

A. General:

1. Accident prevention signs shall conform as to design with OSHA Section 1910.145 of Subpart J, Part 1910, Chapter XVII, Title 29 of the Code of Federal Regulations. Exit signs shall conform with Section 1910.37(g) of the OSHA Safety and Health Standard for General Industry, Article 10, Section 10.113 of the Fire Code of the State of New York, and where applicable with local fire regulations.
2. In addition to the signs identified on the schedule in Part 3 of this section, the following shall be provided:
   a. Exit signs shall be provided in accordance with Section 26 50 00.
   b. "Caution Automatic Equipment May Start at Any Time" signs shall be provided in accordance with paragraph 43.05.11-2.07.
   c. Provide chemical hazard signs and warnings in accordance with OSHA standard 1910.1200

B. Design Requirements:

1. Size:
   a. Sign size shall be as follows:
      1) 14 inch x 20 inch
      2) 10 inch x 14 inch
      3) 7 inch x 10 inch
2. Type:
   a. The sign type shall be as follows:

| Type | Message |
|---|---|
| A | NO SMOKING |
| B | FIRE EXTINGUISHER |
| C | CAUTION – AUTHORIZED PERSONNEL ONLY |
| D-1 | NOTICE – MAXIMUM FLOOR LOAD 350 PSF LIVE LOAD |
| D-2 | NOTICE – MAXIMUM FLOOR LOAD 400 PSF LIVE LOAD |
| E | THINK – SAFETY FIRST |
| F | "ROOM NAMES" |
| G | WARNING - EAR PROTECTION REQUIRED IN THIS AREA |
| H | ACCESSIBLE AREA – NOT USED |
| I | FIRST AID |

| Type | Message |
|---|---|
| J | DANGER-480 VOLTS |
| K | NOTICE – NON-POTABLE WATER – DO NOT DRINK |
| L | DANGER – CONFINED SPACE ENTRY |
| M | As directed by the Owner |
| N | EXIT |

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Sign lettering shall be single stroke and shall contrast in color with the background. For those messages for which there are international symbols, the international symbols shall be used. Chain mounted signs shall have lettering on both sides.

B. Signs shall be 0.100-inch thick fiberglass with embedded fadeproof legends.

### 2.02 SELF LUMINOUS EXIT SIGNS

A. Provide self-luminous exit signs with single and double face dimensions of 8-1/8 inches by 11-7/8 inches by 1-5/8 inches deep. Sign housing shall consist of an AA-A42 color anodized extruded aluminum frame and legend protected by a temper-resistant polycarbonate shield. The size, graphics and background colors of the sign legend shall conform to all relevant code requirements.

B. Lumination for exit signs shall be provided by sealed, replaceable phos-phor-coated tubes containing tritium located directly behind each portion of each letter providing 0.13 to 0.16 foot-lamberts of illumination at time of manufacturer. The tritium light sources shall be housed in a single impact-resistant module.

C. Signs shall be listed by Underwriters Laboratories as being capable of providing a 15-year service life.

D. Provide manufacturer's standard universal mounting brackets, extended wall and ceiling mounting brackets, pendant mounting brackets and recessed mounting brackets as mounting surface and exiting conditions require, or as shown.

E. Product and Manufacturer: Provide one of the following:
   1. Optional Model No. 710A-15 and 710AD-15 Everglo Signs by Self-Powered Lighting Incorporated.
   2. Or approved equal.

### 2.03 ROOM IDENTIFICATION, INFORMATION, ENTRY AND DIRECTIONAL SIGNS

A. Product Description: Provide unframed signs, surface-etched, 1/32-inch raised tactile lettering and pictograms, sandblasted on an opaque 3-ply laminate of self-extinguishing melamine plastic sheet with a non-glare surface and phenolic core.

B. Size and Thickness: 0.125-inches thick; 8-inches by 8-inches with 1/2-inch radiused corners.

C. Exposure: Recommended by the manufacturer for interior and non-direct sun exterior use and acceptable for continuous operating temperatures of 225 degrees F.

D. Graphics and Alphabet: White, Standard Helvetica Medium alphabet and matching arrow type-face; upper and lower case 1-inch high capitals and, in addition, Grade 2 Braille alphabet for room designation, directional, entry and information signs.

E. Colors and Contrast: Background of signs shall be eggshell, matte or other non-glare finish. Characters and symbols shall contrast by at least 70 percent with their background as determined by ADA formula in ADAAG Appendix A4.30.5.

F. Product and Manufacturer: Provide one of the following:
   1. Graphic Blast HC-200 ADA System and Custom Design ADA Series by Best Manufacturing Sign Systems, Incorporated.
   2. Or approved equal.

## 2.04 HEALTH, SAFETY, WARNING, FLOOR LOADING AND FIRE EXTINGUISHER LOCATION SIGNS

A. Product Description: Provide rigid fiberglass reinforced plastic signs with fade-resistant embedded graphics.

B. Size and Thickness: 0.125-inches thick; 10-inches by 14-inches, unless otherwise specified.

C. Graphics and Alphabet: Standard Helvetica Medium alphabet and matching arrow typeface, upper and lower case 1-inch high capitals and, in addition, Grade 2 Braille alphabet message designations and other text.

D. Exposure: Recommended by the manufacturer for both indoor and outdoor use and with an upper service temperature limit of 190 degrees F. Average durability for outdoor use shall be 15 years.

E. Safety Instruction Signs: Standard color of the background shall be white; and the panel, green with white letters. All letters used against the white background shall be black.

F. Caution Signs: Standard color of the background shall be yellow; and the panel, black with yellow letters.

G. Danger Signs: Standard color of the background shall be white; and the panel black with red insert containing white letters. All letters used against the white background shall be black.

H. Warning Signs: Standard color of the background shall be orange; and the panel black with orange insert containing black letters. All letters used against the orange background shall be black.

I. No Smoking Signs: Standard color of the background shall be white. All letters used against the white background shall be red.

J. Biohazard Signs: Standard color of the background shall be white; and the panel black with white letters. Incorporate red international biohazard pictogram on white background.

K. Floor Loading Signs: Standard color of the background shall be white; and the panel blue with white letters. All letters used against the white background shall be black.

L. Fire Extinguisher Location Signs (surface-mounted units only): Standard color of the background shall be red with white letters. Each sign shall incorporate an international fire extinguisher pictogram and a directional arrow indicating location of fire extinguisher.

M. Auxiliary Products:
   1. Mounting Brackets: Provide manufacturer's standard mounting brackets for hanging, projected or double-sided signs.

N. Product and Manufacturer: Provide one of the following:
   1. Graphic Blast Word and Picture Series by Best Manufacturing Sign Systems, Incorporated.
   2. Or approved equal.

## 2.05 PIPELINE IDENTIFICATION SIGNS

A. Pipeline Identification Signs:
   1. Lettering of Titles:
   2. Letter size shall be as indicated in the following table:

| Outside Diameter of Pipe or Covering* | Size of Legend Letters |
|---|---|
| 3/4 inches to 1 1/4 inches | 1/2 inches |
| 1-1/2 inches to 1-7/8 inches | 3/4 inches |
| 2 inches to 5-7/8 inches | 1-1/4 inches |
| 6 inches to 9-7/8 inches | 2-1/2 inches |
| 10 inches and Over | 3-1/2 inches |

**Outside diameter shall include pipe diameter plus insulation and jacketing.*



B. Text and symbols shall be Standard Helvetica Medium, all upper case. Signs shall include text with separate arrow signs indicating direction of flow and be located as specified in Part 3 of this Section.

C. Sign Materials: Provide the following:
   1. Signs shall be coiled construction, polyester with ultraviolet light resistant, sealed, subsurface color graphics, recommended by the manufacturer for both indoor and outdoor use and for service temperature range from -40°F to 248°F.
   2. Provide manufacturer's full selection of standard and custom sizes, colors and graphics. Where manufacturer has established minimum order quantities for custom units provide minimum order quantities at no additional expense to OWNER.
   3. Where large pipe diameters preclude overlap of pipeline sign material, provide Type 304, 1/4-inch wide stainless steel banding straps; two per sign, lengths as required by circumference of pipe or covering. Provide manufacturer's recommended banding tools for stainless steel banding.

D. Product and Manufacturer: Provide one of the following:
   1. Custom B-689 High Performance Pipe Markers by Brady USA, Incorporated Signmark Division.
   2. Or approved equal.

## 2.06 PIPELINE MARKERS

A. General:
   1. Pipelines over 3/4-inch outside diameter: Provide painted pipeline markers.
   2. Each marker shall consist of at least one legend descriptive of the function of the pipe, and a directional arrow.
   3. The size of lettering and marker shall conform to ANSI A13.1.
   4. Location of Markers:
      a. Adjacent to each valve and "T" connection.
      b. At each branch and riser takeoff.
      c. At each pipe passage through a wall, floor and ceiling.
      d. On all horizontal and vertical pipe runs at 25-foot intervals.

## 2.07 VALVE AND PIPELINE TAGS

A. Metal Tags:
   1. For all valves and pipelines smaller than 3/4-inch in diameter provide permanently legible metal tags, 2-inch diameter round, Type 304 stainless steel tags with engraved lettering filled with black enamel. Provide all valve tags with a 3/16-inch diameter hole located so as not to interfere with legend.
   2. Legend for Valve Tags:
      a. Based on information provided on the Drawings, submit to Owner, no less than 150 days before start-up a valve schedule containing all required valves.
      b. The schedule shall contain for each valve, the location, type, a number, and words to identify the valve's function, type of operator and the normal operating position.
      c. Information contained in the valve schedules shall be coded on the tags in a system provided by OWNER. Each valve shall be coded and identified by Owner utilizing a combination of up to twelve letters and numbers.
   3. Miscellaneous Valve and Small Pipeline Tag Accessories:
      a. Stainless Steel Wire: Nylon coated; outside diameter 0.048-inches.
      b. Clamps: Brass.
      c. Lead Seals: Monel; 4 ply, 0.014-inches by 10-inches long; for attaching all tags.
      d. Hand Sealing Press: As recommended by tag manufacturer for crimping lead seals.

B. Product and Manufacturer: Provide one of the following:
   1. Custom Engraved Stainless Steel Valve Tags by Brady USA, Incorporated, Signmark Division.
   2. Or approved equal.

## 2.08 RIGHT-TO-KNOW LABELS, SIGNS AND TAGS

A. Tank Signs:
   1. Provide quantity of signs shown on the Drawings, identifying the chemical, it's hazards, required protective equipment in text and pictograms, first aid for eyes, skin, ingestion and inhalation, information on confined space entry and NFPA 704 required hazard rating system information.
   2. Right-to-know fiberglass signs for storage tanks, (--1--), shall have pressure sensitive adhesive backs and shall be provided with subsurface numbers, symbols, text and legends. Labels shall provide chemical name and chemical abstracts service number, fire and health hazard potential, reactivity, personal protection and target organ legends in compliance with NFPA 704 format and OSHA 1910.1200.

B. Labels: Provide right-to-know polyester labels for each hazardous chemical container. Provide 7-inch by 10-inch labels with information pre-printed by manufacturer. Provide labels with two mil polyester over laminate and with a complete line of all standard and custom pictograms.

C. Tags: Provide right-to-know 15 mil vinyl tags with self-adhering clear polyester over laminate. Tags shall be constructed of laminated plastic and furnished with nylon tie fasteners. Provide 3-inch by 5-3/4-inch tags with two chamfered corners with reinforced 3/16-inch grommet hole.

D. Product and Manufacturer: Provide one of the following:
   1. Custom B-302 Pressure Sensitive Polyester Right-To-Know Labels, B-120 Fiberglass Chemical Tank Signs, Front No. 1/Back No. 1 B-871 Right-To-Know Accident Prevention Tags and Right To Know Pictograms by Brady USA, Incorporated Signmark Division.
   2. Or approved equal.



## 2.09 EXTERIOR BUILDING IDENTIFICATION SIGNS

A. Material: Provide high cast aluminum letters projected mounting.

B. Size: 8-inch high regular depth.

C. Lettering Style: Futura, matching existing building signage on site.

D. Finish: Architectural Class I anodic coating in 0.70-mil thickness, color to match existing building signage on site.

E. Fasteners: Concealed.

F. Product and Manufacturer: Provide one of the following:
   1. Eder Metal Letter Co., Milwaukee, WI.
   2. Spanjer Brothers, Inc., Chicago, IL.
   3. Andco Industries Corp., Greensboro, NC.
   4. Or approved equal.

## 2.10 AUXILIARY MATERIALS

A. Very-High-Bond High-Performance Bonding Tape:
   1. Provide all surface-mounted identification devices with very-high-bond foam tape backing except where specifically specified as requiring mechanical fasteners.
   2. Provide a very-high-bonding pressure sensitive joining system consisting of double-coated conformable acrylic foam tape and release liners:
   3. Thickness: 0.045-inch.
   4. Tape Width: 1-1/2-inches.
   5. Color: Dark grey.
   6. Bonding Adhesive: Acrylic; very-high-bond, solvent and shear resistance.
   7. Primer: High-performance tape manufacturer's recommended acrylic primer.
   8. Product and Manufacturer: Provide one of the following:
      a. Scotch Brand (Very-High-Bond) 4942 VHB Double Coated Acrylic Foam Tape and No. 94 Acrylic Primer by 3M Industrial Tape and Specialties Division.
      b. Or equal.

B. Mounting Brackets: Provide manufacturer's standard mounting brackets for hanging, projected or double-sided signs.
   1. Furnish inserts, and mechanical and adhesive anchoring devices as specified for the installation of identification signs.

C. Fasteners: Provide fasteners of non-magnetic stainless steel of size and type required and recommended by individual identification sign manufacturers.

D. Anchors and Inserts: Use stainless steel anchors and inserts. Use toothed stainless steel bolts for drilled-in-place anchors.



## 2.11 FABRICATION

A. Shop Assembly:
   1. Fabricate and preassemble items in the shop to the greatest extent possible.
   2. Disassemble units only to the extent necessary for shipping and handling limitations.
   3. Clearly mark units for reassembly and coordinated installation.

# PART 3 EXECUTION

## 3.01 GENERAL

A. Signs shall be distributed as follows:

| Process Area | Location | Quantity | Size | Message | Mount |
|---|---|---|---|---|---|
| Fog Building | General | 10 | 14 x 10 | M | To be determined |
| | Exterior Building Signage | 1 | Coordinate with Owner | M | Wall |
| | Exit Signs/Fire Extinguishers | 2 of each type | 14 x 10 | B,N | Wall |
| | First Aid Cabinets | 1 | 8 x 6 | I | Wall |

| Process Area | Location | Quantity | Size | Message | Mount |
|---|---|---|---|---|---|
| | Fog Screening and Pump Room 101 | 2 | 8 x 6 | F | Wall; Adjacent to doors 101A/101B |
| | Fog Screening and Pump Room 101 | 1 of each type | 14 x 10 | C, E | Wall |
| | Fog Screening and Pump Room 101 | 1 | 8 x 6 | D-2 | Wall |
| | Electrical Room 102 | 1 | 8 x 6 | F | Wall; Adjacent to doors 102A |
| | Electrical Room 102 | 1 of each type | 14 x 10 | C,E,B | Wall |
| | Electrical Room 102 | 1 | 8 x 6 | D-1 | Wall |

## 3.02 INSPECTION

A. Examine the substrates and conditions under which the identification signs are to be installed and notify Owner, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Owner.

## 3.03 INSTALLATION

A. General:
   1. Install identification signs and components at the locations shown on the Drawings or, if not shown, as directed by Owner; securely mounted with concealed very high-bond acrylic foam tape or mechanical/chemical fasteners where specified. Attach signs to surfaces in accordance with the manufacturer's instructions, unless otherwise shown on the Drawings.
   2. Mount exit signs in locations shown on the Drawings. Surface mount signs above all exit doors, unless otherwise shown on the Drawings.
   3. Lightly mark and locate the position of all identification devices. Obtain Owner's approval of all locations before mounting. Install level, plumb, and at the proper height. Repair or replace damaged units as directed by Owner.
   4. Install very-high-bond acrylic foam tape on back of identification devices using a full perimeter of specified tape. Leave no gaps in tape perimeter at back of identification devices, peel off second release liner and press onto surfaces.
   5. Install level, plumb, and at the specified height.
   6. The exterior "No Trespassing" signs may need to be mounted on stucco surface or masonry walls with screw fasteners as directed by Owner. Also, signs needing to be attached to wire cyclone fencing shall be as directed by Owner.

B. Room Identification, Directional and Information Signs:
   1. Where permanent identification is provided for rooms and spaces, install signs on the wall adjacent to the latch side of the door.
   2. Where there is no wall space on the latch side of the door, including at double leaf doors, install signs on the nearest adjacent wall.
   3. Mounting height shall be 5 feet-0 inches above the finish floor to the center-line of the sign. Mount such signage so that a person may approach within 3-inches of the sign without encountering protruding objects or, when reading sign, be forced to stand within the swing of a door.

C. Pipe Identification Signs and Tags:
   1. The name of the materials in each pipeline and, alongside this, an arrow indicating the direction of flow of fluids, shall be indicated on each pipeline system.
   2. Titles shall not be located more than 25 linear feet apart and shall also appear directly adjacent to each side of all walls penetrated by pipeline, adjacent to each side of all valve regulators, flowcheck, strainer cleanouts, and all pieces of equipment. Arrows shall be located at intervals not to exceed 15 linear feet apart.
   3. Titles shall identify contents by complete name. Identification title locations shall be determined by Owner, but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering when they are overhead. Title shall be clearly visible from operating positions especially those adjacent to control valves.
   4. Locate nameplates on equipment bases and on structures at readily visible levels in such positions relative to the equipment and structures as to prevent damage to the nameplate.

D. Right-To-Know Signs, Labels and Tags:
   1. Locate tags at 20 feet maximum center-to-center distance along chemical pipelines and fill pipelines and on each side of all locations where pipes emerge from penetrations with other materials.
   2. Install tank signs on all tanks shown to receive signage at quarter-points on tank circumference, 5 foot-0 inches above finished floor.

## 3.04 PROTECTION AND CLEANING

A. After installation, clean soiled identification device surfaces according to manufacturer's instructions. Protect units from damage until Final Acceptance by Owner.

**END OF SECTION**

SECTION 10 43 16

FIRST AID CABINETS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope
   1. This Section specifies first aid cabinets.
   2. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all first aid equipment.
   3. Extent of the first aid equipment is specified.
   4. Types of products required include the following
      a. First aid station.
      b. Miscellaneous mounting brackets, accessories, fasteners.

### 1.02 QUALITY ASSURANCE

A. Reference Codes and Standards
   1. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there was no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. In all cases, the effective version of the Connecticut Building Code at the time of Advertisement for Bids or Invitation to Bid shall be considered the building code in effect.

| Reference | Title |
|---|---|
| 1910.266 App A | Occupational Safety and Health Act of 1970. First-Aid Kits (Mandatory) |

B. Quality Source Control
   1. Furnish as complete first aid equipment produced by one supplier, including hardware, accessory items, mounting brackets, and fastenings.
   2. Furnish all equipment by one supplier unless otherwise accepted by Engineer.

## 1.03 ENVIRONMENTAL CONDITIONS

A. Equipment in this Section shall be subjected to environmental conditions in accordance with Section 01 11 80 Environmental Conditions.

## 1.04 SUBMITTALS

A. Preconstruction/Action Submittals: The following minimum submittals shall be submitted prior to construction of this element of the Work in accordance with Section 01 33 00 Submittals.

1. A copy of this Section, with addendum updates included, and all referenced and applicable Sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from Specification requirements or those parts which are to be provided by the Contractor or others shall be provided. Check marks (✓) shall denote full compliance with a paragraph as a whole.

   If deviations from the Specifications are indicated, and therefore requested, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations.

   The remaining portions of the paragraph not underlined shall signify compliance with the Specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the requirements of the Specification shall be cause for rejection of the entire submittal and no further submittal material will be reviewed.

2. Shop Drawings.



# PART 2 PRODUCTS

## 2.01 ACCEPTABLE PRODUCTS

A. Suppliers

1. The Engineer believes that the Suppliers indicated in this Section are capable of producing equipment and products, which will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular Supplier or product, nor shall it be construed that a named Supplier's standard product will comply with the requirements of this Section.

B. Supplier Qualifications

1. The Supplier shall have five (5) years of experience manufacturing and installing first aid cabinets in similar-sized projects.

## 2.02 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose. If alternatives are proposed, the proposals shall be accompanied with documentation supporting the claimed superiority of the proposed substitutions. The Engineer shall be the sole decider in the equivalency of alternative materials of construction.

B. Industrial First Aid Kit: Provide the following:
   1. Quantity: one unit.
   2. Description: Each unit shall consist of a balanced assortment of first aid supplies adequate to administer first aid for up to 50 people. Provide 24 gage steel, weatherproof, dustproof, rust resistant case with rounded corners with carrying handle and wall brackets.
   3. Product and Supplier: Provide the following:
      a. Industrial First Aid Kit Number 50 by Johnson & Johnson Incorporated.
      b. 36 Unit by Figgie International Incorporated, Fire Protection/Safety Group, Scott Aviation Division.
      c. #50 Person Original Safety First Aid Kit by Northern Safety Company, Incorporated.
      d. Or Approved Equal.



# PART 3 EXECUTION

## 3.01 SHIPMENT AND STORAGE

A. Supplier shall provide Contractor with detailed recommendations and instructions for product storage.

## 3.02 SUPPLIER'S FIELD SERVICES

A. Supplier shall provide field services as further required within this Section.

## 3.03 INSTALLATION

A. The Supplier shall provide the Contractor with detailed recommendations and instructions for installation of the product specified in this Section.

B. Product shall be installed at the locations as directed by Engineer and in accordance with the recommendations of the Supplier.

C. Inspection
   1. Contractor shall examine the substrates and conditions under which the first aid equipment is to be installed and notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

D. Install first aid equipment as specified and in accordance with the Supplier's instructions. Position units plumb and true, securely anchored in place with proper clips, brackets and bolts for the type of mounting required. Location as directed by Engineer.

**END OF SECTION**

SECTION 10 44 16

FIRE EXTINGUISHERS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Scope:
   1. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all fire protection specialties Work.
   2. Extent of fire protection specialties Work is shown and specified.
   3. Types of fire protection specialties Work required includes:
      a. Dry chemical extinguishers.
      b. Carbon dioxide extinguishers.
      c. Mounting accessories and miscellaneous fasteners.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items that must be installed with or before fire protection specialties.

C. Related Work:
   1. Section 10 14 00 Signage.



### 1.02 REFERENCES

A. The references listed below are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. The references listed below indicate those documents in effect at the time of Advertisement for Bids, Invitation to Bid, or on the effective date of the Agreement if there were no Bids. Where documents are referenced in applicable local, state, or federal codes, use the version reference by date in the individual code. If referenced documents are not specifically identified in the applicable code(s), reference to those documents shall indicate the latest version of the documents available at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, reference to those documents shall mean the latest version of replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. When document dates are given in the following listing that are not specifically referenced in an applicable code, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. For questions, refer to Engineer.

| Reference | Title |
|---|---|
| ASTM E814 | Test Method for Fire Tests of Penetration Fire Systems |
| FM Global | FM Approval Guide |
| NFPA 10 | Portable Fire Extinguishers |
| UL | Portable Fire Extinguishers |
| ADA | Americans with Disabilities Act |
| ABA | Accessibility Guidelines for Buildings and Facilities |

## 1.03 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Provide fire protection specialties products from one manufacturer.

B. Certifications: Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide fire extinguishers approved, listed, and labeled by FM Global.
   2. Provide fire extinguishers approved, listed, and labeled to comply with ASTM E814.

C. Regulatory Requirements:
   1. Provide fire protection specialties approved and labeled by UL.
   2. Provide fire protection specialties conforming to NFPA 10 requirements.
   3. Provide fire protection specialties conforming to ADA-ABA Accessibility Guidelines.



## 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00.

B. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Product Data: Submit the following:
      a. Manufacturer's technical data, certification of UL rating, and installation instructions for fire protection specialties.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.
   2. Warranty: Sample of special warranty.

## 1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Substantial Completion.



# PART 2 PRODUCTS

## 2.01 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. General: Provide manufacturer's standard mounting brackets for portable fire extinguishers size as specified.

B. Multi-Purpose Dry Chemical Fire Extinguishers:
   1. Ten-pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, Class C fires. UL rating 4A-60 B:C.
   2. Products and Manufacturers: Provide one of the following:
      a. Cosmic Model 10E by J.L. Industries, a division of Activar Construction Products Group.
      b. MP 10 Series by Larsen's Manufacturing Company.
      c. or approved equal.

C. Carbon Dioxide Fire Extinguishers:
   1. Ten-pound enameled steel container capacity, for Class B and Class C fires UL rating.
   2. Product and Manufacturer: Provide one of the following:
      a. Sentinel Model 10 by J.L. Industries, a division of Activar Construction Products Group.
      b. CD 10 Series by Larsen's Manufacturing Company.
      c. or approved equal.

D. Identification: Refer to Section 10 14 00 Signage.

# PART 3 EXECUTION

## 3.01 INSPECTION

A. Examine substrates and conditions under which fire protection specialties will be installed and notify Engineer in writing of conditions detrimental to proper and timely

completion of the Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to the Engineer.

## 3.02 INSTALLATION OF FIRE EXTINGUISHERS

A. When exact locations of fire protection specialties are not shown on Drawings, locate as directed by Engineer.

B. Securely fasten products to structure, square and plumb, per Supplier's instructions. Mounting heights shall be:
   1. Install fire extinguishers to meet ADA/ABA requirements.
   2. Install fire extinguishers with gross weight greater than 40 pounds with top of fire extinguisher no more than 3.5 feet above finished floor.
   3. Install fire extinguishers with gross weight less than 40 pounds with top of fire extinguisher no more than 4.0 feet above finished floor.
   4. Clearance between bottom of fire extinguisher and finished floor shall be at least four inches.

C. Identification Devices: Refer to Section 10 14 00 Signage.

D. Recharge fire extinguishers provided under this Contract so that most recent inspection date coincides as nearly as possible with date of Substantial Completion. Inform CITY in writing of next required inspection and recharging date.

## 3.03 FIRE EXTINGUISHER SCHEDULE

A. Multi-Purpose Dry chemical, wall mounted.

B. Carbon Dioxide, wall mounted.



**END OF SECTION**

# DIVISION 23

# HEATING, VENTILATING, AND AIR CONDITIONING

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SECTION 23 00 00

HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) BASIC REQUIREMENTS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope: This Section specifies the general requirements for all of the HVAC materials, labor, tools, permits, incidentals, and other services included in Division 23 and elsewhere wherever specifically mentioned in the Specifications.
   1. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.
   2. Ductwork and Accessories shall be per Section 23 30 00.

B. Environmental Conditions: Refer to 2021 ASHRAE Design Conditions for the New Haven Harbor, CT.

C. Fasteners: unless indicated otherwise.
   1. Bolts - ASTM A193, grade B8M Class 1 or ASTM A320 B8M Class 1
   2. Nuts – ASTM A194, grade 8M
   3. Washer – 316 SS

D. Governing Standards:
   1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance the more stringent requirements shall govern.
   2. All work shall comply with UL safety requirements.

E. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

F. Coordinate with other trades (e.g., Plumbing, Fire Protection, Structural) for routing of equipment and connection points

G. Power Supply:
   1. Power supply to equipment with motors shall be as indicated by manufacturer. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

H. Metal Thickness:
   1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

## 1.02 DEFINITIONS

A. Terminology used in this specification conforms to the following definitions:
   1. Authorities Having Jurisdiction: Indicates reviewing authorities, including local building official, local fire marshal, Owner, and other reviewing entity whose approval is required to obtain system acceptance.
   2. ACH: Air changes per hour.
   3. SCFM: Standard cubic feet per minute.
   4. ACFM: Actual cubic feet per minute
   5. Ft^2: Square foot.
   6. TAB: Testing and Balancing.

## 1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00.
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and therefore requested by the Manufacturer, underline each deviation and denote by a number in the margin to the right of the identified paragraph. Provide a detailed, written justification for each deviation. The Owner Representatives shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for requested deviations with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration

B. Action Submittal Items for this Section:
   1. A copy specification section, with addendum updates included and each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   2. If the specification includes the submittal item, revise the text of the submittal item to conform to the phrasing listed in the specifications.
   3. Manufacturer's data including materials of construction, construction details of equipment, wiring diagrams, weight of equipment, mounting, seismic bracing, and support.
   4. Drawings showing general dimensions and confirming the size of equipment, fixtures, motors and drives, and piping connections. (Shop drawings)
   5. Performance curves for pumps and fans developed for the specific application. Performance curves shall show speed, capacity, pressure, and power for specified conditions.
   6. Shop and field painting systems. Include manufacturer's descriptive technical catalog literature and specifications.
   7. Shop Drawings including the physical characteristics of all systems, equipment, and piping layout plans, and control wiring diagrams.
   8. Operation and Maintenance Information: Section 01 78 23.

9. Samples, where required by the specification section.
10. Rigid Equipment Mount Installation Checklist and installation forms in accordance with Section 43 05 13.
11. See Division 23 specifications sections for additional requirements.
12. Certificates of Unit Responsibility.
13. Sound Power rating for both fan inlet and outlets at rated capacity.
14. Installation forms in accordance with Section 43 05 13.
15. Testing and Commissioning forms in accordance with Section 23 05 93.

C. Informational Submittal for this Section:
   1. Structural Design and Anchorage: Section 01 73 24.

D. Operations and Maintenance Data and Manuals:
   1. Adequate operation and maintenance information shall be supplied as required in the Submittals section and Equipment Operating and Maintenance
   2. Manual Information section: Operation and maintenance manuals shall be submitted in accordance with the Submittals section and Equipment Operating and Maintenance Manual Information section.

E. Drawings and Data:
   1. The data and specifications for each unit shall include, but shall not be limited to, the following:
      a. Makeup Air Units
         1) Name of manufacturer.
         2) Type and model.
         3) Construction materials, thickness, and finishes.
         4) Input and output heating capacities.
         5) Filter velocities.
         6) Overall dimensions and required clearances.
         7) Net weight and load distribution.
         8) Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in SCFM as the abscissa and brake horsepower, total static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 5 different rotational speeds on a single chart.
         9) Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.
         10) Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.
         11) Electrical requirements including voltage, number of phases, and amperage.
         12) Where specified, information on equipment manufacturers' representatives.
      b. Fans:
         1) Name of manufacturer.

2) Type and model.
3) Construction materials, thickness, and finishes.
4) Overall dimensions and required clearances.
5) Net weight and load distribution.
6) Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in SCFM as the abscissa and brake horsepower, total static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.
7) Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.
8) Where specified, information on equipment manufacturers' representatives.

c. Equipment (all other types):
1) Name of manufacturer.
2) Type and model.
3) Construction materials, thickness, and finishes.
4) Manufacturer's performance data.
5) Overall dimensions and required clearances.
6) Net weight and load distribution.
7) Wiring diagrams.

d. Ductwork:
1) Duct fabrication drawings indicating dimensions of individual shop and field fabricated sections, top and/or bottom duct elevations, joint locations, and dimensions of duct from walls or column rows.
2) Pressure and seal classifications.
3) Reinforcement types and spacing.
4) Joint and seam types.
5) Hanger and support types, spacing, and attachment methods.
6) Access panel and door construction, sizes, and locations.
7) Duct sealant, adhesive, gasket, and tape information.
8) Product data for adhesives and sealants shall include VOC content.
9) Coatings.
10) Ductwork materials and thicknesses.
11) Coils
12) Product data demonstrating compliance with ASHRAE 90.1
13) Ductwork leakage test report.

e. Temperature controls:
1) Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the Drawings.

2) Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring with all terminals accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

3) Sequence of operation for each system corresponding to the control schematics.

4) Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.

5) Space thermostat schedule indicating the types of covers and means of adjustment for each space.

6) Conduit and wire types.

7) Where specified, information on equipment manufacturers' representatives.

f. Seismic Design Requirements:

1) Confirmation of compliance with the requirements of the Special Provisions section.

g. Operation and Maintenance Data and Manuals:

1) Adequate operation and maintenance information shall be supplied as required in Section 01 78 23 and Section 01 33 00. Operation and maintenance manuals shall be submitted in accordance with Section 01 33 00. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.



## 1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the rules and regulations of Authorities Having Jurisdiction over the work specified herein, including all adopted state and local building codes including plumbing, mechanical, fire, building, and electrical.

B. Welding Qualifications:

1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS or ASME Standard Qualification Procedures.
2. All procedure and operator qualifications shall be in written form and subject to Engineer review.
3. Accurate records of operator and procedure qualifications shall be maintained by Supplier and made available to Engineer upon request.
4. The mechanical system installer shall be licensed as stipulated by the authority having jurisdiction.

C. Manufacturers Experience: Unless the equipment manufacturer is specifically named in this Section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

D. Reference Standards:

1. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

| Reference | Title |
|---|---|
| AABC | Associated Air Balance Council, National Standards for Total System Balance |
| ADA | Americans with Disabilities Act |
| AHRI | Air-Conditioning Heating & Refrigeration Institute |
| AMCA | Air Movement and Control Association |
| ANSI | American National Standards Institute |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASPE | American Society of Plumbing Engineers |
| ASSE | American Society of Sanitary Engineering |
| ASTM | ASTM International |
| AWWA | American Water Works Association |
| CISPI | Cast Iron Soil Pipe Institute |
| CSA | CSA International |
| ETL | Electrical Testing Laboratories |
| EPA | Environmental Protection Agency |
| FDA | Food & Drug Administration |
| FM | Factory Mutual Global |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| HI | Hydraulic Institute Standards |
| ISO | International Organization for Standardization |
| MSS | Manufacturers Standardization Society |
| NEBB | National Environmental Balancing Bureau, Procedural Standards for Testing Adjusting and Balancing of Environmental Systems |
| NEMA | National Electrical Manufacturers Association |
| NFPA | National Fire Protection Association |
| NSF | National Sanitation Foundation |
| OSHA | Occupational Safety and Health Administration |
| SMACNA | Sheet Metal and Air Conditioning Contractors' National Association, Inc. |
| UL | Underwriters Laboratories Inc. |
| IBC | International Building Code |
| IFC | International Fire Code |
| IMC | International Mechanical Code |

| Reference | Title |
|---|---|
| IPC | International Plumbing Code |
| UPC | Uniform Plumbing Code |

E. Unit Responsibility:

1. The Supplier shall furnish and install equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Supplier of his responsibility to the Owner's Representative and Owner for performance of all systems in the contracted scope of supply.
2. The Supplier shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Supplier to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 43 05 11-C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.
3. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Section 01 33 00 - Submittal Procedures. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable.

F. Manufacturer’s Instructions:

1. Follow manufacturer's written instructions.
2. If in conflict with Construction Documents, obtain clarification.
3. Notify the Owner’s Representative in writing before starting work.

G. Drawings:
   1. The Drawings shall be taken as diagrammatic, unless otherwise noted.
   2. Size of ductwork and pipes and general method of running them are shown, but it is not intended to show every offset and fitting nor every structural difficulty that may be encountered.

## 1.05 DELIVERY, STORAGE AND HANDLING

A. Shipping, handling and storage shall be in accordance with the Delivery, Storage, and Handling section.

## 1.06 COORDINATION

A. Supplier shall verify that each component of the HVAC system is compatible with all other parts of the system; that all piping, ductwork, equipment, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

B. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

C. Each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply.

D. Information on equipment manufacturers' representatives shall be included with the submittals.

E. The equipment as shown on the plans and specified herein, is based on the equipment furnished by one manufacturer. An equipment which is offered as a substitute to the specific requirements of these Specifications and which differs in detail and arrangement from that shown may require changes in design and construction. All costs which result from such changes in design and construction are to be borne entirely and unconditionally by the Contractor and/or the manufacturer; said costs to include but not be limited to structural, piping, mechanical and electrical changes and all engineering costs incurred as a result of the substitution, in the revision of Plans and Specifications, review of design changes by others, preparation of change orders, and any other costs directly resulting from said substitution.

## 1.07 APPURTENANCES

A. Furnish and install all necessary guides, inserts, anchors and assembly bolts, washers and nuts, hangers, supports, gaskets, couplings, and flanges; and all other appurtenant items shown on the Drawings, specified, or required for the proper installation and operation of the piping; devices included in or on the piping equipment; and piping accessories.

## PART 2 PRODUCTS

### 2.01 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

### 2.02 MANUFACTURERS AND FABRICATION

A. Provide like items from one manufacturer, including but not limited to: fans, air handlers, air conditioning units, heat pump units, heaters, vibration isolation devices, etc.

B. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

C. Anchor Bolts and Expansion Anchors: Section 05 05 20.

1. Anchor bolts, expansion anchors, nuts, and washers shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 20. Unless otherwise stated in the individual equipment specifications, anchor bolt, washer and nut materials shall conform to the requirements above with the provisions of Section 05 05 20 unless otherwise indicated on the Drawings.



### 2.03 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

### 2.04 PERFORMANCE REQUIREMENTS

A. See Section 43 05 11.

B. All air moving equipment fans shall be sized such that the correct SFCM is the output ACFM at the hottest, most humid condition with enough horsepower for the coldest inlet temperature. All controls shall have a temperature reset based on the outside temperature adjusting for the proper SCFM or ACH.

C. Coordination:

1. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
2. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Owner’s Representative, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.
3. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

4. The independent TAB agency shall be contracted prior to construction to do “balancability reports”. The TAB agency shall perform periodic site walk throughs to identify items prior to testing. These include but are not limited to finding located or missing dampers and valves, variable air volume (VAV) box sizing, piping issues, duct sealing, and issues with building pressures.
5. Prior to official cleaning, testing, adjusting, and balancing, the mechanical Contractor shall pre-test each section prior to any air balance agency testing, Inspector witnessing, mechanical Engineer witnessing, duct insulation installation, duct shafts are closed up, or any other structural construction that will have an impact is continued. Return air ducts and exhaust may be tested with positive pressure.
6. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.
7. Mechanical Contractor is responsible for coordinating with the project air balance agency.
8. For additional TABB coordination requirements consult Division 23 and the following Specifications:
    a. Testing Adjusting and Balancing for HVAC: Specification 23 05 93.
    b. Sheetmetal Ductwork and Accessories: Section 23 30 00.
    c. Other ductwork as required
9. Air systems shall be complete and operating with dampers, filters, ductwork, air outlet and inlet devices, duct-mounted equipment, and control components.

D. General Equipment Stipulations:
    1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the Special Provisions section, the requirements specified herein shall take precedence.
    2. Unless otherwise noted, all equipment handling air shall meet the duct seal and leakage classes per 23 30 00. Manufacturer shall provide test data confirming cabinet construction can meet the requirement

E. Seismic Design Requirements: Seismic design requirements for products specified herein shall be as indicated in the Section 01 73 24.

F. Design Criteria:
    1. Design of HVAC equipment shall be based on the atmospheric conditions at the project site. Temperature, humidity, prevailing wind speed and direction, elevation, corrosive or contaminated environments, and human comfort shall be considered, as applicable.
    2. Equipment sizing shall be based on Environmental Conditions: Refer to 2021 ASHRAE Design Conditions for the New Haven Harbor, CT.

G. Dimensional Restrictions:
    1. Layout dimensions will vary between manufacturers. At least 3 feet of clear access space shall be provided on all sides of the unit
    2. Equipment shall be designed to operate at the elevation indicated in the 2021 ASHRAE Design Conditions for the Rochester International Airport. All equipment

furnished for sites above 2000 feet above sea level shall be properly derated to operate and meet the specified capacities at the site conditions.

H. Type, Performance, Characteristics, Arrangement, Accessories: As noted in the Division 23 specification sections.

I. Fans and Shafts:
   1. Statically and dynamically balanced per AMCA 204 fan application category BV-3 (ISO 1940 Grade 6.3) or better and designed for continuous operation at maximum rated fan speed and motor horsepower.
   2. Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve to the left of the peak pressure/efficiency point.
   3. For additional requirements see Sections 23 34 13.13, and 23 34 13.16.

J. Electric Motor General Requirements:
   1. Designed for continuous operation in 40°C environment.
   2. For temperature rise in accordance with NEMA MG-1 limits for insulation class, service factor, and motor enclosure type.
   3. Type specified, scheduled, or noted for respective units.
   4. The use of ECM motors on HVAC equipment, up to 10 HP is acceptable with engineering concurrence. Coordinate with Engineer

K. Provide ductwork and equipment supports, hangers, guides, and anchors as specified herein.

L. When standard hangers, supports, and accessories are not adequate the Contractor shall employ a registered Structural Engineer, registered in the state where the work is to be installed, to prepare design calculations for all such supports, hangers, and accessories for seismic restraint needed for the ductwork and equipment installation. Calculations and shop drawings shall be signed by the above-named Engineer and submitted to the Owner's Representative.

M. Special Features for Hazardous Environments:
   1. Provide for particular units when noted or scheduled on Drawings, spark proof fan wheels and explosion proof motors.



## 2.05 MATERIALS

A. Base contract upon furnishing materials as specified.

B. Materials, equipment, and fixtures used for construction are to be new, latest products as listed in manufacturer's printed catalog data and are to be UL, ETL, or CSA approved, or have adequate approval or be acceptable the Authorities Having Jurisdiction.

C. Articles, fixtures, and equipment of a kind to be standard product of one manufacturer.

D. Gas piping shall be A53 Grade B seamless or A106 Grade B.

## 2.06 COATINGS

A. Surface Preparation:
   1. All fabricated surfaces from ferrous metal, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations.
   2. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

B. Coatings shall be electrostatically coated (e-coat) and uniformly applied. The electro-coat process shall ensure complete encapsulation of all conductive surfaces with uniform dry film thickness. After e-coat cure, equipment shall receive a spray-applied, polyurethane black topcoat to prevent UV degradation of epoxy e-coat film. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

C. Submit product data on the type coating selected, the coating thickness, the application process used to meet the requirements below and verification of conformance with the salt spray test requirement.
   1. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer.

D. Coils/HX exposed to ambient
   1. No material bridging is allowed, including enhanced and micro-channel fin designs
   2. Submit the estimated heat transfer loss of the coil. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation

**E-Coating Requirements**

| Coating Quality | Test Procedure | Coating Performance (Nominal plus) |
|---|---|---|
| Dry Film Thickness | ASTM D7091 | 1 mil |
| Water Immersion | ASTM D870 | 1000 hrs |
| Cross Hatch Adhesion | ASTM B3359 | 4B-5B Rating |
| Salt Spray | ASTM B117<br>ASTM B117-G85 | 6000 hrs<br>2000 hrs |
| Heat Transfer Reduction (Coils Only) | AHRI 410 | <1% |
| Humidity | ASTM D1735 | 1000 |
| Operating pH Range | N/A | 3-12 |
| Temperature | | -40 F to 300 F (Coils Only) |
| Weathering (topcoat) | ASTM 4587 | 2200 |



## 2.07 COLOR

A. Equipment shall have the manufacturer's standard color unless otherwise indicated in the schedules or specifications.

B. Equipment may use the manufacturer's finish if it meets the criteria above or otherwise indicated in the schedules or individual specifications.

## 2.08 ELECTRICAL

A. Electrical controls and disconnects shall be furnished and installed under the Electrical section, except where specified herein.

B. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings.

## 2.09 PIPING ACCESSORIES

A. General: Final pressure gauge and thermometer ranges shall be between 1.1 and 1.3 times the system operating conditions. Shut off if testing pressure exceeds the gauge range during testing.

B. Thermometers:
   1. Thermometers shall conform to ASTM E1. Mercury shall not be used in thermometers.
   2. Thermometers shall be Weksler Instruments "Adjust Angle", Ashcroft "Series EI Everyangle" or Weiss Instruments, Inc. "Vari-angle".
   3. Thermometers shall be bimetal type and shall have a dial at least 4 1/2-inch diameter, with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless-steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.
   4. Each indicator shall be furnished with an angularly adjustable frame for convenient viewing. Unless otherwise indicated, thermometer range shall be 0 to 200°F.
   5. Each thermometer shall be furnished with a stainless steel thermowell for installation in the piping systems. The thermowells shall have ¾-inch NPT thread mounts, a minimum pressure rating of 250 psig, and a nominal 4-inch insertion length.

C. Pressure Gauges:
   1. Pressure gauges shall be Ashcroft "Duragauge 1279", Weksler, or Weiss Instruments, Inc.
   2. Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1 and ASME B40.100. Accuracy shall be ANSI Grade A or better.
   3. Gauges shall be indicating dial type with C type phosphor bronze Bourdon tube, stainless steel rotary geared movement, phenolic open-front turret, stainless steel or phenolic ring, case, adjustable pointer, and acrylic or shatterproof glass window.
   4. The dial shall be 4 1/2 inch in diameter with black markings on a white background. The units of measurement shall be psi and shall be indicated on the dial face. The pointer shall span not less than 200 degrees nor more than 270 degrees. The range shall be selected so that the normal operating reading is near the midpoint of the scale.
   5. Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in the Ball Valves section.
   6. All stem-mounted gauges shall be provided with 1/2 inch NPT connections.

D. Diaphragm Seals:
   1. Pipe-mounted diaphragm seals shall be provided where indicated on the Drawings.
   2. Diaphragm seals shall be thread-attached type with cleanout ANSI Type 316 stainless steel diaphragm, plated carbon steel upper housing, and stainless steel lower housing.
   3. The diaphragm seal shall be of "continuous" design to safely contain the process fluid in the event of gauge failure or removal from the system under pressure.
   4. The lower housing shall be provided with a tapped ¼ inch [6.3 mm] NPT flushing connection and an MxF stainless steel needle valve.
   5. Each gauge isolator and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.
   6. Gauge isolators shall be as manufactured by Ashcroft "Type 101", Weksler, or Weiss Instruments, Inc.

## 2.10 ACCESS PANELS/DOORS

A. General: Provide flush mounting access panels as required for service of valves, drains, and test connections and other Item requiring maintenance or inspection. Where access panels are located in fire-rated assemblies of building, rate access panels accordingly. Ceiling access panels to be minimum 24-inch x 24-inch or required and approved size. Wall access panels to be minimum 12-inch x 12-inch or required and approved size. Babcock-Davis Series BN (non-rated), BI series (rated) or equal. All panels/doors shall incorporate doors/access panels with air seals suitable to provide airtight seal shall be provided between door and frame. The door swing shall be such as to open against system pressures.



## 2.11 AIR FILTRATION

A. General: Air filters in air handlers shall be 2-inch thick, MERV 8, pleated, disposable filters unless noted otherwise in Division 23 sections.

## 2.12 ROOF CURBS: FOR ROOF MOUNTED FANS AND AIR CONDITIONER UNITS

A. Each unit shall be provided with a prefabricated mounting curb.

B. AHRI Guideline B except as modified below
   1. 1997 version Table 1
      a. Up to 24" width shall be 16" above roof surface
      b. 49" to 60" Width shall be 30"
      c. See details in guide

C. Comply with local code requirements for minimum curb height, but in no case shall curb height be less than 16 inches, as measured from top of bar joist to top of curb, nor shall curb height be less than 8 inches as measured from top of roof membrane to top of curb. Roof curb to be manufactured of prime galvanized steel construction, 14 gauge as required, meeting ASTM A653/653M, with fully welded corners and with seams joined by continuous water and air tight welds. Roof curb shall be internally reinforced with angles 48" on center and factory installed wood nailer. Top of all roof curbs shall be level, with pitch built into curb when deck slopes. 2 inch by 4 inch (nominal dimension) pressure treated continuous wood nailers mechanically fastened with corrosion resistant fasteners at 12 inches on center to exterior face of curb. Shop prime welded connections with zinc-rich paint complying with SSPC-Paint 20. Label curbs with "INTAKE" designating to align with the intake of the equipment. Fans shall be labeled “FRONT” to designate where the equipment nameplate coincides. Frame duct openings with 18 gauge curb sections level with perimeter curb sections, minimum height 18"

D. The outer shell of the curb shall be formed with an integral cant strip and mounting flange. The bottom of the curb shall have a baseplate which encloses the lower edge of the roof insulation. A damper holding tray shall be provided. Provide curb for flat, pitched or ridged roof as required.

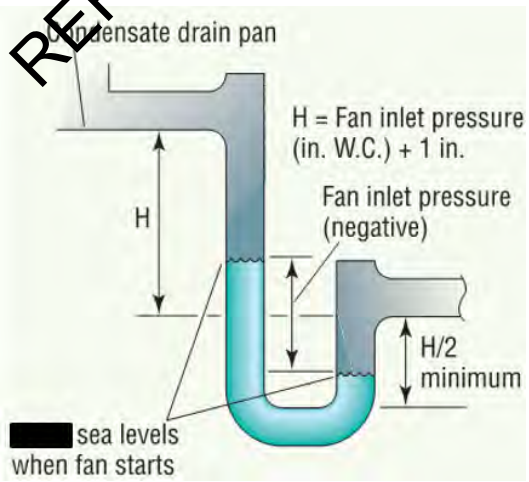
E. Insulate interior of the curb with 2 inches of 1.5 lb/cu ft neoprene-coated fiberglass insulation.

F. Provide seismic restraints to secure the unit to the curb in accordance with Section 01 73 24.

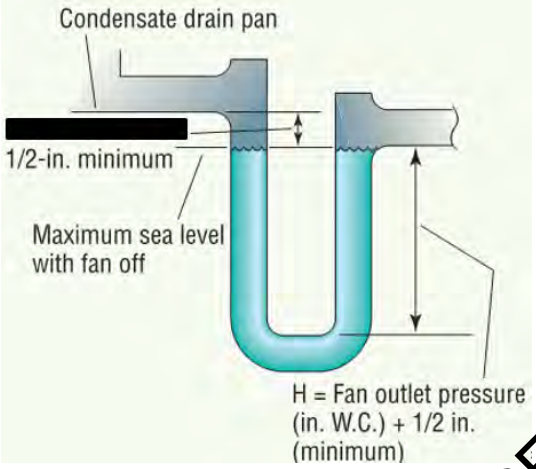
## 2.13 CONDENSATE DRAINS

A. Contractor to confirm that pad elevation is tall enough to meet the following minimum criteria with the equipment point of connection. Immediately contact the Engineer if not.

B. Draw through unit



C. Blow Through unit




## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Equipment Mounting:
   1. Procedures: Section 43 05 13
      a. Install equipment for the Equipment Mounting Systems specified in Division 23 and in accordance with the Equipment Mounting Schedule specified in Section 43 05 13.
   2. Install equipment requiring access (i.e., drain pans, drains, control operators, valves, motors, cleanouts, and water heaters) so that they may be serviced, reset, replaced, or recalibrated. Do not install equipment in obvious passageways, doorways, scuttles, or crawlspaces which would impede or block intended usage.
   3. Install equipment and fixtures in accordance with manufacturer's installation instructions
      a. Maintain manufacturer's recommended clearances.
      b. Install plumb, level, and firmly anchored to vibration isolators per manufacturer's requirements.
      c. Obtain installation instructions from manufacturer prior to rough-in of equipment and examine instructions thoroughly.
      d. When requirements of installation instructions conflict with Construction Documents, request clarification from the Engineer prior to proceeding with installation. This includes proper installation methods, sequencing, and coordination with other trades and disciplines
   4. Furnish and install all supports, bracing and blocking required for the proper installation of the work specified.
   5. Furnish and install miscellaneous supports/metal required for installation of equipment, ductwork, piping, and vents

B. Piping and Equipment Identification: Divisions 33, 40, and 43.

C. Piping and Valves:

1. Coordinate work to account for expansion and contraction of piping materials and building as well as anticipated settlement or shrinkage of building. Install work to prevent damage to piping, equipment, and building and its contents. Provide piping offsets, loops, expansion joints, sleeves, anchors, or other means to control pipe movement and minimize forces on piping. Verify anticipated settlement and/or shrinkage of building. Verify construction phasing, type of building construction products, and rating for coordinating installation of piping systems.
2. Include provisions for servicing and removal of equipment without dismantling piping.
3. Provide unions, couplings, or flanges where equipment is installed in piping. Unions shall be dielectric unions or couplings at points of connection of ferrous to non-ferrous metal piping, unions, couplings, or flanges shall by dielectric type.
4. Provide a shut-off stop valve in the branch of every water, air, gas, or vacuum pipe service upstream of every fixture or outlet.
5. Except for condensate drains, provide valves where equipment drain connections are furnished and carry the discharge pipe to the nearest floor drain, drain trench, or sump. Where no receptacle for drain exists, install drain piping to 1-inch above the floor. Drain piping and valve materials shall conform to the requirements of the system served.
6. Install escutcheons secured to pipe with set-screw where pipes or tubing pass through exposed walls or ceilings.

D. In plenums, provide plenum rated materials that meet the requirements to be installed in plenums. Immediately notify the Owner's Representative of discrepancy.

E. Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, utilize equipment wiring diagrams to coordinate with electrical systems so that proper wiring of equipment involved is affected.



## 3.02 CLEANING

A. Prestartup Requirements:

1. Prior to testing, thoroughly clean the inside of each completed piping system of all dirt, loose scale, sand, and other foreign material.
2. Cleaning shall be by sweeping, flushing with water or blowing with compressed air, as appropriate for the size and type of pipe.
3. Flushing shall achieve a velocity of at least 3 feet per second.
4. The Contractor shall install temporary strainers, temporarily disconnect equipment, or take other appropriate measures to protect equipment while cleaning piping.

B. Post Startup Requirements:

1. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.
2. Upon completion of the duct system cleaning, the duct system shall be visually inspected for cleanliness to verify no visible contaminants are present to the satisfaction of Owner's Representative.

3. If the visual inspection is inconclusive, then additional tests in accordance with the National Air Duct Cleaners Association shall be performed. Any ducts that are considered not to be clean by the Owner's Representative shall be re-cleaned and re-tested. Any damaged materials or surfaces shall be repaired or replaced.
4. A report shall be provided indicating the successful cleaning of the ductwork, method used to determine the cleanliness, and results of any tests is required.

## 3.03 STARTUP REQUIREMENTS

A. System equipment shall be subject to preliminary field tests as indicated in Equipment Startup and Checkout section

## 3.04 FIELD TESTING AND INSPECTIONS

A. Test all HVAC systems and arrange for inspection by the Authorities Having Jurisdiction.

B. General:
1. Furnish all equipment, material, personnel, and supplies to perform the tests and make all taps and other necessary temporary connections.
2. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Owner's Representative.
3. All tests shall be conducted in a manner acceptable to Owner's Representative and shall be repeated as many times as necessary to secure Owner's Representative acceptance of each system.
4. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and tests shall be repeated.
5. All repairs to piping shall be made with new materials.
6. Caulking of threaded joints or holes will not be acceptable.

C. Perform leakage tests on all pipe installed in this project or on any alterations or extensions of existing. Furnish all equipment, material, personnel, and supplies to perform the tests and make all taps and other necessary temporary connections. Leakage tests shall be performed on all piping at a time agreed upon and in the presence of the Owner. All visible leaks shall be repaired, regardless of the test results.

D. The test pressure, allowable leakage, and test medium shall be as specified for the piping systems. Test pressure shall be measured at the highest point on the line, except that pressure at lowest point shall not exceed pipe manufacturer's rated test pressure, unless specifically noted otherwise.

E. All visible leaks shall be repaired, regardless of the test results.

F. Perform following operations and checks before units are operated for any purpose:
1. Verify shipping blocking and bracing have been removed.
2. Verify unit is secure on mountings and supporting devices and connections for ductwork, electrical, etc. are complete. Verify proper thermal overload protection is installed in motors, starters and disconnects.

3. Perform specified cleaning and adjusting. Disconnect fan drives from motors, verify proper motor rotation, and verify fan wheel free rotation and smooth operation of bearings. Reconnect fan drive systems, align belts, and install belt guards.
4. Lubricate bearings and other moving parts with factory-recommended lubricants.
5. Verify manual and automatic volume control dampers are positioned properly and that fire and smoke dampers in related ductwork are in full-open position.
6. Disable automatic temperature control operators, where applicable.

G. Startup equipment, in accordance with manufacturer's startup instructions, and in presence of manufacturer's representative. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
1. Do not place equipment in sustained operation prior to initial balancing of systems.
2. Conduct tests of equipment and systems to demonstrate compliance with requirements specified. Document tests and include in Operation and Maintenance Manuals.

H. The equipment and controls of this Section shall be completely tested, adjusted, and placed in operating condition.

I. Retest equipment and controls, as necessary, during the progress of the work. No work shall be covered until it is properly tested and made tight.

J. Replace damaged or malfunctioning controls and equipment with new. Refurbished is not acceptable.

K. When about to turn the apparatus over to the Owner, put all parts of the apparatus in perfect working order and thoroughly clean out all parts of the equipment.

L. Clean exterior and interior surfaces of each unit. Vacuum clean fan wheel and surfaces exposed to the air handled by the unit.

M. Check damper operation and linkages. Adjust for proper damper operation.

N. Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

| Filter Type | Dirty Filter Conditions |
|---|---|
| 1 inch pleated | 1.0 inch water column |
| 2 inch pleated | 1.0 inch water column |

O. Perform ductwork pressure test prior to air balancing per 23 30 00 Sheet Metal Ductwork and Accessories.

P. All heating, ventilating, and air conditioning systems installed under this Section shall be carefully adjusted by a qualified Air Balancing Contractor to deliver and exhaust air quantities as specified or described herein while maintaining the spaces served at the design temperature and design air pressure differentials. A final balancing report shall be

produced and submitted to the Owner showing the airflow SCFMs, fan statics, and motor amperages.

## 3.05 TESTING, TRAINING, AND COMMISSIONING

A. Upon completion of work and adjustment of equipment and systems testing, demonstrate to the Owner's Representative that equipment furnished and installed or connected under provisions of these Specifications functions in manner required.

B. Manufacturer's Field Services:
   1. Furnish services of a qualified person at time approved by Owner's Representative, to instruct maintenance personnel, correct defects or deficiencies, and demonstrate to satisfaction of Owner's Representative that entire system is operating in satisfactory manner and complies with requirements of other trades that may be required to complete work.
   2. Complete instruction and demonstration prior to final job site observations.

C. TABB Procedures and Requirements: See Section 23 05 93.

## 3.06 ROOF CURBS

A. Roof curbs to be mounted level on roof in accordance to NRCA manuals and details. Secure to structure per engineered/sealed seismic installation details.

B. Seal openings between curb, roof opening, ducts, electrical conduits, piping, and building interior.

**END OF SECTION**

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies the labor and services necessary to test, adjust, and balance under actual operating conditions air and hydronic systems design flow rates. Nothing herein shall be construed as relieving the contractor of his overall responsibility of this portion of the work.

### 1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.



| Reference | Title |
|---|---|
| NEBB | Procedural Standards for Testing Adjusting and Balancing of Environmental Systems |
| AABC | National Standards for Total System Balance |
| ASHRAE 70 | Standards--Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets |

B. Testing Agency:

1. The Contractor shall procure the services of an independent air and hydronic balancing and testing agency, belonging to the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB), to perform air and hydronic balancing, testing and adjustment of systems. The Contractor shall submit a copy of the National Project Certification Performance Guaranty, issued to the testing agency by the AABC, as a part of the balancing report specified in paragraph 2.01 Balancing Report.

C. Codes and Standards:
   1. The Contractor shall comply with applicable procedures and standards of the certification sponsoring association:
      a. "National Standards for Field Measurements and Instrumentation, Total Systems Balance, Air Distribution-Hydronics Systems," AABC.
      b. "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", NEBB.
      c. "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets," ASHRAE.
   2. Calibration and maintenance of instruments and accuracy of measurements shall comply with the requirements of the standards.

## 1.03 SPECIAL REQUIREMENTS

A. Tests and adjustments shall include the complete testing and balancing of all hydronic systems and heating, ventilating, and air conditioning systems and necessary adjustments to the heating, air conditioning, and ventilating equipment to accomplish the specified design flow rates.

B. Should any apparatus, material or work fail to meet the specified requirements in these tests, the Contractor shall make the necessary corrections and retest the apparatus, material, or work at no additional cost to the Owner.



## 1.04 BALANCING

A. General:
   1. The Contractor shall review plans and specifications prior to testing and balancing the air and hydronic systems. The contractor shall submit a proposed approach and schedule for approval prior to the start of testing and balancing work. Characteristics to be tested and adjusted to conform to the values specified include the following:
      a. Total airflow rates delivered by fans and air-handling units.
      b. Flow rates at all grilles, registers, diffusers, supply and exhaust and return ducts.
      c. Distribution patterns at air outlets.
      d. Total water flow rates at each heating and cooling coil, control valve, and pump.
      e. Capacity and temperature rise or drop across each heating and cooling coil.
      f. Operation and modulation of each control valve.

B. Airflow Rate Measurements:
   1. Airflow rates shall be obtained by adjustment of the fan speeds, dampers, or registers. All flow rates shall be measured with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between the design values specified for clean and dirty filters, with auxiliary systems in operation and with all doors and windows closed.
   2. Flow rates at grilles, registers, branch ductwork and air distribution patterns shall be tested in strict accordance with ASHRAE Standard-70.

C. Water Flow Rate Measurements:

1. Total water flow rates shall be measured at each heating coil, cooling coil, unit heater, heat recovery coil, control valve and pump. Water flow rates shall be obtained by adjustment of balancing cocks, valves, and fittings. All flow rates shall be measured with control valves 100 percent open. Pump capacities shall be determined by differential pressure measurement. Temperature shall be measured across the heat transfer elements in the system.

## 1.05 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The RPR shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
2. Sample copy of each of the NEBB or AABC report forms.
3. Proposed approach and schedule of testing and balancing work as specified in paragraph 1.04 Balancing.
4. A description of each air and hydronic system including equipment to be balanced.



## PART 2 PRODUCTS

## 2.01 BALANCING REPORT

A. Report Data:

1. The final certified balancing report shall include the following actual field-verified data:
   a. Equipment data
      1) Manufacturer and model, size, arrangement, class, location, and equipment number.
      2) Motor horsepower, voltage, phase, and full load amperage.
      3) Fan cfm, static pressure, rpm, and operating motor BHP.
   b. Duct size, supply or exhaust recorded cfm, velocity, pressure measurements, location of all measurements.
   c. Pipe size, recorded gpm, velocity, pressure measurements, balancing valve size and model, location of all measurements.

d. Terminal units
    1) Manufacturer and model, supply or exhaust, location, and identification number.
    2) Recorded and design cfm.
    3) Recorded and design noise levels and velocities, where specified.

B. Report Requirements:
1. Each individual final reporting form must bear the signature of the person who recorded the data and that of the supervisor of the reporting organization.
2. One certified organization shall perform the testing and balancing services.
3. All instruments which were used shall be listed and identified including the last date each was calibrated.

C. Final Report:
1. Final report shall be submitted prior to Contractor's request for final inspection. In addition to providing all specified data and information on applicable reporting forms, report shall include the following:
    a. A schedule for testing and balancing parts of the systems which must be delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor. Delayed work shall be completed as early as the proper conditions will allow, after consultation with the RPR.
    b. Due to delayed testing, reports shall be submitted after execution of those services.
    c. A total balance report shall include the following components:
        1) General Information and Summary
        2) Instrument Calibration
        3) Air Systems
        4) Hydronic Systems
        5) Temperature Control Systems
        6) Sound and Vibration Systems
        7) Record drawings with specified and measured flow rates



## 2.02 CERTIFICATE OF COMPLETION

A. At completion of testing and balancing, Contractor shall submit a Certificate of Compliance stating that each apparatus, device, outlet, and system has been tested, adjusted, and balanced so that it is operating in conformance with manufacturer's recommendations and with the specified conditions.

## 2.03 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
1. The balancing report specified in paragraph 2.01.
2. Documentation to confirm compliance with codes and standards.
3. NEBB or AABC certification

## PART 3 EXECUTION

### 3.01 GENERAL

A. The balancing agency shall conduct the above field tests in the presence of the RPR.

B. Following completion of testing and balancing the system shall be left in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

### 3.02 PERFORMANCE OF WORK

A. Air Systems:
   1. General: Testing, adjusting, and balancing shall be performed after the system installation is complete but prior to acceptance of the project.
   2. Measurements: The Contractor shall perform the following:
      a. Measure and adjust air supply and exhaust units to deliver at least 100 percent of the design air volume at 100 percent cooling.
      b. Measure static air pressure conditions on fans, including filter and coil pressure drops, and total pressure across the fan.
      c. Adjust fan speeds and motor drives within drive limitations, for required air volume. Set a speed to provide air volume farthest distance from the fan without excess static pressure. Check draw amps of fans on initial start-up. If running amps exceed nameplate, shut off motor immediately, notify the RPR, and make necessary drive changes as directed.
      d. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.
      e. Airflow rates shall be measured with supply, return, and exhaust systems operating with heating and cooling coils wet, with filter bank resistance midway between design values specified for clean and dirty filters, with auxiliary systems in operation. The deflection pattern of supply outlets shall be adjusted to ensure uniform air distribution throughout the space served.
      f. Airflow rates supplied, exhausted, or returned shall be within plus or minus 5 percent of the design values specified.
   3. Systems to Be Balanced:
      a. FOG Receiving Building Ventilation (refer to sheet M-00-602 and D-63-102)

B. Hydronic Systems:
   1. General: Testing, adjusting, and balancing shall be performed after the system installation is complete and prior to acceptance of the project.
   2. Measurements: The Contractor shall perform the following:
      a. Measure and adjust pumps to deliver at least 100 percent of the design water flow. Check draw amps of running pumps. If in excess of nameplate, shut off immediately and notify the RPR. Proceed as directed by the RPR.
      b. Measure and adjust water flow at coils for design conditions, plus or minus 10 percent. Check conditions at coils for required performance at design conditions.
      c. Measure and adjust total water flow rates at each control valve.

3. Systems to be Balanced:
    a. Maintenance Building Boiler Loop (refer to sheet M-00-602)

## 3.03 FINAL INSPECTION

A. Following completion of testing and balancing, but prior to submitting the balancing report, the Contractor shall recheck, in the presence of the RPR, random selections of data water and air quantities, air motion, and sound levels recorded in the report. Points and areas for recheck shall be as selected by the RPR. Measurement and test procedures shall be as approved for work forming basis of the report.

B. Selections for recheck will not exceed 25 percent of the total tabulated in the report.

C. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new reports submitted, and new inspection test made.

D. Following acceptance of the reports by the RPR, the Contractor shall permanently mark all damper positions, circuit balancing valves, and balancing valves so that they can be restored to their correct position if disturbed at any time. If a balancing device is provided with a memory stop, it shall be set and locked. Devices shall not be marked until after final inspection.



END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

## PART 1 GENERAL

### 1.01 SUMMAR TY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating piping.
   2. Condensate-drain piping.

B. See Section 23 21 23 for pumps, motors, and accessories for hydronic piping.

### 1.02 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Hot-Water Heating Piping: 200 psig at 200 deg F.
   2. Condensate-Drain Piping: 150 deg F.



### 1.03 SUBMITTALS

A. Product Data: For each type of the following:
   1. Plastic pipe and fittings with solvent cement.
   2. Pressure-seal fittings.
   3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   4. Air control devices.
   5. Hydronic specialties.

B. Shop Drawings: Detail at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Field quality-control test reports.

D. Operation and maintenance data.

### 1.04 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. General:
   1. Sizes: Unless otherwise specified, provide valves of same size as upstream pipe size.
   2. All valves of each type shall be the product of one manufacturer.
   3. All exposed valves shall be furnished with operators, handwheels, levers, or other suitable type wrench including handles as specified herein or as shown on the Drawings.
      a. Provide handwheels, fastened to valve stem, for valves other than quarter-turn.
      b. Provide lever handle for quarter-turn valves 6-inches and smaller. Provide gear operators for quarter-turn valves 8-inches and larger and plug valves installed over 5-feet above finished floor.
      c. All threaded stem valves shall open by turning the valve stem counter-clockwise.
      d. All exposed valves and valve operators shall have a non-bleeding shop coat, unless otherwise specified.
      e. Valves 4-inch and larger located more than 7 feet above the floor level shall be furnished with chain operators. Chains shall be galvanized and shall extend to within 3 feet of the floor. Provide hook so that chain may be stored clear of walkways.
      f. All buried valves shall be provided with 2-inch-square operating nut and valve boxes.
   4. Valve Identification: Manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

B. Valves in Insulated Piping: With 2-inch stem extension and 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 on valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied.
   3. Butterfly Valves: With extended neck.

C. Building Service: Unless otherwise specified on the Drawings, provide the following:
   1. Shutoff and Isolation Valves:
      a. Pipe Sizes 3-inches and Smaller: Ball Valve.
      b. Pipe Sizes 4-inches and Larger: Butterfly Valve.
   2. Drain Service: Ball Valves.
   3. Throttling: Balancing Valves.
   4. Strainer Blow-Off: Ball Valve.
   5. Bypass Around Pressure-Reducing Valves: Globe Valves.
   6. Check Valves: Swing, Wafer, or Lift.

### 2.02 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings, or a comparable product by one of the following:
      a. Anvil International, Inc.
      b. S. P. Fittings; a division of Star Pipe Products.
      c. Victaulic Company of America.
   4. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
   5. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

E. Wrought-Copper Unions: ASME B16.22.

## 2.03 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

G. Grooved Mechanical-Joint Fittings and Couplings:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings, or a comparable product by one of the following:
      a. Anvil International, Inc.
      b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
      c. National Fittings, Inc.
      d. S. P. Fittings; a division of Star Pipe Products.
      e. Victaulic Company of America.
   4. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
   5. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.



## 2.04 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.

B. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

C. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.

D. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

## 2.05 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
      a. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      b. 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).
   2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
      a. 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).
      b. 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).

G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 2.06 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Charlotte Pipe and Foundry Company.
      b. IPEX Inc.
      c. KBi.
   3. CPVC and PVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Charlotte Pipe and Foundry Company.
      b. IPEX Inc.
      c. KBi.
      d. NIBCO INC.
   2. MSS SP-107, CPVC and PVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

## 2.07 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Hart Industries International, Inc.
      d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
      f. <Insert manufacturer's name.>
   2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Calpico, Inc.
      b. Lochinvar Corporation.
   2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.



## 2.08 VALVES

A. Automatic Flow-Control Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Belimo
      b. Or Approved Equal
   2. Body: Brass or ferrous metal.
   3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
   4. Combination Assemblies: Include bonze or brass-alloy ball valve.
   5. Identification Tag: Marked with zone identification, valve number, and flow rate.
   6. Size: Same as pipe in which installed.
   7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
   8. Minimum CWP Rating: 175 psig.
   9. Maximum Operating Temperature: 250 deg F.

B. Pump Discharge Valve:
   1. Pump discharge valve shall be Amtrol tri-flow, Armstrong flo-trex, Bell & Gossett triple duty, Mueller control-chek, Taco multipurpose, or equal, modified to provide the specified features.
   2. Pump discharge valve for grooved-end piping systems shall be Gustin-Bacon throttle check, Mueller locxend control check, Victaulic detector check, or equal, modified to provide the specified features.

C. Balancing Valve:
   1. Balancing valve shall be Amtrol florater, Armstrong circuit balancing valve, Bell & Gossett circuit setter, Illinois series 6000, Taco circuit setter, or equal, modified to provide the specified features.

D. Globe Valves:
   1. Globe Valves through 2-½-inch in Copper Pipe:
      a. Rating: 200 psi water.
      b. Type: Renewable disc, globe or angle.
      c. Connections: Solder ends for copper pipe.
      d. Materials: All bronze.
      e. Manufacturers: Jenkins Figure 995A; Crane No. 1702S; or Approved Equal.
   2. Globe Valves through size 3-inch:
      a. Rating: 300 psi WOG.
      b. Type: Union bonnet, handwheel operated, straight or angle pattern.
      c. Connections: Threaded.
      d. Materials: All bronze, except disc shall be Teflon.
      e. Manufacturer: Jenkins 106A; Crane 7TF; or Approved Equal.



## 2.09 METERS AND GAUGES

A. General: Pressure gauge and thermometer ranges shall be approximately two times the system operating conditions.

## 2.10 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Belimo
   b. Or Approved Equal.

B. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS ½.
   5. Discharge Connection: NPS 1/8.
   6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 225 deg F.

## 2.11 HYDRONIC PIPING SPECIALTIES

A. 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; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4-inch misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.



# PART 3 EXECUTION

## 3.01 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
   2. Schedule 40 steel pipe, Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be the following:
   1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Hot-Water Heating Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

D. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

## 3.02 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

## 3.03 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

S. Identify piping as specified in Section 40 05 45.

## 3.04 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.

6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

## 3.05 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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 unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plastic 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
   4. PVC Nonpressure Piping: Join according to ASTM D 2855.

I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

J. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

## 3.06 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

D. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

E. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Install tank fittings that are shipped loose.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

## 3.07 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "S" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

**END OF SECTION**

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SECTION 23 21 23

HYDRONIC PUMPS

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section includes the following:
   1. Close-coupled, in-line centrifugal pumps.

### 1.02 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

C. Operation and maintenance data.

### 1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.



## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.02 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Armstrong Pumps Inc.
   2. Aurora Pump; Division of Pentair Pump Group.
   3. Bell & Gossett; Div. of ITT Industries.
   4. Flowserve Corporation; Div. of Ingersoll-Dresser Pumps.
   5. Grundfos Pumps Corporation.
   6. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
   7. PACO Pumps.
   8. Patterson Pump Co.; a Subsidiary of The Gorman-Rupp Co.

9. Peerless Pump; a Member of the Sterling Fluid Systems Group.
10. Taco, Inc.
11. Thrush Company Inc.
12. Weinman; Div. of Crane Pumps & Systems.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Oil lubricated, bronze-journal or thrust type.

D. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing.

E. Capacities and Characteristics:
1. Capacity: See plans
2. Total Dynamic Head: See plans
3. Maximum Operating Pressure: 125 psig.
4. Maximum Continuous Operating Temperature: 225 deg F.
5. Inlet and Outlet Size: See plans
6. Impeller Size: See plans
7. Motor Speed: 1750 rpm
8. Motor Horsepower: See plans
9. Electrical Characteristics:
   a. Volts: 480
   b. Phase: Three.
   c. Hertz: 60.
   d. Full-Load Amperes: See plans
   e. Minimum Circuit Ampacity: See plans
   f. Maximum Overcurrent Protection: See plans

## PART 3 EXECUTION

### 3.01 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight.

F. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
   2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.



### 3.02 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

### 3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

I. Ground equipment according to Division 26.

J. Connect wiring according to Division 26.

**END OF SECTION**

SECTION 23 30 00

SHEET METAL DUCTWORK AND ACCESSORIES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope: This Section specifies provisions for materials, installation and testing of sheet metal ductwork, including:
   1. Galvanized steel ductwork
   2. Aluminum ductwork
   3. Stainless steel ductwork
   4. Hangers and supports
   5. Flexible connections
   6. Turning Vanes
   7. Dampers
   8. Duct silencers
   9. Duct access doors
   10. Duct insulation.



### 1.02 RELATED SECTIONS

A. As required by Section 23 00 00 and Division 01 - General Requirements.

### 1.03 SUBMITTALS

A. See Section 23 00 00 for Submittal requirements.

### 1.04 QUALITY ASSURANCE (IN ADDITION TO 23 00 00)

A. Reference Standards:
   1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

| Reference | Title |
|---|---|
| AMCA 500 | Test Methods for Louvers, Dampers and Shutters |
| AMCA 511 | Certified Ratings Program for Air Control Devices |
| ASHRAE CH 1 | Handbook - Equipment Volume, Duct Construction |
| ASHRAE CH 33 | Handbook - Fundamentals Volume, Duct Design |
| ASHRAE 90.1 | Energy Standard for Buildings Except Low-Rise Residential Buildings |

| Reference | Title |
|---|---|
| NFPA 90A | Standard for the Installation of Air Conditioning and Ventilating Systems |
| SMACNA | HVAC Duct Construction Standards Metal and Flexible |
| UL 181 | Factory-made Air Ducts and Connectors |
| UL 555 | Standard for Safety; Fire Dampers |

## PART 2 PRODUCTS

### 2.01 GENERAL

A. The installing duct contractor shall provide all ductwork, plenums, and all auxiliary work and products of any kind necessary to make the HVAC systems complete and ready for operation. Ductwork shall comply with the following restrictions and conditions:

1. Snap lock seams shall not be permitted.
2. Where space conditions permit, full radius turns shall be used at offsets.
3. Turning vanes shall be provided where tees, bends, and elbows are not 1-1/2 times the width at centerline and in all rectangular elbows.
4. Ductwork elbows, takeoffs, and fittings shall be in accordance with the SMACNA and ASHRAE standards for the pressure class and conditions specified.
5. Visible duct deflection, loss of shape, or unwarranted noise or vibration resulting from faulty or inadequate support, reinforcing, metal gage, fabrication, or joint spacing shall be corrected at no expense to the Owner.
6. Unless otherwise noted, duct work and all outdoor air ducts shall be Seal Class A and in no case exceed Leakage Class 3.5.
7. Mechanical contractor is responsible for coordinating with the project air balance agency.



### 2.02 METAL DUCTWORK

A. Galvanized Steel Ductwork: Galvanized steel ductwork shall be of the gauge and fabrication that conforms to SMACNA “HVAC Duct Construction Standards”. Galvanized steel sheet, lock-forming quality, ASTM A653/A 653M FS Type B, with G60/Z180 coating. Ductwork shall have not less than 1-1/4 ounces of galvanized coating (total for both sides) per square foot of sheet. Ducts to have mill phosphatized finish for surfaces exposed to view.

B. Aluminum Ductwork: Aluminum ductwork shall be alloy 3003-H14 conforming to ASTM B209 and ASTM B211 and shall be constructed in accordance with SMACNA “HVAC Duct Construction Standards”.

C. Stainless Steel Ductwork: Stainless steel ductwork shall be Type 304 or 316 and shall be constructed in accordance with SMACNA “HVAC Duct Construction Standards”.

## 2.03 JOINTS AND REINFORCING

A. Transverse stiffeners and joints shall be appropriately spaced to maintain duct cross-section integrity in accordance with the pressure class specified and at the prevailing operating velocities. After joints are crimped, they shall be further secured by bottom punching or riveting. Longitudinal seams shall be Pittsburgh lock and shall be cross-broken outward. Intake or exhaust side ducts shall be cross-broken inward. Discharge ducts shall be cross-broken outward. All plenums and casings shall be similarly cross-broken and further reinforced with 1-inch x 1-inch x 1/8-inch angles running diagonally between joints, riveted to the casings.

B. Ductwork shall have slip joints. Joints shall not interfere with airflow in the ducts. Exterior ducts shall be stiffened, braced, and supported in a manner designed to maintain duct integrity and cross-section under wind and snow loads specified in the appropriate codes or standards. Interior ducts shall be suitably braced and stiffened at floor and roof penetrations as well as over their unsupported length in a manner designed to maintain duct integrity and limit vibration and noise in accordance with recognized standards of the industry.

C. Ducts over 17 inches in largest dimension shall be cross-broken or beaded on all four sides. In ducts over 72 inches at each transverse joint 3/8-inch stay rods shall be installed. Spacing between rods or rods on side of duct shall not exceed 48 inches.

D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.
   3. Water Based Sealant for Brush On Application: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts. Min. 69 percent solids, nonflammable. Durodyne Duroseal, Hardcast Versa-Grip 181, McGill United Duct Sealer.
   4. Solvent Based Sealant for Brush-On Application: One-part, nonsag, solvent-release-curing, polymerized butyl sealant with a minimum of 75 percent solids, nonflammable. McGill Uni-Coat, Hardcast Sure-Grip, 404.
   5. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.
   6. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.
   7. Two-Part Tape and Adhesive System: Hardcast FTD 20/DT, McGill Air Seal Uni-Cast.
   8. Silicon Sealant: Hardcast PT-302 or Approved Equal.
   9. Polyurethane Sealant: General-purpose non-brittle sealant for gunned application. Vulkem 616 or Approved Equal.

## 2.04 DUCT SLEEVES

A. Sleeve flanges shall not be less than 4 inches wide and shall be installed tight against each side of the barrier. Sleeves shall be 2 inches larger than the duct or external duct insulation. The space between the duct (or insulation) and the sleeve shall be packed with fiberglass or material of original wall. Duct flanges not less than 4 inches wide shall be installed tight against the wall on each side and fastened to the duct sleeves. Duct sleeves shall be constructed of materials matching the duct material for which they are installed.

## 2.05 SINGLE WALL CASINGS

A. General: Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards.

B. Floor Interface: Mount floor mounted casings on 4-inch high concrete curbs. At floor provide continuous steel perimeter angle on curb. Rivet panels on 8-inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gauge galvanized expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.

C. Wall Penetrations: Reinforce to span panel stiffeners at penetrations.

D. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where specified or required for access to equipment for cleaning and inspection.
   1. Provide clear wire glass observation ports, minimum 6 by 6 size.
   2. Minimum 18 gauge double wall construction.
   3. Continuous hinge or three hinges to open against system pressure.
   4. Neoprene gasket on four sides of door.

E. Reinforcing: Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge back facing and 22 gauge perforated front facing with 3/32-inch diameter holes on 5/32-inch centers. Construct panels 3-inches thick packed with 4.5 lb/cu. ft. minimum glass fiber media, on inverted channels of 16 gauge.



## 2.06 HANGERS AND SUPPORTS

A. General:
   1. Duct support details and spacing shall conform to SMACNA “HVAC Duct Construction Standards” and Section 01 73 24 for the pressure class and conditions specified or required for the particular duct system. The specific support detail utilized shall be as appropriate for each particular duct and location, except as otherwise shown. Supports shall be spaced to prevent visible duct deflection and loss of system integrity.
   2. Aluminum ductwork shall be constructed with strength and dimensional stability comparable to conventional galvanized steel duct. In the absence of other criteria, aluminum sheet and reinforcing shall have a moment of inertia three times greater than that recommended for steel ductwork.

3. Duct supports shall generally match the duct material for which they are installed. Supports for galvanized steel duct shall be hot-dip galvanized after fabrication. Supports for aluminum duct shall be 6061-T6 conforming to ASTM B308.

B. Concealed Ceiling Spaces: Rectangular ductwork shall be supported with metal strap hanger screwed to the sides and bottom of duct. One strap each side with minimum of two screws in side and one in bottom of each strap.

C. Exposed Areas:
   1. Rectangular ductwork shall be supported with shelf angle trapeze hanger or unistrut with rods or angles by welding or bolting. Sway bracing shall be provided, minimum of one at right angle to each duct run.
   2. Round ductwork shall be supported with two half round bands with rods bolted to the bands. Sway bracing shall be provided, minimum of one at right angle to each duct run.

## 2.07 ACCESS DOORS

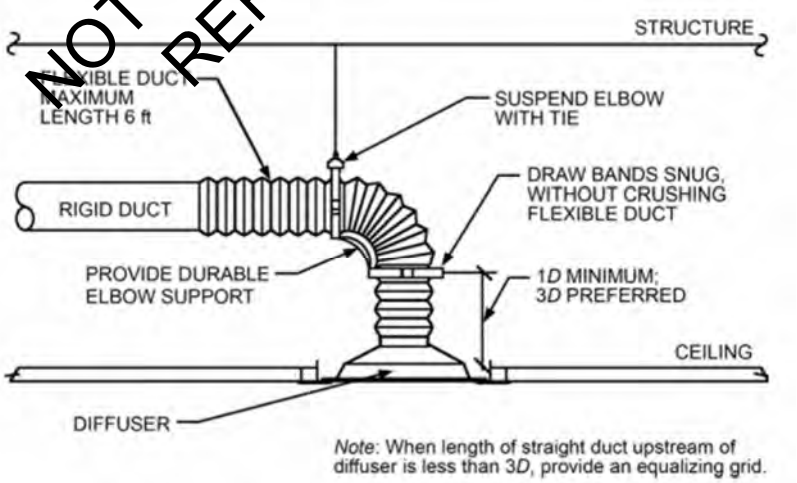
A. The doors shall be rigid and shall be provided with airtight gaskets and shall not vibrate or cause noise under service. Doors in insulated ducts shall be the insulated type. Doors shall be continuous hinged type with ventlock latch on outside.

B. Plenum access doors shall be 24 inches by 66 inches, or as specified.

## 2.08 FLEXIBLE CONNECTIONS

A. Flexible duct shall be per SMACNA – HVAC DUCT CONSTRUCTION STANDARDS METAL AND FLEXIBLE DUCT and 2013 ASHRAE Fundamentals
   1. 2013 ASHRAE Fundamentals 21.7 – Installed at 0-4% compression and no more than 6 feet long fully stretched.
   2. Bends shall be per SMACNA sections 1.3.8 and 3.5, subsection S3.24 for both.






A. DIFFUSER WITH FLEXIBLE DUCT CONNECTION

B. Flexible Duct Branches: Flexible branches shall be U.L. listed, insulated factory-fabricated assemblies. Flexible ducts shall meet the duct insulation requirements of the International Mechanical Code and Minnesota State Energy Code.

1. Construction: Standard factory fabricated product. Inner wall: Impervious vinyl or chlorinated polyethylene, permanently bonded to a vinyl or zinc-coated spring steel helix.
2. Insulation: Fiberglass blanket insulation covered by an outer wall of vinyl or fiberglass-reinforced metalized vapor barrier.
3. Listing: UL 181 listed Class 1 flexible air duct material. Overall thermal transmission: No more than 0.25 BTU/in or hr/sq. deg. F at 75 F differential, per ASTM C335.
4. Vapor transmission value no more than 0.10 perm, per ASTM E96
5. Pressure rating: 4-inch wg positive pressure and 1-inch wg negative pressure.
6. Performance Air friction correction factor: 1.1 maximum at 4% compression. Working air velocity: Minimum 2000 FPM.
7. Flame spread rating: No more than 25.
8. Smoke development rating: No more than 50 as tested per ASTM E84.
9. Insertion loss: Minimum attenuation of 29 DB for 10-foot straight length at 8-inch diameter at 500 Hz.

C. Flexible Duct Connections: Flexible connections in ducts shall be made of neoprene fiberglass cloth, installed in folds, and of sufficient length to accommodate the maximum deflection resulting from vibration and contraction without causing strain. Minimum length in folded position shall be 4 inches. Flexible connections shall be designed to be removed from the line and be reinstalled without disassembling adjacent ductwork. Connections shall be installed with a minimum 4-inch clearance between metal parts on fan connections, equipment connections, and distribution devices.

1. Flexible duct connections for normal service shall be Ventfabrics Inc. "Ventglas;" Duro-Dyne Corp.; "Neoprene;" or Approved Equal.
2. Flexible duct connections for outdoor service shall be Ventfabrics Inc. "Ventlon;" Duro-Dyne Corp.; "Duratron;" or Approved Equal.
3. Flexible duct connections for corrosive environments shall be Ventfabrics Inc. "Ventel;" Duro-Dyne Corp.; "Glasseal;" or Approved Equal.



## 2.09 TURNING VANES

A. Turning vanes shall be 2-inch blades for ducts up to 18 inches in either dimension and shall be 4-1/2-inch blades for larger ducts. All turning vanes shall be constructed of double thickness vanes. Turning vanes shall be constructed of materials matching the ductwork in which they are installed.

B. All duct elbows shall include turning vanes unless otherwise noted.

## 2.10 DAMPERS

A. General: All dampers shall be made of material similar to the ductwork in which the damper is located. Aluminum construction is acceptable for installation in galvanized steel ductwork. Where aluminum construction is not available where aluminum ductwork is utilized, stainless steel shall be used. Where stainless steel construction is

not available, aluminum construction with corrosion resistant applied coating may be used.

B. Backdraft Dampers: Aluminum or stainless steel construction. Blades shall be provided with extruded vinyl or polyurethane edge seals mechanically locked into blade edge. Channel type frames with flanges to facilitate mounting. Bearings shall be corrosion resistant synthetic and linkage shall be concealed in frame. Backdraft dampers shall be sized and located as specified on the Drawings. Backdraft dampers shall be counterbalanced for vertical or horizontal airflow as shown on the Drawings. Where specified, corrosion-resistant, factory applied coatings shall be Heresite applied in strict conformance with the paint manufacturer's instructions. Ruskin; Greenheck; or Approved Equal.

C. Balancing Dampers: Manually operated, opposed blade or single blade, quadrant-type balancing dampers. All balancing dampers shall be made of material (similar to the ductwork) two gauges thicker than the duct in which the damper is located. Each damper shall have an operator with indicator handle and a locking mechanism. Damper operator shall be Young Regulator; Ventfabrics Inc.; or Approved Equal.

D. Control Dampers: Control dampers shall be low-leakage design, constructed of galvanized steel, extruded aluminum or stainless steel as required, and configured for installation as shown on the Drawings. Blades shall be parallel opening and shall be provided with felt, vinyl, polyurethane or neoprene edge seals mechanically locked into blade edge. Minimum 4-inch channel type frames with flanges to facilitate mounting. Bearings shall be corrosion resistant synthetic and linkage shall be concealed in frame. Where specified, corrosion-resistant, factory applied coatings shall be Heresite applied in strict conformance with the paint manufacturer's instructions. Dampers shall be configured for internal actuator mounting. Manufacturers shall be Ruskin; Greenheck; or Approved Equal.

   1. Damper Actuators: Actuators shall be internal mount type, 120 VAC, Actuator shall be sized to provide operation of damper through full range of motion in a maximum of 40 seconds. Manufacturer shall be Ruskin; Honeywell; or Approved Equal.

E. Fire and Smoke Dampers:

   1. General: Constructed and tested in accordance with UL 555 and UL labeled, 1 ½- or 3-hour fire protection rating as required.
   2. Manufacturers: Ruskin; Air Balance, Inc.; Prefco Products, Inc.; United Air; Pacific Air Products, or Approved Equal.
   3. Fire Dampers: Equipped for vertical or horizontal installation as required by arrangement of respective unit, with 165°F fusible link.
      a. Frame: Fabricated of minimum 20-gauge galvanized steel or 16-gauge stainless steel, with mitered and interlocking corners.
      b. Type, Style: “B” for applications where air velocity is over 600 FPM, “A” for applications where air velocity is less than 600 FPM, “C” where installed in round or oval duct.
      c. Blades: Fabricated of minimum 24-gauge galvanized steel or 16-gauge stainless steel, with interlocking blade edges or full length 16-guage stainless or galvanized steel blade connectors.

d. Ceiling fire dampers: Have minimum 20-gauge frame, rectangular or round, style to suit ceiling construction, equipped with minimum 24-gauge blades with non-asbestos refractory insulation.

4. Controls: Operator and controls will provide the following functions:
   a. Fail-safe closure on signal from smoke sensors or central control panel.
   b. Fail-safe closure on power failure (after a 20-second delay to eliminate momentary power loss closure).
   c. Automatic reset of dampers from central control panel after resolution of emergency condition. DAMPERS MUST NOT OPEN AUTOMATICALLY ON RESTORATION OF POWER.
   d. External manual control override or reset from outside the duct with or without the availability of electrical power.
   e. Where required, central control panel shall be mounted in a readily accessible location where specified on the Drawings. The control panel shall have a clearly marked damper closer switch for panic operation. Additional switches of similar appearance and marking shall be located inside the computer room next to the door into corridor and inside other offices as specified on the Drawings.
   f. The damper shall provide all the automatic closing functions of a basic fire damper with a fusible actuator overriding all control functions at 165°F.

## 2.11 ROOF CURBS

A. Provide roof curbs for duct penetrations. Roof curbs shall be straight sided with 2 inch flashing flange, 1 inch rigid insulation, wood nailer and shall be constructed from 18 gauge galvanized steel. Roof curb shall be suitable for duct dimensions and shall be coated with Heresite Hi-Pro Polyester or manufacturer's equivalent to protect against UV damage. Manufacturer shall be Greenheck Model GPI; or Approved Equal.



# PART 3 EXECUTION

## 3.01 GENERAL REQUIREMENTS: SECTION 23 00 00

## 3.02 DUCTWORK SCHEDULE

A. Ductwork material and pressure classification shall be as described in the following table:

| Exposure | Material |
|---|---|
| Indoor Dry | Aluminum, Galvanized |
| Indoor Wet | Aluminum, Galvanized |
| Outdoor | Aluminum, Galvanized |
| Process Non-Corrosive | Aluminum, Galvanized |
| Process Corrosive | 316 Stainless Steel |
| Chemical Corrosive | FRP or 316 Stainless Steel |

## 3.03 DUCT INSTALLATION

A. The duct layout shown on the Drawings is diagrammatic in nature. Coordinate the ductwork routing and layout, and make alterations to the ductwork routing and layout to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Drawings are required, alterations may be made so as not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or duct run as shown on the Drawings. In the event the Owner determines that the installed ductwork is inconsistent with the above mentioned criteria, remove and replace at no additional cost to the Owner.

B. All sheet metal ductwork shall be erected in a first class and workmanlike manner and shall be in accordance with the SMACNA "HVAC Duct Construction Standards" and as specified above. No ductwork shall be fabricated or installed until it has been carefully coordinated with other trades. All transverse duct joints shall be taped airtight. Duct dimensions shown are “net” inside clear. Each air supply outlet and each air return or outside air intake shall have either an integral volume control device or shall be furnished with a volume damper.

C. Ductwork shall be installed in accordance with SMACNA and NFPA. All ductwork specified on the Drawings is schematic. Therefore, changes in duct size, duct configuration, and location may be necessary to conform to field conditions.

D. Ductwork and accessories shall be installed to provide a system free from buckling, warping, breathing, and vibration. Ductwork installation shall permit installation of other required services without piercing, crimping, or reducing duct sizes. Where space conditions permit, full radius turns shall be used at offsets. The inside of all ducts visible through grilles and registers shall be painted flat black.

E. All ductwork shall be made airtight. Flanged joints shall be sealed with closed-cell neoprene gaskets compressed between mating flanges. All other joints and seams shall be sealed with liquid or mastic type sealants. Taped joints shall not be permitted. All joints shall comply with the requirements of SMACNA Seal Class A and Leakage Class 3.

F. Existing ductwork to be reused shall be cleaned and inspected prior to installation of new systems. Contractor shall notify the Owner of deficiencies in existing ductwork scheduled for reuse. The deficiencies will be corrected as directed by the Owner.

G. Acoustical lining may be used only where specified in the Ductwork Schedule. Lining shall be installed as recommended by the manufacturer. Acoustically lined ductwork need not be wrapped with external thermal insulation. Exhaust air and foul air ducts need not be insulated, unless otherwise specified.

H. Install ducts, unless otherwise specified, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

J. Coordinate layout with suspended ceiling, air duct accessories, lighting layouts, and similar finish work.

K. Electrical and IT Equipment Spaces: Route ducts to avoid passing through transformer vaults, electrical equipment spaces, and enclosures.

L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on four sides by at least 1-1/2-inches.

M. Fire-and Smoke-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire, smoke or combination fire and smoke dampers as governed by the Building Code and the Authority Having Jurisdiction, including sleeves, and firestopping sealant.

N. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes. Reference SMACNA's Seismic Restraint manual: Guidelines for Mechanical Systems.

O. Anchor ducts securely to building in such a manner as to prevent transmission of vibration to structure. Do not connect duct hanger straps to roof deck. Do not support ducts from other ducts, piping or equipment.

P. Construct exterior ductwork or ductwork which is otherwise exposed to weather watertight and slope 1/4-inch per foot to avoid standing water.

Q. Do not install duct size transition pitch angles which exceed 30 degrees for reductions in duct size in the direction of airflow, and 15 degrees for expansions in duct size in the direction of airflow.

R. Provide openings in ductwork where required to accommodate thermometers and control devices. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

S. Install flexible duct with bend radius equal to 1.5 times the diameter. Minimum length 2 feet. Maximum length 6-feet with flexible duct fully stretched, unless noted otherwise.
   1. Provide round neck grilles/diffusers or square-to-round transitions. Flex duct connections directly to square neck not allowed.
   2. Flex duct allowed in concealed spaces above lay-in ceilings only.



## 3.04 INSTALLATION OF DUCT ACCESSORIES

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where specified.

D. Where installing volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts for air balancing. Install at a minimum of two duct widths from each branch takeoff. Provide balancing dampers for all air inlets and outlets.

F. Provide test holes at fan inlets and outlets and where required for air testing and balancing.

G. Install fire and combination fire and smoke dampers, with fusible links, and in accordance with manufacturer's UL-approved written instructions.

H. Install all dampers square and free from racking with blade running horizontally.

I. Install fixed turning vanes in square throat rectangular elbows and in tees.

J. Drain Pans: Install under each cooling coil and heating coil. Provide drain (sized per Code) connection from each drain pan and pipe to nearest floor drain through trap and 10-inch air gap. Drain pans over 6 feet in length require drain connections from both ends. Pitch drain pans in direction of air flow and to drain. At all equipment with cooling coils or heating coils that are located above ceilings, provide 24-gauge galvanized steel secondary drain pans with supports and 3/4-inch overflow piping to observable location. Provide escutcheon (same color as ceiling) at overflow piping penetration in ceiling. Support secondary drain pan independently from equipment.

K. Install duct silencers independent of ducts with flexible duct connectors, lagged with loaded vinyl sheet on inlets and outlets or rigidly to ducts.

L. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
   1. On both sides of duct coils.
   2. Downstream from volume dampers , turning vanes, and equipment.
   3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
   4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot (15-m) spacing.



## 3.05 CLEANING

A. General Requirements: Section 23 00 00.

B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

C. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

D. Grille and Exposed Duct Cleaning:
   1. After completion of ductwork installation, operate each fan system (excluding exhaust fans) for a minimum of 30 minutes prior to installation of ceiling grilles and diffusers. After grilles and diffusers are installed, clean out accumulation of particles from grilles and diffusers prior to acceptance.
   2. Clean exterior surface of ducts exposed to public view of chalk, pencil, and pen marks; labels; sizing tags; dirt; dust; etc., so that upon completion of installation, ducts are left in clean and unblemished manufactured conditions.
   3. Exposed duct and grilles to remain free of dust entrained streaks due to leakage at joints and grille connections during warranty period. Clean leaks, seal and refinish to match existing if visible streaks develop.

## 3.06 TESTING

A. Procedures: Sections 23 05 93.

B. Duct test holes with patches in ducts shall be provided where directed or necessary for testing and balancing purposes.

**END OF SECTION**

SECTION 23 31 16

FIBERGLASS REINFORCED PLASTIC (FRP) DUCTWORK

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope: This Section specifies Fiberglass Reinforced Plastic (FRP) ductwork for foul air systems.

### 1.02 SUBMITTALS

A. Procedures: Section 01 33 00.

B. Items to be Submitted for this Section:
   1. Shop Drawings
   2. Ductwork:
      a. Statement of resins (liner, structural and corrosion liner) and reinforcing proposed for use.
      b. Certification from the manufacturer of the selected resin system that the selected resin and catalyst systems are appropriate for the service conditions of the duct systems as detailed within this Section.
      c. Design calculations, stamped by an engineer registered in the State of Connecticut, and complete fabrication details shall be submitted to Owner for approval.
      d. For Filament-Wound Laminates:
         1) Helix angle.
         2) Glass content range.
         3) Strand yield.
         4) Strand by inch in the winding band.
         5) Ply thickness.
         6) Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.
      e. For All Fabricated Parts:
         1) Construction type.
         2) Laminate thickness.
         3) Ply sequences.
         4) Glass content range.
      f. For All Secondary Overlays (Both Interior and Exterior):
         1) Laminate thickness.
         2) Ply sequences and widths.
         3) Construction details for all other special configurations and fabricated parts.
      g. Pressure, vacuum, and temperature rating of duct.
      h. Dimensions of subassemblies to be shipped.

i. Manufacturer's data and descriptive literature for duct accessories.
j. Drawings at minimum 3/16-inch scale, full size, showing layout, support locations, and field joint locations.
k. Stamped and signed structural engineering design calculations.
l. Information, details, and requirements for installation and support of duct and torque values for flange bolting.
m. Name of manufacturer.

3. Supports:
   a. Location plan.
   b. Type and details.
   c. Materials of construction.
   d. Stamped and signed structural engineering design calculations for special supports.
4. Expansion Joints/Flexible Connectors:
   a. Type and model.
   b. Materials of construction.
   c. Force required for expansion/contraction.
   d. Name of manufacturer.
5. Butterfly Dampers:
   a. Statement of resins and reinforcing proposed for use.
   b. Complete damper shop drawings illustrating component configuration, dimensions, and material list.
   c. Pressure, vacuum, and temperature rating.
   d. Certified damper leakage test results by AMCA-approved laboratory in accordance with AMCA 500D standards, pressure drop characteristics, and operator torque requirements.
   e. Materials of construction.
   f. Total weight including operator.
   g. Type and model.
   h. Name of manufacturer.
6. FRP round duct sample, minimum size 12 inches diameter by 12 inches long representing the quality of workmanship and glass/resin being quoted. These will be retained for quality comparison on materials shipped to jobsite.
7. Qualifications:
   a. Fabricator: List of references substantiating experience.
   b. Installer: Manufacturer's certification that installer is qualified for installation work.
8. Manufacturer's installation instructions.
9. Procedure for protection and handling of materials prior to shipping.
10. Certificates:
    a. Manufacturer's certificate of compliance.
    b. Manufacturer's certificate of proper installation.

11. Manufacturer's factory inspection report.
12. Quality control forms.

## 1.03 QUALITY ASSURANCE

A. Reference Standards:
   1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In case of conflict between the requirements of this Section and those of the listed documents the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

| Reference | Title |
|---|---|
| AMCA 500 D | Laboratory Methods of Testing Dampers for Rating |
| ANSI B16.1 | Cast Iron Pipe Flanges and Flanged Fittings Classes 12, 125, and 250 |
| ASME B18.22.1 | Plain Washers |
| ASTM A193/A193M | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service |
| ASTM A194/A194M | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both |
| ASTM C582 | Standard Specification for Contact Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment |
| ASTM D2563 | Standard Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts |
| ASTM D2583 | Standard Test Method for Indentation Hardness of Rigid Plastics by Means of Barcol Impressor |
| ASTM D3982 | Standard Specification for Contact Molded "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Duct and Hood |
| ASTM E84 | Standard Test Method for Surface Burning Characteristics of Building Materials |



B. Shipment and Storage:
   1. Do not ship ducting by nesting small diameter components inside larger diameter components.
   2. Protect flanged sections by bolting to wooden blinds 2 inches greater than outside diameter of flange.
   3. For nonflanged components, use either rigid plugs inside ends to prevent deflection or protect with wooden boxes.
   4. Crate materials whenever practical prior to shipment.
   5. Firmly fasten and pad components shipped to prevent shifting or flexing of components while in transit.

C. Qualifications:
   1. Fabricator Qualifications: Minimum 5 years' experience fabricating FRP ductwork.
   2. Installer Qualifications: Minimum 5 years' experience installing FRP ductwork.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS/PRODUCTS

A. Candidate manufacturers of FRP Ductwork include: Spunstrand, Bondstrand LD VE FR, Ershigs Inc., or Approved Equal. The FRP Ductwork manufacturer's standard models or products may require modification to conform to specified requirements.

B. Candidate manufacturers of vinyl ester resin include: Ashland Chemical Hetron FR 992, Dow Chemical Dekrane 510-A, or Approved Equal. The vinyl ester resin manufacturer's standard models or products may require modification to conform to specified requirements.

C. Candidate manufacturers of expansion joints include: Hoyt Rubber Company Inc. Style 945, or Approved Equal. The expansion joint manufacturer's standard models or products may require modification to conform to specified requirements.

D. Candidate manufacturers of butterfly dampers include: Swartwout Model 914, Ershigs Inc., or Approved Equal. The butterfly damper manufacturer's standard models or products may require modification to conform to specified requirements.

E. Candidate manufacturers of zero leak butterfly dampers include: Spunstrand ZL Series, Ershigs Inc. Type B, or Approved Equal. The zero leak butterfly damper manufacturer's standard models or products may require modification to conform to specified requirements.

F. Candidate manufacturers of hand actuators include: Swartwout Dyna-Torque Model DT2, or Approved Equal. The hand actuator manufacturer's standard models or products may require modification to conform to specified requirements.



### 2.02 PERFORMANCE REQUIREMENTS

A. Service Conditions:
   1. Air Stream Contents: Saturated air streams containing hydrogen sulfide in concentrations up to 50 ppm at 115 degrees F.
   2. Pressure and Vacuum: Design conditions are 20 inches water column pressure and 12 inches water column vacuum.

B. Design Requirements:
   1. General:
      a. Conform to ASTM D3982 and NBS PS15-69.
      b. Duct manufacturer's design for round section, including duct wall thickness and stiffeners.
      c. Round duct shall have a safety factor of 2 to 1 for pressure and 2 to 1 for vacuum service.

d. A 1/4-inch laminate shall have the following minimum physical properties:

| Design Requirement | Ref Standard | Value |
|---|---|---|
| Minimum Ultimate Tensile Strength | ASTM D638 | 12,000 psi |
| Minimum Flexural Strength | ASTM D790 | 19,000 psi |
| Minimum Flexural Modulus of Elasticity (tangent) | ASTM D790 | 800,000 psi |

2. Field Conditions:
   a. Design of ductwork shall include field verification of existing conditions, space limitations, and required connections.
   b. Verification of field conditions shall be completed prior to fabrication.
3. Rectangular Duct and Transitions:
   a. Rectangular duct design criteria shall be submitted to the Owner for review and approval.
   b. Where transitions, rectangular duct or other special system components not specifically detailed in this Section are needed, fabricator shall be responsible for the design of the component.
   c. Minimum safety factor for critical buckling due to vacuum shall be 5:1.
   d. Deflection of flat panels shall be limited to 1 percent of the width of the panel.
   e. Corrosion liner shall not be included in structural calculations.
4. FRP Ducting Detail Drawings: Use the following Details in conjunction with requirements set forth herein. When conflict exists between details herein and referenced standards, details herein take precedence. Details are attached to the end of this Section.
   a. Detail 1: FRP Duct Stiffener Installation.
   b. Detail 2: FRP Drilled Flange - Duct Drilling.
   c. Detail 3: 1-1/2" FRP Drilled Flange – For Duct Drain.
   d. Detail 4: Duct Drain and Pressure Indicator Attachment Flange.
   e. Detail 5: Blind Flanges.
   f. Detail 6: 1-1/2" Dia. Duct Drain and P.I. Nozzle Installation.
   g. Detail 7: FRP Butt Joints.
   h. Detail 8: FRP Tee Joints.
   i. Detail 9: FRP Miter Joints.
   j. Detail 10: FRP Lateral Joints.
   k. Detail 11: FRP Butt Joints and Tee Joints Charts.
   l. Detail 12: Damper Nozzle Installation.
   m. Detail 13: 90 and 45 Degree Elbows. All elbows shall be long radius.
   n. Detail 14: Eccentric and Concentric Reducers.
   o. Detail 15: 90 Degree Tee and Cross.

## 2.03 MATERIALS

A. FRP Ductwork materials of construction shall be as follows:

| Component | Material |
|---|---|
| Resin | Premium corrosion-resistant, fire-retardant, vinyl ester resin. Minimum 3% antimony trioxide. |
| Chopped Strand Mat | Type E glass, minimum 1-1/2 ounces per square foot, with silane finish and styrene soluble binder |
| Continuous Roving for Chopper Gun Spray-Up | Type E glass |
| Woven Roving | Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish |
| Continuous Roving for Filament Winding | Type E glass with a silane type finish |

B. Fastener (bolts, nuts, washers, backing strips) shall be type 316 stainless steel.

C. Gaskets shall be Neoprene or Buna-N.

D. Expansion joint / flexible connection materials of construction shall be as follows:

| Component | Material |
|---|---|
| Expansion joint material | Neoprene or Buna-N |
| Backing rings | Type 316 stainless steel |

E. Butterfly damper materials of construction shall be as follows:

| Component | Material |
|---|---|
| Resin | To match connecting ductwork |
| Frames | FRP |
| Blades | FRP |
| Axles | Continuous FRP rod |
| Bearings | Molded PTFE |
| Blade stops | FRP bar |
| Blade seals | Neoprene |
| Shaft seals | Neoprene |
| Hand actuator worms | Heat-treated carbon steel |
| Hand actuator worm wheels | Cast ductile iron |
| Hand actuator shaft | Stainless steel |
| Hand actuator shaft / worm wheel seals | Buna-N |
| Bolts | Type 316 stainless steel |
| Nuts | Type 316 stainless steel |
| Washers | Type 316 stainless steel |

F. Ductwork Fabrication:
   1. Resin:
      a. Resin shall be premium corrosion-resistant, fire-retardant vinyl ester resin.

b. FRP fabrications shall not exceed a flame spread index of 25 and smoke development rating of 50 when tested in accordance with ASTM E84 Tunnel Test.

c. Structural wall resin shall contain a minimum of 3 percent antimony trioxide to achieve the designed low flame spread index requirement.

d. Special Catalyst: In accordance with the recommendations of the resin manufacturer for the intended service.

e. Add ultraviolet absorbers to surfacing resin to improve weather resistance.

f. Color: Use no dyes, pigments, or colorants, except in the exterior gel coat. Exterior gel coat shall be selected by Owner from the fabricator's standard color palette.

2. Method of Construction:

a. Inner Surface: Inner surface exposed to the exhaust environment shall be a resin-rich liner between 0.01-inch and 0.02-inch thick obtained by using one layer of Nexus veil saturated with the specified resin.

b. Interior Layer: Resin-rich interior surface of nominal 100 to 120 mils thick for the entire corrosion barrier, using chopped strand glass mat or chopped glass roving backing the veil. Use no additive in the corrosion barrier. The inner surface and interior layer shall have a glass content of 27 percent plus or minus 5 percent.

c. Structural Layer: Fabricated using either hand lay up construction per ASTM D3982 or filament wound. Structural layer shall not be less than the following thicknesses:

| Diameter (inches) | Thickness (inches) |
|---|---|
| 6 - 20 | 1/8 |
| 20 - 26 | 3/16 |
| 30 - 58 | 1/4 |

d. Exterior Coat: Resin rich with no exposed raw fibers. For interior duct, the final coat shall be a factory applied intumescent coating to achieve the designated results for low smoke development. For exterior duct, resin coat with ultraviolet (UV) inhibitor.

3. Reinforcement:

a. Fittings and special sections shall be reinforced or their shell thickness increased where combined stresses due to internal pressure and bending will exceed maximum stress.

b. Shell thickness or reinforcing shall be as required to keep combined stresses below maximum recommended.

4. Flanges or resin rich bell and spigot connections are preferred method of joining sections of duct where inside overlay is not possible.

5. Butt Joints:

a. Butt joints shall be overlaid both inside and outside.

b. Butt joints shall only be permitted in duct sections that are accessible for inside overlay.

c. Field butt joints, when needed, shall be made at locations at least 12 inches from any increasing or decreasing cross section of duct.

d. Minimum width of overlay shall be as indicated in Detail 7 herein.
e. Butt joints shall be built up in successive layers and shall be crevice-free in accordance with ASTM D2563.
f. Width of the first layer shall be 4 inches (minimum).
g. Successive layers shall increase uniformly to the specified minimum total width of overlay; centered on the joint.
h. Crevices shall be filled with resin, leaving a smooth inner surface.
i. Comply with Detail 7 for joint tolerance and Detail 11 for overlay criteria.
j. The inner surface of butt joints shall be free of cracks and crazing, with a smooth finish, with an average of not more than two pits per square foot (pits shall be less than 1/8-inch diameter and maximum of 1/32-inch deep), and covered with sufficient resin to prevent exposure of inner surface fabric.
k. Minimal waviness is permissible provided surface is smooth and free of pits.

6. Flanges:
   a. Flange dimensions (except thickness) and drilling patterns for all flanges that connect to equipment, expansion joints, or dampers are to correspond to ASME/ANSI B16.1, Class 25.
   b. All flanges to be factory drilled.
   c. Flange dimensions and drilling patterns for all duct joints are to correspond to ASTM D3982 for FRP ductwork, or Details 2 herein, whichever is more stringent.
   d. Back Face of Flanges shall be spot-faced, flat and parallel to the flange face, and of sufficient diameter to accept an SAE metal washer under the bolt head or nut.
7. Furnish gussets on flanged nozzles from ducts.
8. Duct and Fittings:
   a. Round: ASTM D3982.
   b. Rectangular:
      1) Contact molded to a thickness as dictated by structural calculation.
      2) Reinforcing with angles or tees is acceptable to meet required pressure/vacuum service.
   c. Joints: Butt wrapped unless otherwise indicated on Contract Drawings except flanged at connections to expansion joints, butterfly dampers, blast gates, or mechanical equipment to facilitate disassembly.
   d. Fittings:
      1) Plain end or flanged, manufacturer's standard sizes.
      2) Comply with Details 13, 14, and 15 herein.
      3) Chemical resistance equal to or greater than the duct.
      4) Bends with a centerline radius of 1.5 times the diameter shall be either smooth radius elbows formed over a removable mold or mitered elbows fabricated from straight duct with the following mitre segments:
         a) Bends up to 30 Degrees: 1 mitre/2 gore.
         b) 31-Degree to 60-Degree Bend: 2 mitre/3 gore.
         c) 61-Degree to 90-Degree Bend: 4 mitre/5 gore.

5) Provide integral turning vanes at elbows where indicated on Contract Drawings.

e. Flanges shall have a minimum thickness of 3/4-inch, where connecting to equipment, expansion joints, or dampers. Flange thickness shall comply with Details herein.

f. Transitions:

1) Glass-fiber reinforced, with wall stiffness equal to that of duct, designed using the pipe design criteria.

2) Maximum deflection of a side shall be less than 1 percent of the width of that side at the design internal pressure.

3) Shop-installed reinforcing such as ribs or angles shall be used if required to meet deflection requirements.

9. Cure products to at least 90 percent of the minimum Barcol hardness specified by resin manufacturer.

## 2.04 FEATURES

A. Fasteners:

1. Bolts:

a. ASTM A193/A193M, ANSI coarse thread series, Grade B 8M hex head.

b. Length such that after installation bolts will project 1/8-inch to 3/8-inch beyond outer face of the nut.

2. Nuts: ASTM A194/A194M, Grade 8M.

3. Washers: ANSI B18.22.1, flat.

4. Backing strips, drilled for the above bolting requirements, shall be employed for all connections at fans, demisting sections, and wherever shear or moment loads may be encountered on duct connections.

B. Gaskets: Full-face, ASTM D2240, Type A Durometer 50-70, 3/16-inch minimum thickness.

C. Inspection Plates:

1. Removable inspection plates, made of the same material as the parent duct, not less than 6 inches square or 8 inches round, bolted with all stainless steel hardware, at all turning vane locations and condensate drain low points.

2. Gasketed and shall make an airtight seal with the parent duct.

3. Submit location, fabrication, and installation details.

D. Expansion Joints/Flexible Connections:

1. Provide where indicated on Contract Drawings or as required for proper duct installation.

2. Type: W-design configuration with integral flanges suitable for service with FRP duct.

3. Backing Rings: 3/8 inch thick, 2 inches wide, ANSI B16.1, Class 25 diameter and drilling.

4. Length: 12 inches, flange-to-flange (unless otherwise indicated on Drawings).

5. Extension: 0.5 inch.

6. Compression: 2.0 inches.
7. Lateral Offset: 1.0 inch.
8. Thickness: 1/4 inch, minimum.

E. Supports and Hangers: Comply with Section 40 05 07, Section 40 05 07.13, and Section 40 05 07.16.

F. Butterfly Dampers:
   1. Design Requirements: Each damper shall be designed for the following conditions:
      a. Air Temperature Range: 40 to 105 degrees F.
      b. Design Pressure: match ductwork.
   2. Construction:
      a. Blades: Stiffeners as required.
         1) 36-inch and Under: 0.25 inch thick.
         2) Above 36 Inches: 0.50 inch thick.
      b. Axles: 6 inches extension beyond frame; stiffeners as required.
      c. Flanges: Flanges shall comply with PS 15-69 Table 5 at design pressure of 25 psi and shall have ANSI B16.1, Class 25 diameter and drilling.
      d. Bolts: ASTM A193/A193M, ANSI B18.2.1, ASA coarse thread series, Grade B 8M heavy hex head. Length such that after installation bolts will project 1/8-inch to 3/8-inch beyond outer face of the nut.
      e. Nuts: ASTM A194/A194M, ANSI B18.2.2, Grade 8M.
      f. Washers: ANSI B18.22.1, flat.
      g. Single-blade type complete with channel-type frame, close-fitting blade, full-length axle, and bearings.
      h. Same inside dimensions as the connecting ductwork.
      i. Axles not less than 3/4-inch in diameter and continuous through the damper.
      j. Maximum leakage rate of 5.25 cubic feet per minute per square foot of damper area at a differential pressure of 30 inches WC.
   3. Zero Leak Dampers:
      a. Design and construction requirements for zero leak dampers shall conform to requirements for butterfly dampers except as noted.
      b. Zero leak dampers shall be leak free at a differential pressure of 30 inches WC for a period of 1 hour.
      c. Minimum damper blade thickness shall be equal to flange thickness specified in this section.
      d. Share seal shall be Viton O-ring.
   4. Hand Actuators:
      a. Provide for dampers larger than 24-inch diameter:
      b. Hand actuators shall be worm geared driven.
      c. Actuators shall be totally enclosed, weather-proof, and permanently lubricated in a die-cast aluminum housing.
      d. Housing shall be epoxy coated in the factory with a minimum dry film thickness of 8 mils.

e. Hand wheel sizes shall be computed assuming a maximum rim effort of 80 pounds.

f. Actuator shall be bolted to damper with stainless steel bolts as required.

g. Number of turns of hand wheel in order to rotate blade 90 degrees: Minimum of 4 and maximum of 12.

h. Provide indicating arrows identifying direction of rotation for correct operation of dampers with "Open" and "Close" clearly marked. Indication shall be legible and of substantial durability.

i. Chain Wheels:

1) Dampers installed with shaft centerlines more than 5 feet 6 inches above the floor shall be provided with chain wheels and operating chains.

2) Chain wheels shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel.

3) Reasonable side pull on the chain shall be permitted by the chain wheel without "gagging" of the wheel.

4) Provide suitable actuator extensions, if necessary, to prevent interference of chain and adjacent piping or facilities below.

5) Operating chains shall be hot-dip galvanized carbon steel. Loop and extend within 4 feet of the floor below damper.

6) Provide and install galvanized tie-back hooks on adjacent pipe supports or structures to hold operating chains out of walkways or access areas when damper is not in operation.

G. Drains:

1. In addition to drains shown on the drawings, drain sumps, with 1-1/2 inch minimum flanged outlets, shall be provided at all low points.
2. All drain sumps shall be fitted with a 1-1/2 inch ball valve.

H. Marking:

1. Identify each duct component with the fabricator's name, resin, minimum thickness, and date of manufacture.
2. Use permanent marking. Seal decals and labels into laminate exterior with resin.
3. For piece marking used for installation, use oil-based paint for easy removal.

I. Additional Equipment:

1. Construction details are provided on the drawings included in this Section.
2. If additional details or items are required (such as transitions, etc.) the Contractor shall submit such details.
3. Approval is required prior to the start of fabrication.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. All material and equipment shall be installed as specified and as required by the applicable state and local codes.

B. Cut, fit, and install in accordance with duct manufacturer's recommendations.

C. Ductwork shall be free of vibration when in operation. All necessary vibration isolation devices shall be provided and installed by Contractor.

D. Install plumb and straight. Unless otherwise indicated, install ductwork sloped at minimum 1 percent slope for proper condensate drainage in direction of flow or 2 percent slope in opposite direction of flow.

E. Joining systems shall be suitable for installation without the prior need for sanding.

F. Field Joining Materials: FRP duct manufacturer shall supply all materials needed for any required FRP duct field joining. Supply of these materials shall be in accordance with the requirements of this Section. Provide material in kit form; one kit per joint.

G. Field Joining: Any required field joining shall be accomplished by a competent person in accordance with the requirements of this Section.

H. Install in accordance with Section 40 05 07, Section 40 05 07.13, and Section 40 05 07.16.

I. Provide for expansion and contraction.

J. Large elbows and terminal ends of ducts shall be supported independently.

K. Flexible connections as described herein shall be provided between fans and ductwork, and elsewhere as indicated on the layout drawings.

L. Certify installation on Manufacturer's Certificate of Proper Installation.

M. Anti-seize thread compound on all nuts and bolts.

N. Damper axles in horizontal position unless otherwise necessary for proper installation.

O. Flange bolts shall be tightened to slightly compress gaskets without disturbing the flanges in order to make a good seal. A flat washer shall be installed under each nut and bolt head.

P. Proper alignment and grade of ductwork shall be maintained by use of laser beam equipment or surveying instruments. Surveying instruments shall be utilized for verifying laser equipment accuracy due to thermal deflection from differences between the ground temperature and the air temperature within the pipe.repair/restoration

## 3.02 QUALITY ASSURANCE

A. Provide the following information if requested/required:

1. Two sample cutouts demonstrating 50 to 60 mils as manufactured to the standard used in the fabricator's Factory Mutual approval. Structural laminate to be filament wound. Samples to be a minimum of 8-inch diameter cut out, and a

12-inch diameter piece of duct at least 12 inches long complying with ASTM C582.

2. Two copies of the fabricator's ISO 9001-based quality control manual.

B. All FRP ductwork shall be fabricated and installed by qualified, experienced mechanics, who have a minimum of 5 years' experience with the lay-up, fabrication, and jointing of this type of material.

C. Factory Inspection:

1. Owner shall be given access to the FRP ductwork and all quality control records during fabrication and upon completion for the purpose of verifying compliance to the Contract Documents.
2. The Owner shall maintain the right to tour the FRP duct manufacturer's plant anytime that fabrication is in progress prior to final shipment. The Owner may exercise the option, without any advance notice; to tour the plant and inspect all stages of fabrication to ensure that quality control is being maintained.
3. Inspection by Owner does not relieve any responsibility of the fabricator to meet the requirements of this Specification.
4. Final Inspection: The Owner may carry out a final inspection of the equipment prior to shipment. Fabricator shall give the Owner a minimum of 5 days' advance notice of scheduled ductwork shipment. Prior to final inspection by Owner, the ductwork shall be cleaned of all foreign material, and shall be in a position that allows easy access and viewing.

D. Acceptance:

1. Lack of compliance with any aspect of the Specifications and Drawings will be grounds for rejection of the equipment.
2. Repair of Rejected Equipment: The Owner, prior to implementation, must approve repair procedures. No more than 5 percent of the surface area of each FRP duct component may be repaired.

E. Quality Assurance Report:

1. The fabricator's quality control manager will provide the Owner with a complete quality control report for the job. The report will be available within 15 days after the final parts are shipped.
2. The fabricator will have available, after each shipment, the completed QC sheets for review upon request at any time.



## 3.03 QUALITY CONTROL

A. Field join ductwork only when ambient temperature is above 55 degrees F and below 100 degrees F.

B. Testing:

1. All ductwork shall be leak tested using a small high pressure blower with a calibrated orifice and manometer. The blower shall maintain at least 20 inches static pressure during the test. Leakage in the entire system shall be no more than 1 percent of the design scfm for that part of the system.
2. Seal all audible leaks.

3. Notify Owner of all tests with a minimum of a 24-hour notice.
4. Provide necessary fittings, blind flanges, etc. to isolate sections of duct and to enable all sections of ductwork to be tested.

C. Manufacturer's Services:
1. The FRP duct manufacturer shall have a representative on-site beginning with the installation of the ductwork to supervise installation of the FRP duct system. The representative shall remain on-site no less than two 8-hour days to witness installation of all ductwork to ensure the installer is employing the proper procedures.
2. The manufacturer's representative shall instruct the installer on the proper installation procedures.

D. Cleaning: Blow ductwork clean using system fans; purged continuously for not less than 48 hours at a flow rate not less than design flow rate. If required, system fan shall be throttled on inlet side to prevent motor overload. Temporary screen shall be installed on system fan inlet to protect fan from entering debris.

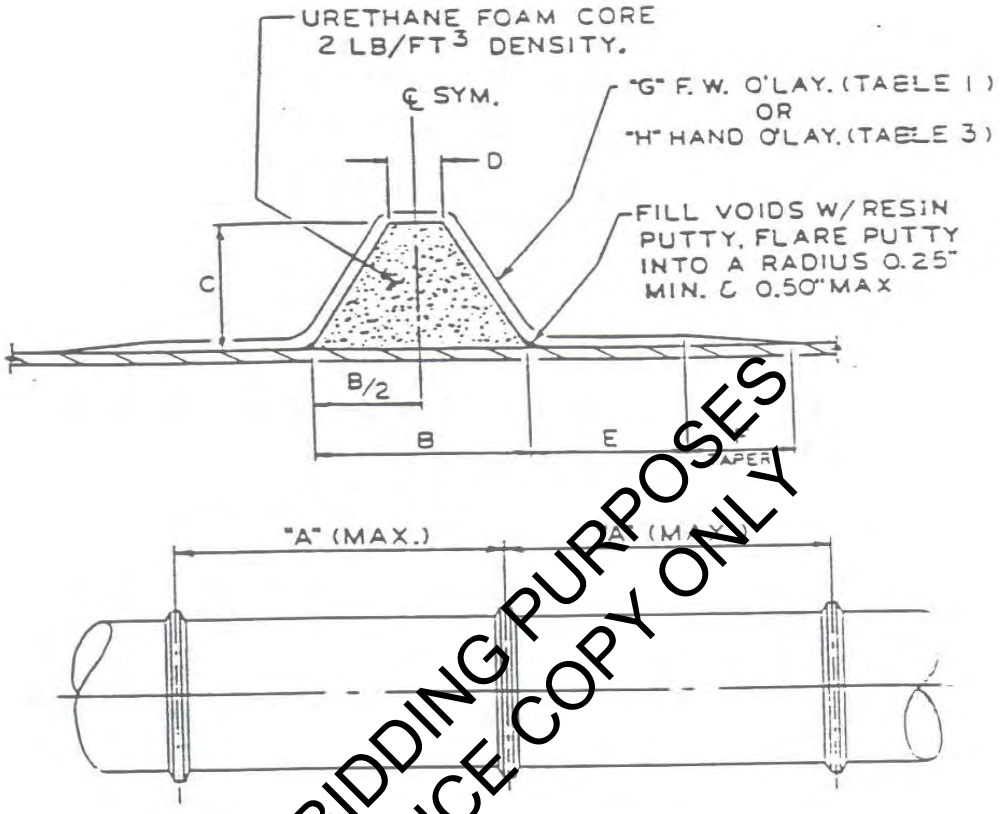
E. Testing: In addition to any testing herein, perform all testing for this product or system consistent with the requirements of Section 01 45 23, the applicable codes, and the manufacturer's current Quality Assurance program.



## 3.04 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.
1. Detail 1: FRP Duct Stiffener Installation.
2. Detail 2: FRP Drilled Flange - Duct Drilling.
3. Detail 3: 1-1/2" FRP Drilled Flange – For Duct Drain.
4. Detail 4: Duct Drain and Pressure Indicator Attachment Flange.
5. Detail 5: Blind Flanges.
6. Detail 6: 1-1/2" Dia. Duct Drain and P.I. Nozzle Installation.
7. Detail 7: FRP Butt Joints.
8. Detail 8: FRP Tee Joints.
9. Detail 9: FRP Miter Joints.
10. Detail 10: FRP Lateral Joints.
11. Detail 11: FRP Butt Joints and Tee Joints Charts.
12. Detail 12: Damper Nozzle Installation.
13. Detail 13: 90 and 45 Degree Elbows. All elbows shall be long radius.
14. Detail 14: Eccentric and Concentric Reducers.
15. Detail 15: 90 Degree Tee and Cross.

**END OF SECTION**

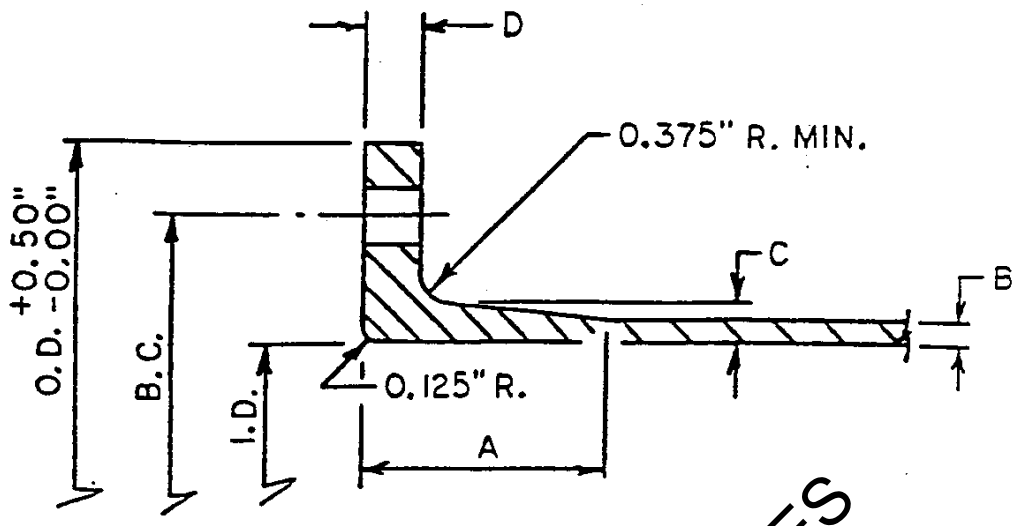





| DUCT SIZE | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 42" | 15'-0" | 2" | 2" | 1" | 4" | 2" | 0.28" | 0.29" |
| 48" | 15'-0" | 2" | 2" | 1" | 4" | 2" | 0.28" | 0.29" |
| 54" | 15'-0" | 2" | 2" | 1" | 4" | 2" | 0.28" | 0.29" |
| 60" | 15'-0" | 3" | 3" | 1" | 4" | 2" | 0.28" | 0.29" |
| 72" | 10'-0" | 3" | 3" | 1" | 4" | 2" | 0.28" | 0.29" |

FRP DUCT STIFFENER INSTALLATION

DETAIL - 1

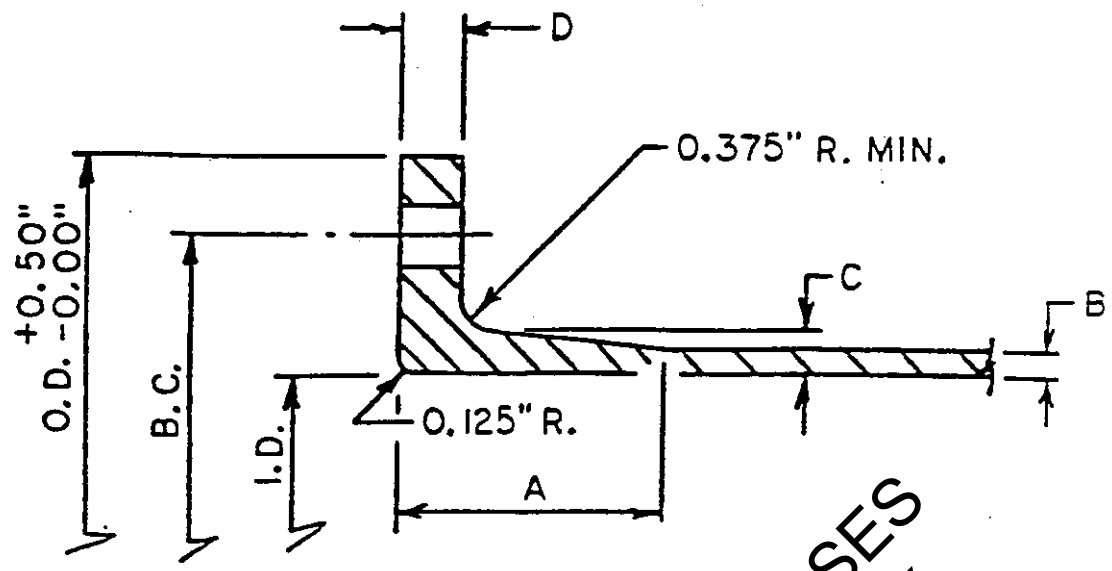



| NOZZLE I.D. | NOZZLE O.D | BOLT CIRCLE | NO. OF BOLT HOLES | DIA. OF BOLT HOLES | A | B (table 2) | C | D |
|---|---|---|---|---|---|---|---|---|
| 12" | 16 3/8" | 15" | 12 | 1/2" | 2" | 0.30" | 0.47" | 0.50" |
| 14" | 18 3/8" | 17" | 12 | 1/2" | 2" | 0.30" | 0.47" | 0.50" |
| 16" | 20 3/8" | 19" | 16 | 1/2" | 2 1/2" | 0.30" | 0.54" | 0.63" |
| 18" | 22 3/8" | 21" | 16 | 1/2" | 2 1/2" | 0.37" | 0.60" | 0.63" |
| 20" | 24 3/8" | 23" | 20 | 1/2" | 2 1/2" | 0.37" | 0.60" | 0.63" |
| 24" | 28 3/8" | 27" | 20 | 1/2" | 2 1/2" | 0.41" | 0.60" | 0.63" |
| 30" | 34 3/8" | 33" | 28 | 1/2" | 2 1/2" | 0.41" | 0.63" | 0.63" |
| 36" | 40 3/8" | 39" | 32 | ½" | 2 ½" | 0.48" | 0.63" | 0.63" |
| 42" | 46 3/8" | 45" | 36 | ½" | 2 ½" | 0.47" | 0.75" | 0.75" |
| 48" | 54 3/8" | 52" | 44 | 5/8" | 3" | 0.48" | 0.75" | 0.75" |
| 54" | 60 3/8" | 58" | 44 | 5/8" | 4" | 0.61" | 1.00" | 1.00" |
| 60" | 66 3/8" | 64" | 52 | 5/8" | 4" | 0.61" | 1.00" | 1.00" |
| 72"X24" | 80"X32" | *** | *** | *** | 4" | 0.61" | 1.00" | 1.00" |

*** To be designed by Contractor

FRP DRILLED FLANGE - DUCT DRILLING

DETAIL - 2



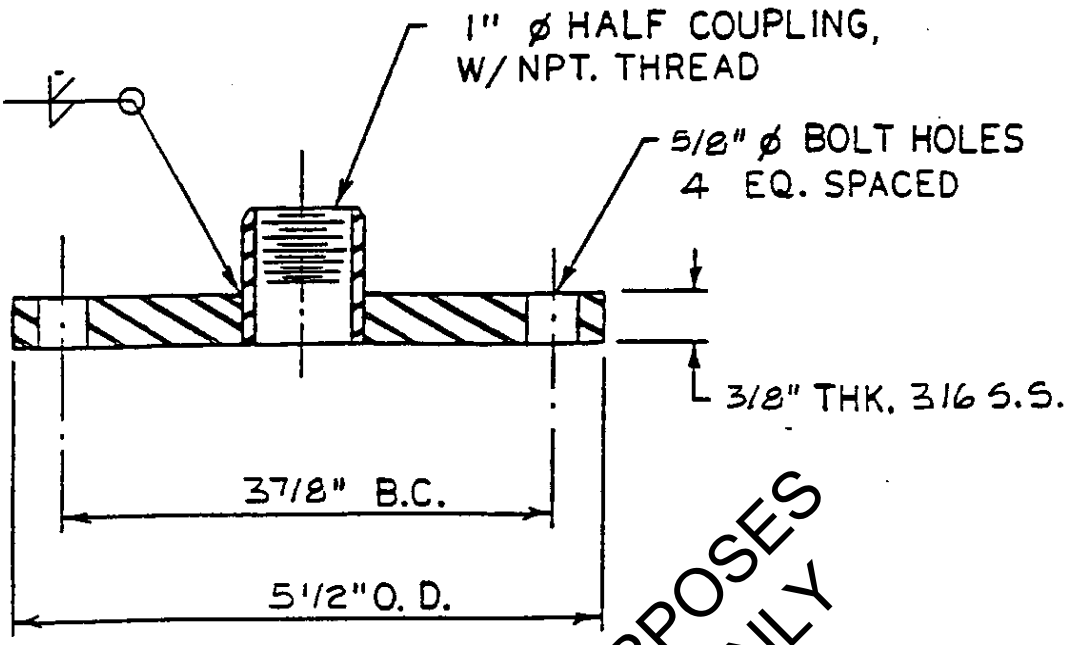



125/150 PATTERN

| NOZZLE I.D. | O.D | B.C. | NO. OF BOLT HOLES | DIA. OF BOLT HOLES | A | B | C | D |
|---|---|---|---|---|---|---|---|---|
| 1 ½" | 5" | 3 7/8" | 4 | 5/8" | 2" | 0.22" | 0.50" | 0.50" |

1 ½" FRP DRILLED FLANGE – FOR DUCT DRAIN

DETAIL - 3




1 ½" FLANGE



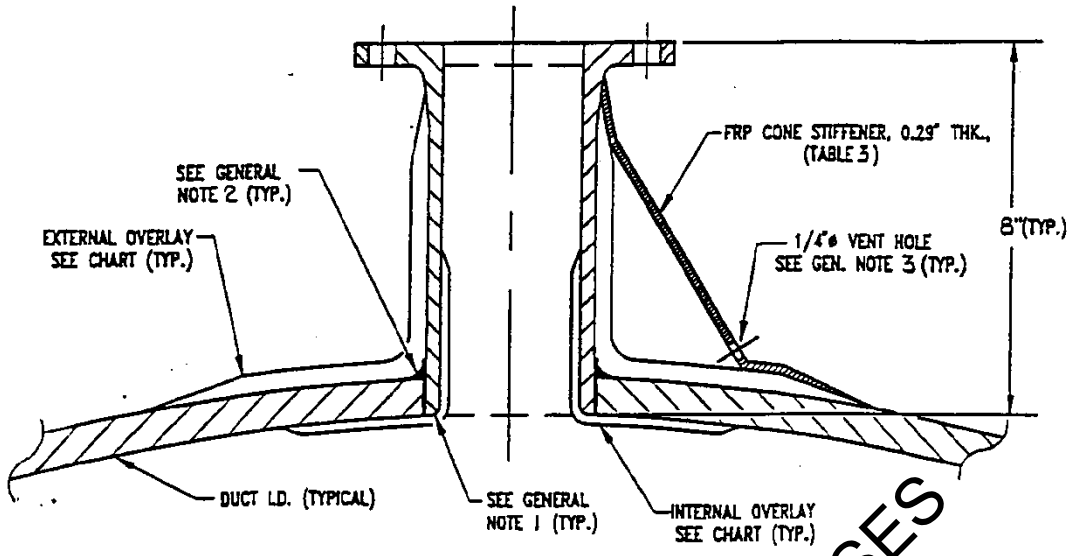
DUCT DRAIN AND PRESSURE INDICATOR ATTACHMENT FLANGE

DETAIL - 4

| NOZZLE I.D. | NOZZLE O.D | BOLT CIRCLE | NO. OF BOLT HOLES | DIA. OF BOLT HOLES | A (table 2) |
|---|---|---|---|---|---|
| 12" | 16 3/8" | 15" | 12 | 1/2" | 0.30" |
| 14" | 18 3/8" | 17" | 12 | 1/2" | 0.30" |
| 16" | 20 3/8" | 19" | 16 | 1/2" | 0.30" |
| 18" | 22 3/8" | 21" | 16" | 1/2" | 0.37" |
| 20" | 24 3/8" | 23" | 20 | 1/2" | 0.37" |
| 24" | 28 3/8" | 27" | 20 | 1/2" | 0.41" |
| 30" | 34 3/8" | 33" | 28 | 1/2" | 0.41" |
| 36” | 40 3/8” | 39” | 32 | ½” | 0.48” |
| 42” | 46 3/8” | 45” | 36 | ½” | 0.47” |
| 48” | 54 3/8” | 52” | 44 | 5/8” | 0.48” |
| 54” | 60 3/8” | 58” | 44 | 5/8” | 0.61” |
| 60” | 66 3/8” | 64” | 52 | 5/8” | 0.61” |

BLIND FLANGES

DETAIL = 5




| NOZZLE I.D. | EXTERNAL OVERLAY | | INTERNAL OVERLAY | |
|---|---|---|---|---|
| | THK. (TABLE 3) | WIDTH (TABLE 5) | THK. (TABLE 4) | WIDTH. (TABLE 6) |
| 1 1/2" | 0.29" | 10" | 0.11"-(MMCC)" | 4" |



GENERAL NOTES:

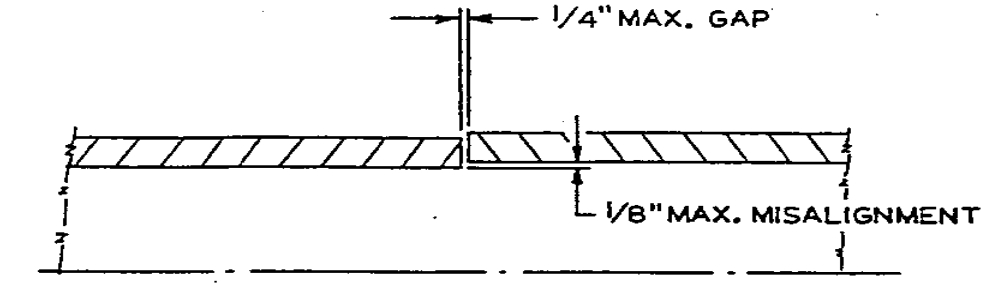
1. RADIUS INSIDE EDGE OF NOZZLE, IF INTERNAL OVERLAY IS APPLIED, 1/8" MIN. TO ¼" MAX. WHERE INTERNAL OVERLAY IS NOT POSSIBLE RESIN COAT EDGES AS SHOWN IN DETAIL-10 AND APPLY 0.30" THICK EXTERNAL OVERLAY.

2. FILL VOIDS WITH RESIN PUTTY. FLARE PUTTY INTO A RADIUS ¼" MIN. TO 3/8" MAX.

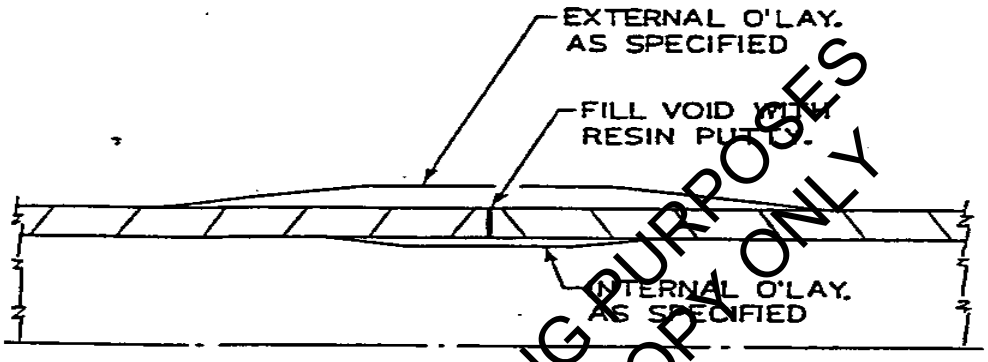
3. LOCATE VENT HOLE AS LOW AS POSSIBLE, RESIN COAT EDGE OF HOLE.

1 ½" DIA. DUCT DRAIN AND P.I. NOZZLE INSTALLATION

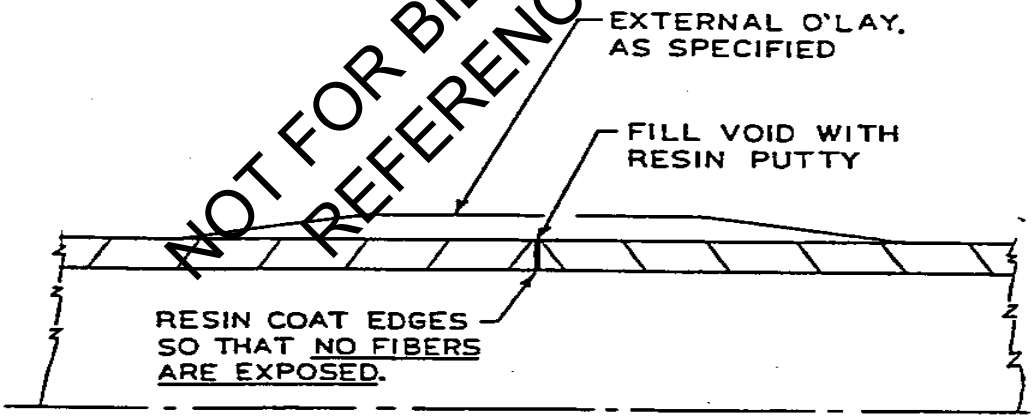
DETAIL - 6




JOINT TOLERANCE




JOINT W/ INTERNAL OVERLAY

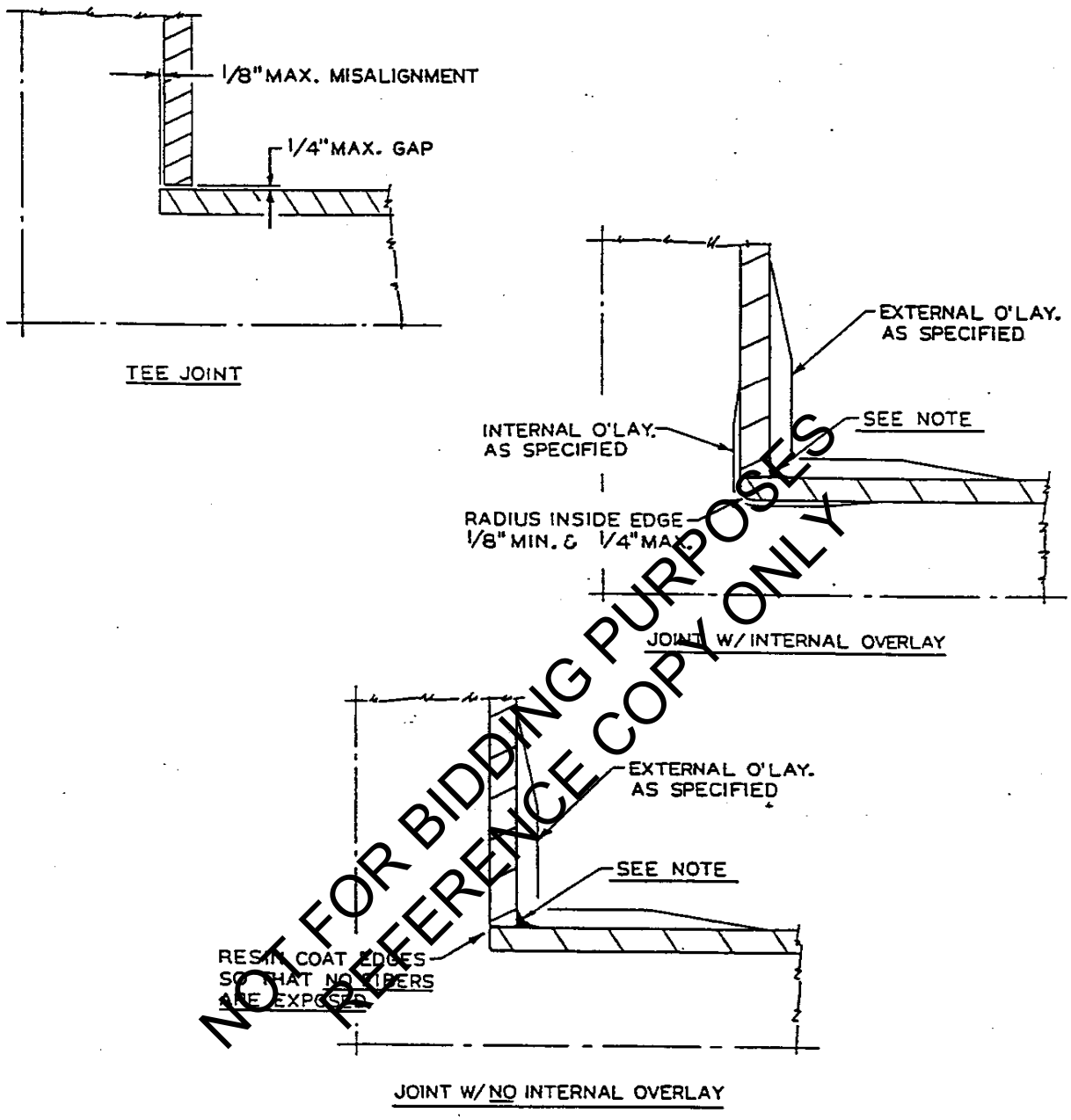



JOINT W/ NO INTERNAL OVERLAY



FRP BUTT JOINTS

DETAIL - 7



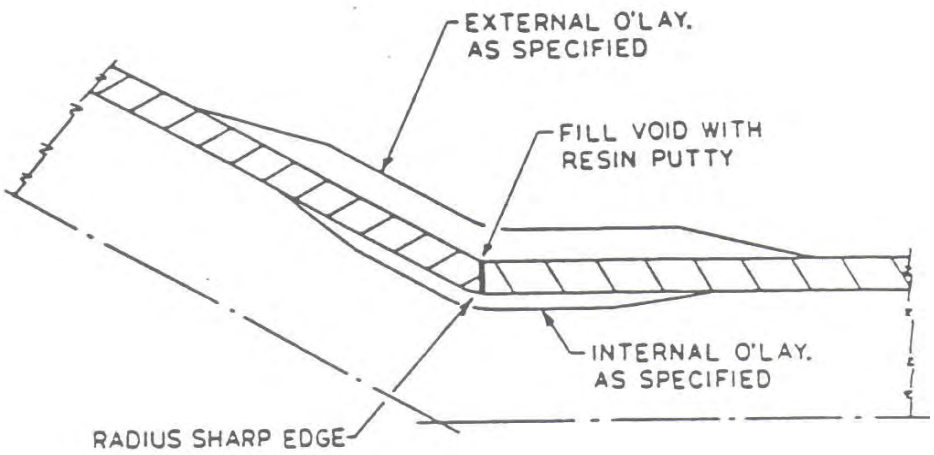



GENERAL NOTE:

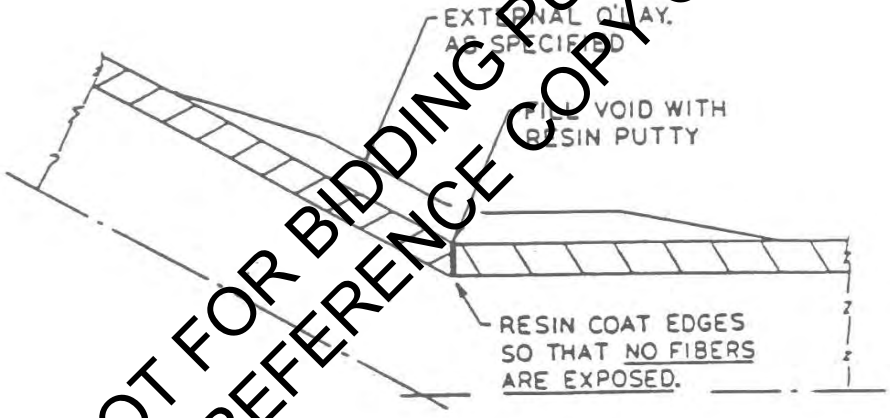
1. FILL VOIDS WITH RESIN PUTTY AS SHOWN. FLARE PUTTY INTO A RADIUS ¼" MIN. TO 3/8" MAX.

FRP TEE JOINTS

DETAIL – 8




JOINT W/ INTERNAL OVERLAY

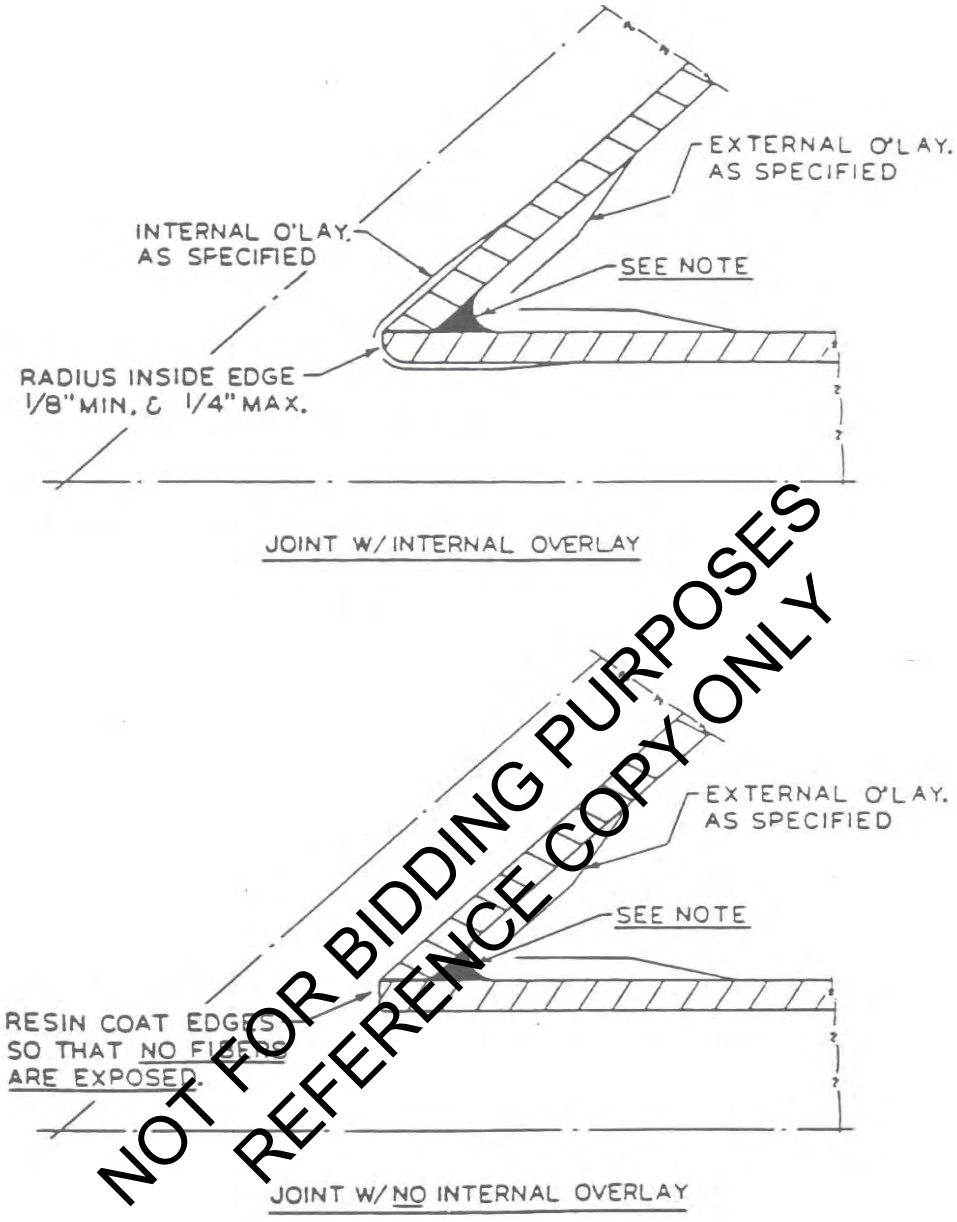



JOINT W/ NO INTERNAL OVERLAY



FRP MITER JOINTS

DETAIL - 9






GENERAL NOTE:

1. FILL VOIDS WITH RESIN PUTTY AS SHOWN, FLARE PUTTY INTO A RADIUS 3/8" MIN.AND ¾" MAX

FRP LATERAL JOINTS

DETAIL – 10

| FRP DUCT BUTT JOINT OVERLAY | | |
|---|---|---|
| DUCT I.D. | EXTERNAL OVERLAY ( TABLE 2 ) | |
| | THK. | WIDTH |
| 12" | 0.30" | 8" |
| 14" | 0.30" | 8" |
| 16" | 0.30" | 8" |
| 18" | 0.37" | 10" |
| 20” | 0.37" | 10" |
| 24" | 0.36" | 10" |
| 30" | 0.36" | 12" |
| 36" | 0.36" | 14" |
| 42" | 0.36" | 14" |
| 48” | 0.40” | 14” |
| 54” | 0.47” | 14” |
| 60” | 0.47” | 16” |
| 72” | 0.47” | 16” |

Note: For 24" Dia. And Larger, and where accessible apply an internal overlay (MMCCX6"wide)

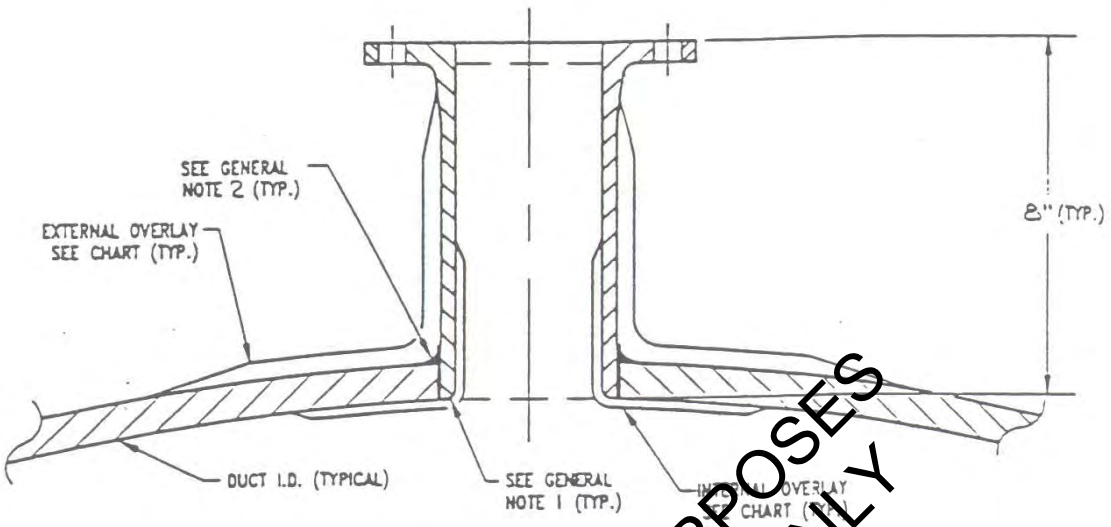
| FRP DUCT TEE JOINT OVERLAY | | |
|---|---|---|
| DUCT | EXTERNAL OVERLAY ( TABLE 2 ) | |
| I.D. | THK. | WIDTH |
| 12" | 0.30" | 10" |
| 14" | 0.30" | 10" |
| 16" | 0.30" | 10" |
| 18" | 0.37" | 12" |
| 20" | 0.37" | 12" |
| 24" | 0.37" | 12" |
| 30" | 0.37" | 14" |
| 36" | 0.37" | 14" |
| 42" | 0.4" | 14" |
| 48” | 0.4” | 16” |
| 54” | 0.4” | 16” |
| 60” | 0.4” | 16” |

Note: For header diameter 24" and larger and where accessible, apply an internal overlay (MMCCX6"wide)



FRP BUTT JOINTS AND TEE JOINTS CHARTS

DETAIL - 11




| NOZZLE I.D. | EXTERNAL OVERLAY | | INTERNAL OVERLAY | |
|---|---|---|---|---|
| | THK. | WIDTH | THK. | WIDTH |
| 12” | 0.36” | 14” | 0.11” | 6” |
| 14” | 0.36” | 14” | 0.11” | 6” |
| 20” | 0.36” | 14” | 0.11” | 6” |

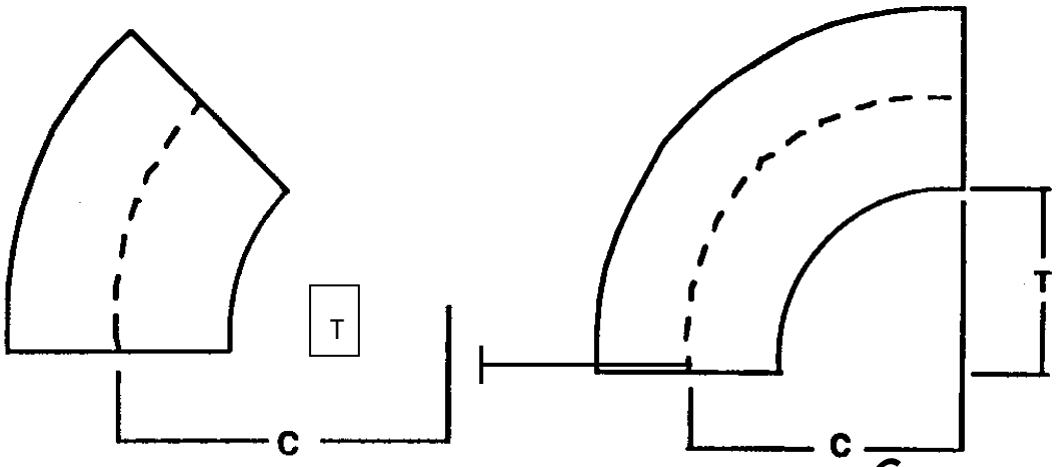


GENERAL NOTES:

1. RADIUS INSIDE EDGE OF NOZZLE 1/8” MIN. TO 1/4” MAX.
2. FILL VOIDS WITH RESIN PUTTY, FLARE PUTTY INTO A RADIUS 1/4 MIN. TO 3/8” MAX.

DAMPER NOZZLE INSTALLATION

DETAIL – 12




| DIAMETER | C | DIAMETER | C |
|---|---|---|---|
| 4” | 6” | 22” | 33” |
| 5” | 7 1/2” | 24” | 36” |
| 6” | 9” | 26” | 39” |
| 7” | 10 1/2” | 28” | 42” |
| 8” | 12” | 30” | 45” |
| 9” | 13 1/2” | 32” | 48” |
| 10” | 15” | 36” | 54” |
| 12” | 18” | 42” | 63” |
| 14” | 21” | 48” | 72” |
| 16” | 24” | 54” | 81” |
| 18” | 27” | 60” | 90” |
| 20” | 30” | 70” | 105” |



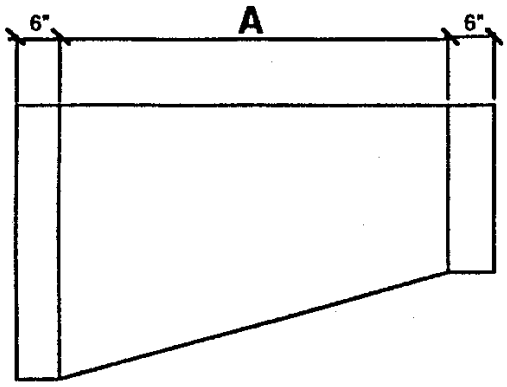
LONG RADIUS ELBOWS — SHORT RADIUS ELBOWS
C = 1.5 x DIAMETER — C = 1.0 x DIAMETER
T = 1.0 x DIAMETER — T = 0.5 x DIAMETER

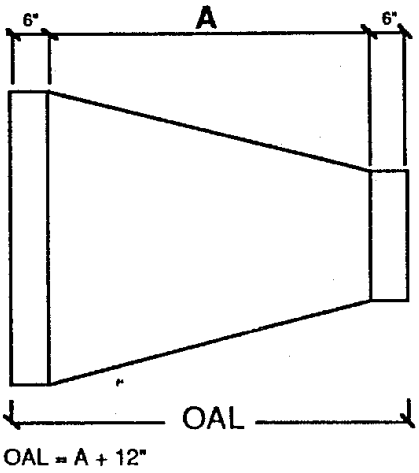
GENERAL NOTE:

1. ELBOWS 2” DIA. THROUGH 30” DIA ARE ONE (1) PIECE MOLDED SMOOTH RADIUS. 32”DIA AND LARGER ARE FIVE (5) PIECE MITERED 90 DEGREE ELBOWS AND 3 PIECE MITERED 45 DEGREE ELBOWS.

90 AND 45 DEGREE ELBOWS

DETAIL – 13




ECCENTRIC REDUCER

| INCHES OF REDUCTION | A |
|---|---|
| 1” | 4 ¼” |
| 2” | 8” |
| 3” | 11 ¾” |
| 4” | 15 1/2” |
| 5” | 19 1/4” |
| 6” | 23” |
| 7” | 26 3/4” |
| 8” | 30 1/4” |
| 9” | 34” |
| 10” | 37 ¾” |
| 11” | 41 1/2” |
| 12” | 45 1/4” |
| 13” | 49” |
| 14” | 52 3/4” |
| 15” | 57 1/4” |
| 16” | 64” |
| 17” | 67 3/4” |
| 18” | 71 1/2” |
| 19” | 69 1/4” |
| 20” | 75 1/4” |

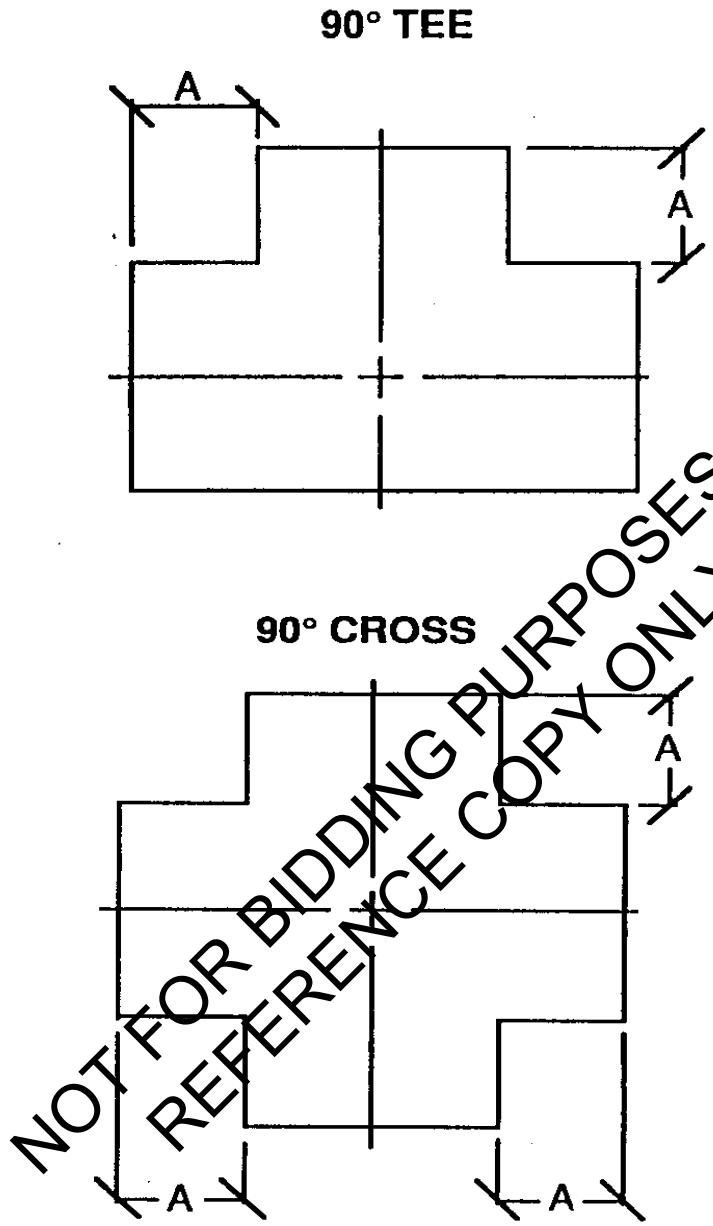
CONCETRIC REDUCER

| INCHES OF REDUCTION | A |
|---|---|
| 1” | 2 1/8” |
| 2” | 4” |
| 3” | 5 7/8” |
| 4” | 7 3/4” |
| 5” | 9 5/8” |
| 6” | 11 1/2” |
| 7” | 13 3/8” |
| 8” | 15 1/8” |
| 9” | 17” |
| 10” | 18 7/8” |
| 11” | 20 3/4” |
| 12” | 22 5/8” |
| 13” | 24 1/2” |
| 14” | 26 3/8” |
| 15” | 28 5/8” |
| 16” | 32” |
| 17” | 33 7/8” |
| 18” | 35 3/4” |
| 19” | 34 5/8” |
| 20” | 37 5/8” |



ECCENTRIC AND CONCENTRIC REDUCERS

DETAIL – 14






FOR DIAMETERS 10" DIA AND SMALLER: A = 4" AND FOR DIAMETERS 12" DIA AND LARGER: A = 6"

90 DEGREE TEE AND CROSS

DETAIL - 15

SECTION 23 37 13.13

DIFFUSERS REGISTERS AND GRILLES

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This section specifies all diffusers, registers, and grilles associated with the heating, ventilating, and air conditioning systems.

### 1.02 QUALITY ASSURANCE

A. Reference:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ANSI / ASHRAE 70 | Method of Testing the Performance of Air Outlets and Air Inlets |
| SMACNA | Sheet Metal and Air Conditioning Contractors' National Association |



### 1.03 SUBMITTALS

A. The following information shall be provided in accordance with Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for

any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Catalog data and a complete description of the diffusers, registers, grilles, and accessories.
3. Specified air quantity, discharge pattern, throw, static pressure drop, and acoustical performance.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. A factory applied finish shall be provided as scheduled on the drawings. Color for diffusers installed in ceilings shall match ceiling tile color. Each unit shall be set flat against the room surface finish and shall have a felt gasket or seal to prevent air leakage. Diffusers, grilles, and registers shall be as specified on the drawings. All air outlets shall be factory painted and protected prior to shipment. Color shall be as selected by the Engineer. All diffusers, registers, and grilles shall be by a single manufacturer.

### 2.02 MANUFACTURERS

A. The Owner and Engineer believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement however shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed to mean that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Titus, Price, or approved equal.

### 2.03 DAMPERS

A. Dampers where specified shall be of the same material as the diffuser, furnished by the diffuser manufacturer, and shall be operated by a key through the diffuser face.



## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Diffusers, registers, and grilles shall be aligned, connected, and installed in accordance with the manufacturer's recommendations and with SMACNA Standards. Adjust diffuser vanes to maximize air coverage in the room being ventilated.

### 3.02 TESTING AND BALANCING

A. Testing, adjusting, and balancing shall be as specified in Section 23 05 93.

**END OF SECTION**

SECTION 23 52 39

HOT WATER BOILER

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This section specifies the dual fuel boiler.

B. Type:
   1. Boiler to be dual fuel, accepting Fuel Oil and Natural Gas.

### 1.02 DESIGN AND PERFORMANCE CRITERIA

A. Design and Performance Requirements:
   1. Design boiler and all appurtenances to meet the following minimum performance requirements at an altitude of 100 feet using altitude correction and in accordance with the conditions specified in this Section:

| | |
|---|---|
| a) Gross output, minimum BTU/hr HHV | 2,100,000 |
| b) Nominal capacity, boiler hp | 63.8 |
| c) Fuel input at rated capacity | |
| 1) Oil (GPH) | 17.6 |
| 2) Natural gas (MBH) | 2,547 |
| d) Hot water flow rate, gpm | 220 |
| e) Hot water discharge temperature, °F | 200 |
| f) Return hot water temperature, °F | 180 |
| j) Thermal Efficiency | |
| 1) Oil (GPH) | 86.5% |
| 2) Natural gas (MBH) | 83.9% |



### 1.03 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.
   2. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date,

regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| AMBA | American Boiler Manufacturers Association |
| ASME | Boiler and Pressure Vessel Code, Section IV |
| ASME CSD-1 | Control and Safety Devices for Automatically Fired Boilers [2015 or current edition] |
| FM | Factory Mutual |
| NFPA 70 | National Electrical Code [2014 or current] Edition |
| NFPA 85 | Boiler and Combustion Systems Hazards [2015 or current edition] |
| UL 795 | Commercial-Industrial Gas-Fired Heating Equipment [2016 or current edition] |

B. Requirements of Regulatory Agencies:

1. Boiler unit must be completely packaged, fire-tested, listed, and rated by the AMBA. Components must be UL labeled. Labeling requirement includes but is not limited to: all electrical devices and panels, all gas train components and devices as required for natural gas boilers, boiler logic controllers, and motors. Complete boiler package must meet all applicable safety requirements. Fire test, using natural gas and fuel oil.
2. Design and construct boiler in accordance with the latest edition of the ASME code for hot water service and to National Board Rules. Pressure-relief valves and boiler must bear the ASME seal.



## 1.04 UNIT RESPONSIBILITY

A. Design, selection and operation of all systems and components, including boiler and boiler stack must be performed by equipment manufacturer.

B. Factory test packaged boilers to check the construction, controls, and operation of the units. Hydrostatically test in accordance with ASME Boiler Code. Provide a copy of all test results and manufacturer ASME data sheets to the Owner's Representative.

## 1.05 SUBMITTALS

A. Provide submittals with the following information:

1. Use check-marks (✓) to denote full compliance with a paragraph. Underline and denote deviations with a number in the margin to the right of the identified paragraph. Remaining portions of the paragraph not underlined signify the Contractor's compliance with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment. Include addendum updates applying to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with "no

changes required". Failure to include copies of relevant drawings with the submittal will cause for rejection of the entire submittal with no further review.

2. Manufacturer's catalog and/or other data confirming conformance to specified design, material and equipment requirements.
3. Predicted performance data and/or curves as applicable developed for the specific application, confirming conformance to specified design and operating requirements and characteristics.
4. Electrical and control diagrams.
5. Installation requirements, showing clearance required for maintenance purposes.
6. Motor data.
7. Temperature of flue gas in the stack using natural gas at 25, 50, 75, and 100 percent firing rate.
8. Boiler efficiency using natural gas at 25, 50, 75, and 100 percent of rated capacity.
9. Boiler emissions using natural gas, at 100 percent load.
10. Boiler emissions using fuel oil, at 100 percent load.
11. Piping connection sizes for the hot water supply and return, exhaust stack, and other appurtenances.
12. Hot water flow, pressure drop through boiler.
13. Hold up water volume of all the water contained within the operating boiler.
14. Gas train and all safety equipment details for both gases.
15. Estimated pressure drop through gas train at rated condition.
16. Information and data for all instrumentation and controls, and for the control panel, including wiring and interconnection diagrams.
17. Control panel layout drawing, wiring diagrams, and fabrication details. Layout drawing must include a component bill of materials listing, indicating all control panel components, their manufacturer, model, and quantity.
18. Engineering calculations for anchorage and bracing system for equipment. Additional quality assurance submittals.
19. A complete description of the stack, breeching and accessories sufficient to demonstrate compliance with these Specifications, including performance data at given conditions.
20. Operating and Maintenance Data.
21. Controller and OIT display programs, in color. Programs must include all logical functions, I/O summary, screen shots, and configurations for review and approval prior to shipment of the system to the installation site. Final versions provided in both .pdf printed format and original software files, in compact disk format.
22. Safety relief valve capacity, size drawings and details. Include selection details included to describe the method used to size the valve or valves, identify the spring or devices needed to provide required relief pressure and describe installation details.



## 1.06 FACTORY TESTING

A. Completely assemble boiler and test at the factory on natural gas fuel and fuel oil, prior to shipment.

B. Submit a copy of the test results as Product Data, 2.04.

## 1.07 SHIPMENT, PROTECTION AND STORAGE

A. After completion of factory test. Dismantle, mark and ship piping and items of equipment or trim that could be damaged in shipment separately in safe packaged containers.

# PART 2 PRODUCTS

## 2.01 ACCEPTABLE MANUFACTURER

A. Boiler manufacturer must be prepared to demonstrate at least 10 years of similar experience.

B. The following candidate manufacturers are believed to be capable of producing equipment and/or products that will satisfy the requirements of this section. This statement cannot be construed as an endorsement of a manufacturer's products, nor can it be construed that the named manufacturer's standard equipment or products will comply with the requirements of this section. Candidate manufacturers include Burnham Commercial Boilers or approved equal.

## 2.02 MATERIALS AND CONSTRUCTION

A. Boiler:

1. Hot water boiler shall be a high efficiency, pressurized, cast iron sectional wet base boiler and not require a refractory combustion chamber. It shall be suitable for forced draft firing and capable of achieving a minimum combustion efficiency of 88% fired with No. 2 oil and 85% fired with gas. Thermal efficiency shall be a minimum of 86% with No. 2 oil and 83% fired with gas. Heat transfer shall be enhanced by the addition of removable baffles.
2. Boiler shall be a 3-pass cast iron sectional type design with large combustion chamber and horizontal flue passes with cast fins. Class 25 high silicone content cast iron shall provide resistance to temperature variations and thermal stress. A high-temperature silicone-coated fiberglass rope gasket will be compressed into a cast tongue and groove connection around the perimeter of the section, providing a durable, gas-tight seal.
3. Boiler shall have a return mixing tube with drilled openings in each section, allowing proportionate distribution of return water throughout the entire section assembly. Cool return water shall be pre-heated by the hot supply water as it enters the section assembly thereby reducing thermal stress on individual sections without the use of external mixing devices. Boiler supply water temperatures, measured on the supply manifold shall be no less than 200°F. Return water coming back to the boiler may be no less than 180°F.
4. A single supply water manifold shall be located at the rear of the boiler with eight tappings for the installation of temperature and pressure controls, gauges, probe-type low water cut-offs, and electronic control sensors. A single top rear return connection shall be considered standard equipment.
5. Boiler shall be furnished as a knocked down unit for field erection. Sections shall be assembled using precision machined cast iron push nipples.
6. Cast iron burner swing door shall be lined with lightweight refractory insulation and shall have reversible hinges, allowing a minimum of 90° swing to the left or right side of boiler, allowing unobstructed access to combustion chamber and flue passages.

The flue passages and combustion chamber shall be accessible from the front of the boiler for cleaning, and from the back of the boiler to vacuum soot and combustion residue from the fireside.

7. Rear flue collector, with test tapping, shall be constructed of cast iron and shall be concealed under a highly insulated boiler jacket.
8. Boiler shall be equipped with a flange mounted flame retention type burner. Input, output and combustion efficiency shall be certified to efficiency test procedures specified in I=B=R/BTS-2000. Boiler efficiencies must meet ASHRAE 90.1 and the National Energy Policy Act of 1992 requirements.
9. Boiler shall be constructed for 80 PSI water working pressure in accordance with the ASME Section IV Rules for Construction of Heating Boilers. Individual sections shall have been subjected to a hydrostatic pressure test of 200 PSIG at the factory before shipment and they shall be stamped or cast with the ASME 'H' symbol.
10. The boiler shall be provided with a heavy duty 20 gauge steel jacket with modular 4-inch thick insulation and have a rust resistant powder coat finish. The boiler jacket shall contain a concealed electrical chaseway for power and limit circuit wiring within the top jacket panels, providing a clean finished look when the jacket is installed. Individual lift-off jacket side panels may be installed after system piping and allow ease of access to the boiler sections.
11. Boiler trim shall include:
    a. One (1) 3-1/2" inch dia. combination pressure-temperature gauge.
    b. Safety high limit aquastat; auxiliary safety high limit aquastat with manual re-set (must specify on order); low fire hold aquastat (LHL and full modulation burners only).
    c. Firing rate controller.
    d. Dial type stack thermometer, minimum 3" dial face, ½" NPT connection.
    e. ASME Section IV safety relief valve sized to exceed the gross output of the boiler which shall be factory set to relieve pressure at 50 PSI water working pressure.
    f. One (1) low water cutoff device with manual reset, to comply with CSD-1 requirements. Boiler shall be fitted with a probe type LWCO located above the lowest safe permissible water level established by the boiler manufacturer. LWCO shall be UL listed and FM approved, suitable for commercial hydronic heating service at 80 PSI.



## 2.03 INSTRUMENTATION AND CONTROL SYSTEM

A. General:

1. Supply a boiler control system to provide safety interlocks and water temperature control. The control system shall be fully integrated into the burner control cabinet and incorporate single and multiple boiler control logic, inputs, outputs and communication interfaces. The control system shall co-ordinate the operation of up to eight (8) fully modulating hot water boilers and boiler pumps. The control system shall simply control boiler modulation and on/off outputs based on the boiler water supply temperature and an operator-adjusted setpoint. However, using parameter menu selections, the control system shall allow the boiler to respond to remote system water temperature and outside air temperatures with domestic hot water priority (DHWP) and warm weather shut down (WWSD) or building automation system (BAS) firing rate demand, remote setpoint or remote start/stop commands.

B. Boiler Control

1. Using PID (proportional-integral-derivative) based control, the remote system water temperature shall be compared with a setpoint to establish a target boiler firing rate. If the secondary loop GPM is greater than the primary loop GPM, firing rate is increased in response to the decrease in secondary loop temperature. When the remote system temperature is near the boiler high limit temperature, the boiler supply sensor shall limit the maximum boiler supply temperature to prevent boiler high limit trips. Alternately, using parameter menu selections, the control system shall allow the boiler to respond directly to boiler supply temperature and setpoint to establish a target boiler firing rate while remote system water temperature is used for display purposes only. Each boiler's fuel flow control valve shall be mechanically linked to the air flow control device to assure an air rich fuel/air ratio. All the automated logic required to ensure that pre-purge, post-purge, light-off, and burner modulation shall be provided.

C. Hot Water Temperature Setpoint

1. When the controller is in the local control mode, the control system shall establish the setpoint based on outside air temperature and a reset function curve, or be manually adjusted by the operator. When enabled, the setpoint shall be adjusted above a preset minimum setpoint upon sensing a domestic hot water demand contact input. When in remote mode, the control system shall accept a Modbus or 4-20 mAdc remote setpoint or firing rate demand signal from an external BAS.

D. Multiple Boiler Sequence

1. Multiple boilers shall be modulated in "unison" (all at the same firing rate). The control system shall utilize both water temperature and boiler firing rate percent to start and stop the boilers and shall minimize the total number of boilers in operation. The control system shall start and stop boilers when the water temperature is outside the adjustable temperature limit for longer than the adjustable time delay. In order to minimize temperature deviations, the control system shall start and stop the next boiler when the "lead" boiler is at an adjustable firing rate limit for longer than the adjustable time delay. The control system shall monitor both boiler lockout and limit circuits to automatically skip over those boilers that are powered down for maintenance, tripped or otherwise will not start. When rotation is enabled the lead boiler shall automatically rotate every 1 to 168 hours. The boiler shall be run at low fire for warm-up for a preset low fire hold time. When enabled, warm weather shut down control logic shall prevent boiler operation.

E. User Interface

1. A panel front-mounted English language, two line, sixteen character LCD message display shall be provided to display numeric data, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and boiler historical information. Historical information shall include the last ten lockout and alarm conditions, number of boiler cycle, boiler hours and last ten low boiler return temperature events. When boiler return water temperature is below a minimum setpoint a low temperature events shall be stored with time, date, "lowest temperature for event" and "duration below setpoint" data. A panel mounted red alarm light shall annunciate alarm messages. Alarm conditions requiring a manual reset shall be annunciated by a flashing red light. At a minimum, the boiler system shall display the following:

a. Numeric Display with Engineering Units:
   1) Boiler Supply Water Temperature
   2) Boiler Return Water Temperature
   3) Remote System Temperature (when required by contract drawings)
   4) Outside Air Temperature (when required by contract drawings)
   5) Firing Rate %
   6) Boiler Temperature Setpoint
   7) Mixing Valve % (when required by contract drawings)
b. Status, Startup And Shutdown Sequence English language Messages:
   1) Boiler disabled
   2) Warm Weather Shutdown
   3) Lockout
   4) Pump Purge
   5) Limit Hold
   6) Purge / Pilot Ignition
   7) Low Fire / Pilot Ignition
   8) Main Burner Ignition
   9) Boiler Running
   10) Fan Post Purge
   11) Pump Cooldown
   12) Standby
c. Alarm, System Diagnostic, First-Out English language Messages: (numeric code numbers shall not be acceptable):
   1) Low Water Level (when required by contract drawings)
   2) Low Water Flow (when required by contract drawings)
   3) Fuel Limit (gas pressure or oil temperature)
   4) High Boiler Supply Temperature Limit
   5) Low Return Water Temperature
   6) Low Air Flow
   7) Flame Safeguard Internal Fault
   8) High Supply Temperature
   9) Supply Temperature Sensor Fault
   10) Return Temperature Sensor Fault
   11) Outside Air Temperature Sensor Fault
   12) Remote System Temperature Sensor Fault
   13) Remote Input Signal Fault
   14) Modbus Communication Fault
   15) Memory Fault

F. Flame Safeguard (FSG)
   1. An industrial duty microprocessor-based FSG shall provide: safety interlocks, flame monitoring protection and timed sequences. Sequences shall include forced draft fan start and stop, furnace purge, burner light-off and shutdown and post-purge. FSG

components shall be fully integrated for automatic sequencing of light-off and shutdown.

G. Boiler Pump Sequence

1. Include primary water pump control to allow boiler warm-up to the return water temperature before the boiler start; continue water flow for an adjustable cool down period after the boiler has stopped; and ensure water is always moving past the remote system temperature sensor even after the last boiler has been stopped. The pump shall immediately stop if any trips occur during pre-purge, pilot, or main flame trial for ignition.

H. Flue Gas Condensate Protection

1. Include alarms and control logic to help prevent corrosion in the boiler due to sustained flue gas condensation. These features become increasingly important as we add energy savings modulation and outdoor air reset functions. Provide a 4-20 mAdc, 3 way mixing valve control output based on PID control, measured boiler return temperature and minimum return temperature setpoint or measured boiler return and supply temperature difference and differential setpoint. If the boiler return water temperature drops below setpoint or the differential temperature is excessive the valve shall open to allow hot boiler supply water to blend with cold return water temperature. The valve repositions toward 0% recirculation after return water temperature increases above setpoint. Low boiler return water temperature shall be alarmed using an alarm message, indicating light and an alarm contact out-put. Excessively low boiler return temperature events shall be stored with boiler historical data.

I. Mixing Valve (when required by contract drawings)

1. In order to prevent low return water temperature, provide an electric actuated 3-way mixing valve with a 4-20 mAdc input control signal and slow (1 minute) travel time for each boiler. If the boiler return water temperature is below 130°F (adjustable), the valve shall slowly jog closed causing boiler supply water to blend with the return water. When the return water temperature returns to an acceptable range, the boiler supply valve shall slowly jog open.

J. Communication

1. Include an RS485 modbus slave or peer-to-peer communications data highway on each boiler control system. When peer-to-peer communication is enabled the data highway shall allow the connected boilers to exchange signals as required to provide coordinated fully modulating lead/lag functions. It shall not be required to wire individual control signals between boilers. When modbus communication is enabled the data highway shall allow individual boiler limits, lockout, boiler and system temperatures and firing rate status to be readable and water setpoint, boiler firing rate, and start/stop command to be readable and writable. Provide all equipment capabilities specified in this paragraph, even if a connecting SCADA (Supervisory Control And Data Acquisition system, typically a desk top personal computer) system is not included in this project.

K. Quality Assurance

1. The boiler control system shall be supplied as part of a factory assembled, tested burner control cabinet.

## 2.04 PRODUCT DATA

A. The following information must be provided in accordance with Section 01 33 00:
   1. Copies of all required test and inspection results.
   2. Copies of field test data confirming the following:
      a. Temperature of flue gas at stack firing natural gas at 25, 50, 75, and 100 percent firing rate.
      b. Boiler efficiency firing natural gas at 25, 50, 75, and 100 percent of rated capacity.
      c. Boiler emissions firing natural gas, at 100 percent load.
   3. Certified copies of factory test results.

## 2.05 SPARE PARTS

A. Provide recommended spare parts list.

## 2.06 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.



# PART 3 EXECUTION

## 3.01 INSTALLATION

A. General:
   1. Install boiler where shown on the Contract Drawings and in strict accordance with the manufacturer's recommendations.
   2. Pipe the safety relief valve discharge as shown on Drawings and route their outlets to a point 6 to 10 inches off the floor.
   3. Pipe the gas regulator vents and all other vents in the gas trains to discharge outdoor through the wall of the roof and terminate above the roof.
   4. Pipe all gas train valve and regulator gas vents outdoors, with piping at least one size larger than the devices vent.
   5. Provide ¾" stainless condensate drain pipe from the boiler stack drain point to floor drain adjacent to boiler. Provide stainless steel shutoff valve.
   6. Install the discharge header temperature transmitter.

## 3.02 CLEANING

A. Completely and thoroughly clean boiler before being tested or placed into service. Provide all chemicals, supervision, and labor necessary to clean the boiler, and properly dispose of all used fluids.

B. After cleaning, drain and flush with a high-pressure hose. Inspect boiler, and if any oil or scum remains, the entire cleaning procedure must be repeated.

## 3.03 FIELD QUALITY CONTROL

A. In addition to any testing herein, perform all testing for this product or system consistent with the requirements of applicable codes and NFPA, and the manufacturer's current quality assurance program.

B. After completion of installation and cleaning, the boiler will be subjected to a functional test to demonstrate compliance with specified requirements. Functional and operational tests must be performed on all boiler equipment, accessories, safety equipment, and controls as specified or provided in this Section.

C. Additionally, an operating test of a minimum of 4-hour duration on each fuel for each boiler will be performed, and a certified copy of all test results must be provided to the Owner's Representative. The automatic fuel switchover must be demonstrated by switching fuels and running the two 4-hour tests in one session. The Owner's Representative must be given 14 days written notification before any efficiency tests. The cost of all tests, and the coordination of all field testing, will be the responsibility of the contractor.

## 3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:
   1. Present at site or classroom designated by Owner for minimum training hours listed below, travel time excluded:
      a. 8 hours for functional testing and completion of manufacturer's Certificate of Proper Installation. Testing to include complete low NOx burner operation and performance instructions.
      b. 4 hours for pre-startup operation and maintenance training of Owners personnel.
      c. 4 hours for post-startup operation and maintenance training of Owners personnel.
   2. On- site exhaust emissions testing (by others) guidance and support.

**END OF SECTION**

SECTION 23 57 19

PLATE AND FRAME HEAT EXCHANGERS

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section specifies plate and frame heat exchangers.

B. Equipment List:

| Item | Equipment No. |
|---|---|
| FOG Tank Loop Heat Exchanger | HX-401 |

### 1.02 SUBMITTALS

A. Action Submittal Items for this Section:
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.
   2. Performance calculations developed for this specific application. Performance calculations shall show flow, pressure, capacity and all information to confirm compliance with the requirements of this Section.
   3. Drawings showing general dimensions and confirming the size of equipment, and piping connections.
   4. Shop and field painting systems. Include manufacturer's descriptive technical catalog literature and specifications.
   5. Manufacturer's data including materials of construction, construction details of equipment, and weight of equipment.
   6. Catalog data for all items, including cutaway views, construction features, size and capacity data.
   7. Manufacturer's recommended storage, installation and start-up procedures
   8. Manufacturer's operation and maintenance information in accordance with Section 01 78 23.
   9. Rigid Equipment Mount Installation Checklist
   10. Installation Forms
   11. Testing Forms

B. Informational Submittal Items:
   1. Calculations, stamped by an engineer registered in the State of Washington, demonstrating compliance of the support design with the requirements of this Section.

## 1.03 QUALITY ASSURANCE

A. Performance and Design Requirements:

1. Heat exchanger shall be designed with a minimum working pressure rating of 150 psi and a minimum test pressure rating of 195 psi. Heat exchanger shall be designed and operable for the following conditions:

| Equipment No. | Rated capacity, million Btu/hr | Hot Side 50% Water, 50% Ethylene Glycol | | | | Cold Side 100% Water | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Flow rate, gpm | Inlet temp, °F | Outlet temp, °F (min) | Fluid press. drop, max, psi | Flow rate, gpm | Inlet temp, min, °F | Outlet temp, min, °F | Fluid press. drop, max, psi |
| HX-401 | 1.41 | 160 | 200 | 180 | 10 | 145 | 160 | 180 | 10 |

B. Reference Standards:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

| Reference | Title |
|---|---|
| ASME Pressure Vessel Code | ASME Boiler and Pressure Vessel and Code, Current Edition, Section VIII, Pressure Vessels Division 1, with Addenda |
| ANSI/ASME B16.1 | Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250 |
| ANSI/ASME B16.5 | Pipe Flanges and Flanged Fittings |
| ANSI B16.1-15 | Cast Iron Pipe Flanges and Flanged Fittings |



# PART 2 PRODUCTS

## 2.01 ACCEPTABLE PRODUCTS

A. Heat exchangers shall be Alfa-Laval, Paul Mueller Company, Standard Xchange, Xylem, or equal, modified as needed to provide the specified performance and features.

## 2.02 MATERIALS

| Component | Material |
|---|---|
| Plates | 316 Stainless Steel |
| Gaskets | Nitrile rubber |
| Frames (head plates) | Carbon steel |
| Tie bolts and nuts | Alloy steel |

## 2.03 EQUIPMENT

A. General:

1. Plate and frame heat exchangers shall be freestanding, with a unitized structural frame and multiple gasketed plates.
2. Plate and frame heat exchangers shall be designed, fabricated, and tested for operation in accordance with the ASME Unfired Pressure Vessel Code, Section VIII, Division 1, including latest addenda, and shall be code stamped where required.
3. All welding shall conform to the latest standards of the American Welding Society.
4. Plate and frame heat exchangers shall be complete, preassembled, pressure tested at the factory, and flushed clean, ready for piping connections.
5. Total surface area of the heat exchanger shall include additional surface area as a fouling factor. The additional area shall equal 10 percent of the surface area calculated by the manufacturer as required to provide the heat exchanger performance specified.

B. Frames:

1. Frame shall be adequately sized to allow for opening and cleaning the plates. Frame shall be provided with top and bottom guide bars for support and alignment of plates. Top guide bar shall have smooth finished stainless steel surface for roller or sliding bearing support for movable end frame and for ease of transport for plate suspension. Bottom guide bar shall also have smooth finished stainless steel surface.
2. Fixed and movable end frames shall be reinforced, flat plate carbon steel design. Movable frame shall be supported from the top guide bar by a roller bearing and guided by the bottom guide bar.
3. End frames shall be provided with holes to facilitate lifting with bar. Steel floor base plates for anchor bolts shall be provided.
4. Tightening bolts shall be zinc-plated carbon steel or alloy steel with fixed carbon steel nut. Free nuts shall be heavy carbon steel or alloy steel with heavy-duty carbon steel washers.

C. Plates:

1. All plates shall have provisions for attaching to the upper guide bar from either the top or bottom end. Plate designs shall be herringbone or washboard style with alternate plates rotated 180 degrees. All plates to have internal metal to metal contact points. Perforated flat plates between corrugated plates shall not be used. Plate thickness shall be selected to withstand full operating pressure in one channel with zero pressure in the adjoining channel. Plate thickness shall not be less than 0.0157 inch (0.4 mm). Plate design shall provide gaskets providing a barrier against fluid cross-contamination. The gasket grooves shall have tapered sides to assure positive seating of the compressed gaskets to preclude blowout of the gaskets. End plates shall be provided at the fixed and movable frames.

D. Nozzles:

1. Nozzles shall be ANSI B16.1 Class 125 or 150 pound rated flanges. Nozzles shall be sized such that not more than 10 percent of the design pressure drop through the heat exchanger is caused by the nozzle.

E. Gaskets:

1. Gaskets shall be molded one-piece material, securely cemented or fastened into the continuous gasket grooves in each plate. Inactive port gasket areas shall be vented to the exterior in such a manner that no mixing can occur between fluids. Gaskets shall be designed to be sealed by compression until metal-to-metal contact between plates is secured after tightening of the pack. All gaskets shall be similar except special end gaskets between end plates and frames.

## 2.04 PROTECTIVE COATING

A. All exterior steel surfaces shall be sharp steel shot blasted to SSPC SP 6 63, followed by one coat of two part epoxy spray enamel baked at 250 degrees F.

## 2.05 ACCESSORIES

A. Thermometers:

1. Each heat exchanger shall be provided with a pipeline thermometer, as specified in Section 13320, on each of the four water connections.

## 2.06 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:

1. Operation and maintenance information specified in Section 01 78 23.
2. Manufacturer's recommended installation, operation and maintenance information, including clearance requirements for maintenance and disassembly.



# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Each heat exchanger shall be installed as shown and in accordance with manufacturer's printed instructions. The Contractor shall route piping, provide takedown fittings, make piping connections, and provide access room for removal of the individual plates for the specific heat exchanger selected.

## 3.02 TESTING AND CLEANING

A. During final assembly, all plates, gaskets, and interior surfaces shall be carefully cleaned to remove dirt, metal chips, oil, etc.

B. After assembly, plate and frame heat exchanger shall be tested in accordance with ASME Code, Section VIII, Division I to guarantee compliance with these specifications.

C. After testing, plate and frame heat exchanger shall be drained and dried.

D. After cleaning, all screwed connections shall be sealed tight with plastic plugs, and flanged nozzles shall be covered with plastic plugs or plywood covers.

E. After installation, heat exchangers shall be pressure tested at rated capacity to assure proper operation. Pressure tests shall be performed on both the process fluid and cooling water sides of the heat exchanger. Tests shall consist of cycling the pressure from 0 to

full rated capacity, held for 30 minutes, and then released. Cycle shall be successfully completed three successive times with no pressure in the alternate flow path and no evidence of leakage.

**END OF SECTION**

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SECTION 23 73 13

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This section specifies single zone, low or medium pressure central station air handling units for heating, ventilating and air conditioning.

B. Equipment List:
   1. Refer to sheet M-00-701 for equipment schedules and complete list of air handling units.

C. Operating Requirements:
   1. Air Handling Unit: Refer to sheet M-00-701 for equipment schedules and air handling unit operating conditions.
   2. Heating Coils: Heating coils shall be supplied with water at a temperature of 190 degrees F. Coil face velocity shall not exceed 750 fpm. Coils shall be designed for a 10 degree F water temperature difference. See equipment schedules on sheet M-00-701 for additional operating requirements.
   3. Entering air temperature is 8 degrees F dry bulb (DB) based on ASHRAE Design Conditions for heating. See equipment schedules on sheet M-00-601 for LAT.



### 1.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

### 1.03 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been

discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| AFBMA 9 | Load Ratings and Fatigue Life for Ball Bearings |
| AFBMA 11 | Load Ratings and Fatigue Life for Roller Bearings |
| AMCA | Certified Ratings Program |
| ARI 410 | Forced-Circulation Air-Cooling and Air-Heating Coils |
| ARI 430 | Central-Station Air Handling Units |
| NFPA 70 | National Electrical Code (NEC) |
| NFPA 90A | Installation of Air Conditioning and Ventilating Systems |
| UL 465 | Central Cooling and Air Conditioners |

B. Compatibility:
   1. Air handling units shall be of a single manufacturer to assure compatibility and consistency of installation. Air handling units shall comply with ARI 430 and UL 465 standards.



## 1.04 SUBMITTALS

A. Submittals shall include the following:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
   3. Fan performance curves for the specified operating conditions.
   4. Heating and cooling coil capacity at rated conditions.

5. Motor data.
6. Catalog dimensional data.

B. Delegated-Design Submittal: For vibration isolation[ and seismic restraints] 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. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

C. Seismic Qualification Certificates: For air-handling units, 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. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control reports.

E. Operation and maintenance data.



## PART 2 PRODUCTS

### 2.01 ACCEPTABLE PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trane Inc. (Basis of Design Equipment, Contact: Grant Stanton, grant.stanton@trane.com, 612-581-6768)
   2. Daikin/McQuay
   3. YORK/JCI

### 2.02 MATERIALS

| Component | Material |
|---|---|
| Structural base | Steel channel |
| Fan housing | Galvanized 16-gage steel |
| Fan wheel | Galvanized steel |
| Shaft | Solid steel |
| Coil casing | Galvanized 16-gage steel |
| Coil fins | Aluminum |
| Coils | Copper tube |
| Drain pan | Galvanized or stainless steel |
| Mixing box | Galvanized 16-gage steel |

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

## 2.03 UNIT CASINGS

A. General Fabrication Requirements for Casings:
   1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   2. Casing Joints: Sheet metal screws or pop rivets.
   3. Sealing: Seal all joints with water-resistant sealant.
   4. Factory Finish for Steel and Galvanized-Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
   6. 2" double wall construction with foam insulation of minimum thermal resistance of 13 h-ft$^2$-°F/Btu.
   7. Stainless steel inner liner for all air-touching surfaces.

B. Casing Insulation and Adhesive:
   1. Materials: ASTM C 1071, Type I.
   2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
      c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
   3. Location and Application: Encased between outside and inside casing.

C. Inspection and Access Panels and Access Doors:
   1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
   2. Inspection and Access Panels:
      a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
      b. Gasket: Neoprene, applied around entire perimeters of panel frames.
      c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:
    a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
    b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    c. Fabricate windows in [fan section ]doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
    d. Size: At least 24 inches wide by full height of unit casing up to a maximum height of 72 inches.
4. Locations and Applications:
    a. Fan Section: Doors and inspection and access panels.
    b. Access Section: Doors.
    c. Coil Section: Inspection and access panel.
    d. Filter Section: Doors large enough to allow periodic removal and installation of filters.
5. Service Light: 100-W vaporproof fixture with switched junction box located inside adjacent to door.
    a. Locations: Each section accessed with door.

D. Condensate Drain Pans:
1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
    a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-2004.
    b. Depth: A minimum of 2 inches deep.
2. Formed sections.
3. Double wall stainless steel drain pan.
4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
    a. Minimum Connection Size: NPS 1.
5. Pan-Top Surface Coating: Asphaltic waterproofing compound.
6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
7. Provide drain pans for cooling and heating coils.

E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 43 05 18 when air-handling unit frame is anchored to building structure.

## 2.04 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
   1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
      a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
      b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.

C. Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.

D. Direct plenum fans provided with electronically commutated external- rotor motor with integrated control electronics, radial aluminum impeller with backward curved, continuously welded blades. DDP fans with factory installed VFD/array will NOT be accepted, DDP fan with factory installed VFD per fan and a common single point of power will be only equal other than ECM.
   1. Individual Fan Assemblies shall be statically and dynamically balanced in two planes as per DIN / ISO 1940 to balancing grade G 6.3.
   2. Fan-to-fan interaction can cause a significant increase in individual fan vibration when mounted to the same structure. Fans applied in an array shall be tested as a system and the total fan vibration shall be less that 0.42 (in/s) RMS including all fan-to-fan interaction. This system effect shall be accounted for by the air handler manufacturer. Individual fan vibration performance values shall not be acceptable.
   3. Fan performance shall be rated in accordance with AHRI 430-2020. Fan shall be spaced to minimize aerodynamic fan interaction. Minimum center-to-center spacing between fans shall be 1.6 diameter ratio to ensure proper performance.
   4. Fan wheels shall be constructed of materials that comply with UL 1995 requirements of flame and smoke spread per NFPA 90A. The flame spread index not exceeding 25 and a smoke-developed index not, exceeding 50.
   5. Fan Electrical Power (FEP) rated in accordance with AHRI 430-2020.
   6. Motor shall contain integrated PID controller and accept a 0-10VDC input signal for variable speed control.
   7. Motorized impeller fan section shall include expanded metal door guard(s) supplied on the access door(s) to the fan. Door guard is intended to deter unauthorized entry and incidental contact with rotating components.
   8. Motor efficiency class shall comply with IE4
   9. Fan system manufacturer must stock replacement parts in North America
   10. Fan array shall be designed and constructed for easy field assembly and maintenance. Fan shall be assembled to bulkhead wall with minimal fasteners and the fan shall have quick disconnects for the high voltage and low voltage connections.

E. Factory mounted fan airflow measurement systems shall be provided as indicated on the schedule and drawings to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than +/- 5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.

F. Each horizontal direct drive fan in a multiple-fan array shall be provided with integral back flow prevention: a backdraft damper that prohibits recirculation of air in the event a fan or multiple fans become disabled. Dampers are tested and rated based on AMCA Standard 500. Dampers to be heavy duty type capable of a maximum back pressure that exceeds the design total static pressure with minimal leakage. The dampers should have a minimal total effect on airflow performance both pressure drop when open and system effect on the fan. The damper blades and frame shall be extruded aluminum with blade edge seals locked into the blade edge. Adhesive type seals are unacceptable. AHU manufacturer responsible for providing proper spacing upstream of dampers to ensure full, uniform airflow through upstream components. For units where the damper(s) are supplied at the jobsite, the installing contractor shall contract a certified TAB contractor to verify uniform airflow thru upstream components. Field installed plates for back draft dampers will NOT be accepted.

G. Fan Shaft Bearings:
   1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 120,000 hours according to ABMA 9.
   2. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit and a rated life of 120,000 hours according to ABMA 11.
   3. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.

H. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
   1. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.

I. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements. Premium efficiency, EC motors.

## 2.05 COIL SECTION

A. General Requirements for Coil Section:
   1. Comply with ARI 410.

2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.
5. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces as needed for local zone.

B. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

C. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

D. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

F. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.

G. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

H. Heating coils shall have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Coating process shall ensure complete coil encapsulation and a uniform dry film thickness from 0.8 to 1.2 mil on all surface areas including fin edges. Corrosion durability shall be confirmed through testing to no less than 5,000 hours salt spray per ASTM B117.

I. Hydronic Coils
1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
3. Headers shall be constructed of round copper pipe or cast iron.

4. Tubes shall be 1/2-inch .016 copper, with aluminum fins.
5. Tubes shall be 5/8-inch .020 copper, with aluminum fins.
6. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.
7. Coils shall have stainless steel casings and supports.
8. Number of rows shall not exceed 4.

## 2.06 AIR FILTRATION SECTIONS

A. General Requirements for Air Filtration Section:
   1. Comply with NFPA 90A.
   2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Prefilter Section: Extended-Surface, Disposable Angle Filters:
   1. Factory-fabricated, dry, extended-surface type.
   2. Thickness: 2 inches.
   3. Arrestance (ASHRAE 52.1): 90.
   4. Merv (ASHRAE 52.2): 13.
   5. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.
   6. Media-Grid Frame: Nonflammable cardboard.
   7. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

C. Filter Gage:
   1. 3-1/2-inch diameter, diaphragm-actuated dial in metal case.
   2. Vent valves.
   3. Black figures on white background.
   4. Front recalibration adjustment.
   5. 3 percent of full-scale accuracy.
   6. Range: 0- to 2.0-inch wg.
   7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

## 2.07 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Electronic Damper Operators:
   1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.
    b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
    c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24-V dc.
11. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.
14. Run Time: 12 seconds open, 5 seconds closed.

C. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, extruded-aluminum dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

D. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

E. Combination Filter and Mixing Section:
1. Cabinet support members shall hold manual roll prefilter with 1” polyester media roll.

2. Cabinet support members shall hold 2-inch- thick, pleated, flat, permanent or throwaway filters.
3. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.
4. Mixing boxes shall have opposed blade dampers mounted in galvanized steel frames for internal merging of airstreams. Boxes shall have duct connection flanges on both inlet and outlet and provision for floor and ceiling mounting.
5. Dampers shall be integrally linked to modulate to any position. Dampers shall be sized to handle 100 percent of supply air volume. Dampers shall be mounted on 1/2-inch circular shafts rotating in nylon bushings. Blades shall be a minimum of 6 inches width extruded aluminum with edge seals. Edge seals shall provide less than 15 cfm per square foot leakage at 1-inch pressure. Actuators and linkage shall be provided as required.

## 2.08 CAPACITIES AND CHARACTERISTICS

A. Refer to equipment schecules in the design drawings.

## 2.09 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

D. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.



## 2.10 PRODUCT DATA

A. The following information shall be provided:
1. Applicable operating and maintenance information.
2. AFBMA bearing ratings for the fan and the motor at design conditions.
3. Dimensional drawings of air handling unit.
4. Heating coil and control panel information for all units with electrical heating elements.
5. Certification that the units have been tested and rated in accordance with the applicable AMCA standard test code and certified ratings
6. NEC and UL labels.

## 2.11 SPARE PARTS

A. Spare parts shall be tagged and stored.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Air handling unit shall be installed as specified and in accordance with manufacturer's recommendations. Piping and ductwork shall be connected to coils and air handling units through flexible connections. Air handling unit shall comply with noise requirements and control as specified in Division 01 and 40.

### 3.02 TESTING

A. After completion of installation, each air handling unit shall be completely field-tested and balanced to guarantee compliance with these specifications.

**END OF SECTION**

SECTION 23 81 00

UNITARY HVAC EQUIPMENT

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope: This Section includes provisions for the materials, installation and testing of unitary HVAC equipment, including:
   1. Ductless Split System Heat Pump and Air Conditioning Equipment

### 1.02 RELATED SECTIONS

A. As required by Section 23 00 00 and Division 01 - General Requirements.

### 1.03 QUALITY ASSURANCE

A. Reference Standards:
   1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.



| Reference | Title |
|---|---|
| ANSI/UL 1025 | Electrical Air Heaters |
| ANSI/ASHRAE | 15-2010: Safety Standard for Refrigeration Systems |
| AHRI 210/240 | Unitary Air-Conditioning and Air-Source Heat Pump Equipment |
| AHRI 270 | Sound Rating of Outdoor Unitary Equipment |
| AHRI 340/360 | Commercial and Industrial Unitary Air Conditioning and Heat Pump Equipment |
| AHRI 410 | Standard for Forced Circulation Air-Heating and Air-Cooling Coils |
| NFPA 90A | Standard for the Installation of Air-Conditioning and Ventilating Systems |
| NFPA 90B | Standard for Installation of Warm Air Heating and Air Conditioning Systems |
| NRCA | National Roofing Contractors Association |
| UL 1995 | Heating and Cooling Equipment |

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Air conditioner, heat pumps, and coil capacities, electrical characteristics, special features and accessories shall be as specified in the equipment schedules shown on the Drawings.

B. Electrical: 120-volt, 1-phase equipment shall be provided with factory installed, internally mounted, and UL approved non-fused disconnect switch. Non-fused switch shall provide unit power shutoff and shall be accessible from outside the unit and shall provide power off lockout capability.

C. Controls: Provide complete, integrated packaged control systems for unitary air conditioning equipment. Control systems shall be 24 volt. Provide power for all control components from nearest electrical panel or as indicated on the Drawings. Control systems shall include all necessary components, transformers, accessories, wiring and conduits to provide complete and automatic systems ready for full time operation.

D. System shall include heating, ventilation, and air conditioning controls to automatically start and stop air equipment. The system shall provide space heating and cooling sensing to maintain space temperatures as indicated on the Drawings, provide control of outside air, return air and bypass duct motorized dampers in order to utilize economizer cycle cooling effect. The temperature controls shall automatically cause the system to operate in cooling mode whenever any zone requires cooling which cannot be accommodated by the operation economizer mode.



### 2.02 PERFORMANCE REQUIREMENTS

A. Meet the following:

1. Interior surfaces of units to meet erosion and growth resistance requirements as well as construction requirements for equipment of ASHRAE 62.1.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
3. AHRI Certification: Provide AHRI certified and listed units.
4. Energy-Efficient Ratio (EER): Meet the minimum (S)EER requirement shown on Drawings.
5. Coefficient of Performance (COP): Meet the minimum COP requirement shown on Drawings.
6. Heating Seasonal Performance Factor (HSPF): Meet the minimum HSPF requirement shown on Drawings.
7. AHRI Compliance for Units with Capacities Less Than 135,000 Btu/hr: Rate air-conditioner capacity according to AHRI 210/240.
8. AHRI Compliance for Units with Capacities 135,000 Btu/hr and Greater: Rate air-conditioner capacity according to AHRI 340/360.
9. Sound Power Level Ratings: Comply with AHRI 270.

## 2.03 DUCTLESS SPLIT SYSTEM HEAT PUMP AND AIR CONDITIONING EQUIPMENT

A. Ductless Split System Heat Pump or Air Conditioner and Fan Coil:

1. General: Heat pump or air conditioning systems shall be split, ductless systems. The indoor fan coil units shall be designed for mounting below the ceiling or mounting on the wall as specified on the Drawings. The heat pump or air conditioner shall be designed for outdoor service. Refrigerant piping between the fan-coil unit and heat pump or air conditioner shall be as recommended by the manufacturer.
2. Heat Pumps and Condensing Units:
    a. Unit cabinet shall be constructed of galvanized steel with a powder coated finish.
    b. Fan shall be direct-drive propeller type with horizontal discharge, and corrosion resistant shaft. Fan shall be statically and dynamically balanced. Fan motor shall be totally enclosed with permanently lubricated ball bearings, and shall be provided with internal thermal overload protection where specified.
    c. Compressor shall be hermetically sealed scroll type, mounted on rubber vibration isolators, and covered with sound absorbing blanket. Motor shall be NEMA rated and provided with internal overload to protect against over-current and over-temperature.
    d. Outdoor coil shall consist of seamless copper tubes with mechanically bonded aluminum fins.
    e. Electrical requirements shall be as shown on the schedules. Electrical power shall be a single point connection. Starters, step down transformers and other elements required for the control of the heat pumps and condenser units shall be provided by the supplier of this section. Control voltage to the indoor fan coil shall be 24 VDC.
3. Fan Coil Unit:
    a. Unit cabinet shall be constructed of galvanized steel with a baked enamel paint.
    b. Indoor fan shall be 3-speed centrifugal type motor suitable for multi-speed operation unless noted otherwise. Fan shall be statically and dynamically balanced. Fan motor shall be totally enclosed with permanently lubricated ball bearings and shall be provided with internal thermal overload protection.
    c. Indoor coil shall consist of seamless copper tubes with mechanically bonded aluminum fins and galvanized steel tube sheet. Unit shall include a drain sump under the coil with a drain connection.
    d. Electrical requirements shall be as shown on the schedules. Electrical power shall be a single point connection. Starters, step down transformers and other elements required for the control of the heat pumps and condenser units shall be provided by the supplier of this section. Control voltage shall be 24 VDC.
4. Accessories shall include:
    a. Integral condensate pump, fresh air intake and power ventilation kit shall be provided on the fan coil unit.
    b. Wired remote controller.
    c. Freeze-up, high discharge temperature, and self-diagnostics on the fan coil unit.
    d. Auxiliary electric heater for fan coil unit for heat pump systems. Electric heater shall be configured to operate only when the outdoor heat pump is not functional or when the heating load cannot be met by the heat pump alone.

e. High and low pressure safety switches, low voltage startup capability, and fluid line filter drier on the condenser unit. Refrigerant charge shall be R-410A.

f. Low ambient kit with crankcase heater on the outdoor unit.

5. Manufacturers:

a. Heat Pump Systems:

1) Wall mounted fan coil units shall be Trane TPKA with Trane TRUZA heat pump; or Approved Equal.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Roof curbs to be mounted level on roof in accordance to NRCA manuals and details. Secure to structure per engineered/sealed seismic installation details.

C. Provide external vibration isolation or isolation curb to prevent transmission of unit-borne sound and vibration to building structure. Provide flexible connection for electrical power and hot water piping.

D. Seal openings between curb, roof opening, ducts, electrical conduits, piping, and building interior.

E. Protect the roof from damage during installation. Secure factory touch-up paint to repair scratches and minor damage to equipment prior to start-up. Comb evaporator and condenser coils to repair any minor fin damage.

F. Install units with clearances for service and maintenance. Install ducts and piping adjacent to units to allow service and maintenance.

G. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

H. Hot Water Piping: Comply with applicable requirements in Division 23. Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.

I. Install filters upstream of heating coils prior to operation.

**END OF SECTION**

SECTION 23 83 16

IMMERSION HEAT EXCHANGER PLATES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes requirements for providing immersion heat exchanger (HEX) plates for use in heating FOG (fats, oils, grease) receiving tanks, complete will all accessories as indicated in accordance with the Contract Documents.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 43 05 11 General Requirements for Equipment

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| UIC | Uniform Plumbing Code |
| IPC | International Plumbing Code |
| IECC | International Energy Conservation Code |
| UL | Underwriters Laboratories |
| RPA | Radiant Panel Association |



### 1.04 NOT USED

### 1.05 NOT USED

### 1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
   3. Check-marks (✓) shall denote full compliance with a paragraph as a whole. Deviations shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested

deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

4. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Drawings showing general dimensions and confirming the size of panels and specified appurtenances; piping connections; construction details of equipment (including mounting hardware); wiring diagrams; and weight of equipment.
6. Heat transfer calculations for sizing the immersion heat exchanger plate based upon process conditions.
7. Project specific installation instructions and mounting details for each component. Materials of construction for supports, brackets, and mounting hardware shall be provided.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Performance guarantee as specified in paragraph 1.06 Performance Confirmation.
   3. Operation and maintenance information specified in Section 01 78 23.
   4. Installation Certification Section 43 05 11-Form A as specified in paragraph 3.01.
   5. Training Certification Section 43 05 11-Form B as specified in paragraph 3.08.

C. Closeout Submittals:
   1. Procedures: Section 01 78 23.
   2. Operating and maintenance submittals: Section 01 78 23.



## 1.07 QUALITY ASSURANCE

A. All equipment in this section shall be furnished by a single supplier.

B. Manufacturer shall be experienced in the design and construction of equipment for this purpose and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five years.

C. Warranty
   1. The Contractor shall provide from the equipment manufacturer an extended warranty for a period of 12 months after acceptance of the equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty.

D. Each immersion heat exchanger plate shall be factory tested utilizing the manufacturer's standard inspection and testing regimen.

## 1.08 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00

B. Immersion heat exchanger plates shall be protected against corrosion during storage and prior to being placed into operation. Contractor shall inspect the stored plates weekly to check for signs of damage. Before the plates are put into operation, each one shall be cleaned.

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. Tranter
   2. Mueller
   3. Omega Thermo Products
   4. Approved Equal

## 2.02 TYPE

A. Provide immersion heat exchanger panels in sizes and location as indicated by the Contract drawings. The same manufacturer shall be used for all immersion heat exchanger plates.

B. The heat exchanger panels shall be smooth without fins or coils that could collect debris.

C. Eight immersion heat exchanger plates shall be provided for each FOG receiving tank. The system of eight immersion heat exchanger plates provided for each tank shall meet the performance requirements of this Section when used together.

D. The heat transfer media (fluid) shall be as scheduled below. The use of fluids such as oil, alcohol, or automotive glycol is unacceptable.

E. The immersion heat exchanger plates must be capable of withstanding installation in a process tank that contains food waste, fats, oils, and greases (FOG), and other solids collected in the FOG receiving tanks.

F. Following installation, the immersion heat exchanger plates shall be capable of being removed and reinstalled inside the FOG receiving tanks to perform maintenance on either the plates or the process tankage.

G. Panels shall be mounted to the walls and floor of the tank using lugs capable of withstanding disturbances in tank contents as a result of recirculation. Mounting hardware 316 SS and custom designed by the panel manufacturer for this application. The manufacturer shall provide all hardware required for installation of the panels.

## 2.03 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions:

| Description | Value |
|---|---|
| Fluid Type | Food waste, fats, oils, and greases (FOG), and other solids. Anticipated to be 0 – 3%TS. |
| Tank Starting Temperature | 40 to 75 degrees F |

B. Operating Conditions:

| Operating condition | Value |
|---|---|
| Equipment number | |
| Type | Type 5D |
| Dimensions | Qty. 8 – 48" x 155"<br>Qty. 8 – 48" x 96" |
| Plate Material | 316 SS |
| Plate Inlet Connection | 3/4" NPS Sch. 40 |
| Plate Outlet Connection | 3/4" NPS Sch. 40 |
| Plate Handle | (3) 3/8" diameter x 1 1/2" x 4" formed round bar |
| Maximum Allowable Working Pressure | 150 psi at 400° F |
| Minimum Design Metal Temperature | 150 psi at -20 ° F |
| Heat Exchange Media Type | Water |
| Hot Water Supply Available | 30 gpm at 180 ° F |
| Total Minimum Heated Surface Area | 112 SF at low water level in the tank (2 panels) |
| Design Tank Temperature after heating | 100 ° F |
| Maximum Tank Temperature after heating | 140 ° F |



C. Design Requirements:

1. Heat 15,000 gallons of FOG from 60 to 100 degrees Fahrenheit in a maximum of 8 hours using 30 gpm of hot water at 180° F.

## 2.04 SYSTEM OPERATION

A. Immersion heat exchanger plates will be installed on the floor and on the walls of FOG Receiving Tanks and will be in operation whenever FOG is in the tanks.

## 2.05 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

| Component | Material |
|---|---|
| Immersion Plate Heat Exchangers | 316 Stainless Steel |
| Bolts, nuts, supports | 316 Stainless Steel |

## 2.06 SOURCE QUALITY CONTROL

A. Factory Testing shall be in accordance with Section 43 05 11.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. The immersion heat exchanger plates shall be installed on the walls and the slope of the sump trench as shown on the Contract Drawings and in accordance with Manufacturer's installation drawings.

B. All associated piping and wiring shall be installed in accordance with applicable states and local codes and ordinances in conformance to standard practice.

C. Plates shall be installed on the tank walls with the Manufacturer provided mounting lugs. Space between the back of the plates and the wall shall be three inches. Space between the back of the plates and the floor shall be 12 inches.



## 3.02 TESTING

A. Contractor shall have completed installations checked by the immersion heat exchanger plate manufacturer's factory service representative prior to start up and testing.

B. Clean water testing for the FOG Receiving Tank
   1. After all associated piping and the FOG Receiving Tank transfer pump and recirculation pump have been installed and tested in the FOG Receiving Tank, the Contractor shall demonstrate to the Engineer and the Owner that the immersion heat exchanger plates are capable of meeting the heating time requirements at the design volume as presented in this Section using potable or utility water. After the design temperature is reached within the time presented in this Section, the Contractor shall demonstrate that the immersion heat exchanger plates can hold the water in the FOG Receiving tank at a temperature of 100° F for a period of 5 days. The recirculation pump shall be used to mix the contents of the tank during the testing period.

## 3.03 MANUFACTURER'S FIELD SERVICE

A. Provide manufacturer's services at the jobsite designated by the Owner for the minimum hours listed below, travel time excluded:
   1. 16 hours for installation assistance, inspection, and certification of installation.
   2. 16 hours for performance testing.
   3. 8 hours for operational training (minimum 2 sessions).

**END OF SECTION**

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# DIVISION 26
# ELECTRICAL

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SECTION 26 05 00.01

COMMON WORK RESULTS FOR ELECTRICAL FOR SMALL PROJECTS

## PART 1 – GENERAL

### 1.01 DESCRIPTION

A. Scope: This section specifies general requirements for electrical work. Project Detailed requirements specified in other sections are subject to the general requirements of this section.

1. Furnish labor, equipment, tools, materials, supplies, and perform operations necessary to install a complete and operable electrical system. Furnish incidental material and perform work shown on the Drawings and in the Specifications.
2. Perform electrical work and provide material and equipment in compliance with applicable National, State, and Local codes, regulations, laws, and ordinances.
3. Obtain electrical permits, arrange for required inspections, correct deficiencies resulting from inspections, and pay permit fees and inspections charges. Pay fines and the cost of extra work incurred by action or inaction of the Contractor, at no additional cost to the Authority.
4. Furnish properly executed certificates of final electrical inspection and approval from the Code Authority Having Jurisdiction (AHJ) at the conclusion of the work, before final acceptance.
5. Adhere to the Area Classification shown for the product required and the installation required. Provide products in Hazardous Classified Areas in accordance with NEC Article 500 for the Class and Division specified or identified and products in corrosion areas in accordance with this specification.
6. Maintain a complete set of Contract Drawings in “Record” condition, available for review by the Authority or Engineer. Mark, initial, and date changes, modifications, or corrections, as they occur. Refer to the Record Drawing specification section requirements.
7. Field verify the exact locations of equipment or equipment terminations. Use accepted equipment submittals as the basis of the conduit openings and slab penetrations.

B. Arc Flash Hazard Analysis, Short Circuit Study and Protective Device Coordination Report (Report):

1. This section specifies that the Contractor subcontract an independent full member NETA Engineering and Study Firm / Testing Firm to prepare:
   a. Electrical equipment short circuit study (SCS) for the equipment.
   b. Protective device coordination study (PDCS) report for the electrical distribution power system.
   c. Arc flash hazard analysis (AFHA) and labeling for the equipment.
2. The Testing Firm shall be as described in this Section and shall also be responsible for the electrical testing described therein.
3. Scope:
   a. The Short Circuit and Protective Device Coordination Report shall include analysis including Utility Company equipment that affect the installed equipment’s short circuit ratings, protective device ratings and protective device settings.

b. Report shall also include analysis of the equipment's short circuit ratings, protective device ratings and protective device settings affected by the installed equipment.

c. Report shall include the results of the arc flash hazard analysis study for energized electrical equipment in accordance with the methods outlined in IEEE Standard 1584 and stated hereinafter.

d. Work shall include the fabrication of warning labels with the arc flash hazard analysis results and the installation of the labels on the equipment in accordance with NFPA 70E Article 130.5 that includes nominal system voltage, arc flash boundary, and at least one of the following: Available incident energy and corresponding working distance or the arc flash personnel protective equipment (PPE) level but not both, the minimum arc rating of clothing, site specific level of PPE.

4. Schedule:

a. The report shall be completed, submitted to the Engineer for acceptance and reworked to include the Engineer comments and corrections, as required. The report shall be approved by the Engineer prior to purchase and fabrication of electrical equipment including switchgear.

b. A copy of the Engineer accepted report shall be sent by the Contractor to all affected manufacturers prior to fabrication.

5. Qualifications:

a. The short circuit and coordination report shall be performed by the Study Firm/ Testing Firm as described in this Section. The studies shall be signed by the professional electrical engineer responsible for the studies and registered to practice engineering in the state in which the project is located.

C. Drawing Definitions and Requirements:

1. Elementary or Schematic Diagram: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement that facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

2. One-Line Diagram: Shows by means of single lines and graphical symbols the course of an electrical circuit or system of circuits and the components, devices or parts used therein. Physical relationships are usually disregarded.

3. Block Diagram: Diagram of a system, instrument, computer, or program in which selected portions are represented by annotated boxes and interconnecting lines.

4. Wiring Diagram or Connection System: Includes all of the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. A panel layout diagram shows the physical location of devices and the wiring connections.

5. Interconnection Diagram:

a. Shows external connections between terminals of equipment in panels or electrical assemblies and outside points, such as motors, auxiliary devices, control devices, and instruments. Provide references to connection diagrams that interface to the interconnection diagrams of the continuous line type.

b. Show bundled wires as a single line with the direction of entry/exit of the individual wires clearly shown. Show each wire identification as actually installed. Wireless diagrams and wire lists are not acceptable.

c. Provide wire identification for each end of the same wire for devices and equipment, indicate terminal blocks identification actually installed with individual terminal identification.

d. Show jumpers, shielding and grounding termination details not shown on the equipment connection diagrams on the interconnection diagrams. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram. Signal and DC circuit polarities and wire pairs shall be shown. Show spare wires and cables.

6. Arrangement, Layout, or Outline Drawings: Shows the physical space and mounting requirements of a piece of equipment and may indicate ventilation requirements, space provided for connections, or the location connections are to be made.

7. Drawing Cross-Referencing:

a. Reference each submittal drawing submitted to the associated Contract Document and indicate the one-line diagrams, schematics, control diagrams, block diagrams, and Process and Instrumentation Diagrams (P&IDs) cross-referenced on the submittal drawings.

b. Internally cross-reference submittal drawings related to the same subject shall be referenced to other submittal drawings. Failure to cross-reference Contract Documents with the submittal shall be cause for rejection of the entire submittal with no further consideration.



## 1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ANSI A58.1 / ASCE 7 | Minimum Design Load in Buildings and Other Structures, 1982 |
| ANSI C80.1 | Rigid Steel Conduit - Zinc Coated, 1994 |
| ASTM B3 | Standard Specification for Soft or Annealed Copper Wire, 2001 |
| ASTM B8 | Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft, 1999 |
| ASTM B33 | Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes, 2000 |

| Reference | Title |
|---|---|
| ICEA S-68-516 / NEMA WC 70, 71, & 74 | Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy |
| ICEA S-95-658 | Standard for Non-Shielded Power Cables Rated 2000 Volts or Less, 2000 |
| IEEE 81 | Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, 1983 |
| IEEE 383 | Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations, 1974 (1992) |
| JIC EMP-1 | Electrical Standard for Mass Production Engineering, 1967 |
| NEMA TC2 | Electrical Polyvinyl Chloride (PVC) Conduit, 2003 |
| NEMA 250 | Enclosures for Electrical Equipment (1000 Volt Maximum) |
| NEMA WC-70 | Non-Shielded Power Cable 2000V or Less (ICEA S-95-658), 1999 (2001) |
| NEMA WD-1 | General Requirements for Wiring Devices, 1999 |
| NEMA ICS 2 | Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts |
| NEMA ICS 6 | Industrial Control and Systems: Enclosures |
| NEMA ICS 7 | Industrial Control and Systems: Adjustable-Speed Drives |
| NEMA ICS 7.1 | Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems |
| NFPA 70 | National Electrical Code (NEC) |
| UBC | Uniform Building Code |
| UL 6 | Electrical Rigid Metal Conduit – Steel, 12th Edition, 2000 (2003) |
| UL 44 | Thermoset-Insulated Wires and Cables, 15th Edition, 1999 (2002) |
| UL 67 | Panelboards, 11th Edition, 1993 (2003) |
| UL 83 | Thermoplastic-Insulated Wires and Cables, 13th Edition, 2003 (2004) |
| UL 263 | Fire Tests of Building Construction and Materials, 13th Edition, 2003 |
| UL 360 | Liquid-Tight Flexible Steel Conduit, 5th Edition, 2003 |
| UL 489 | Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, 10th Edition, 2002 (2003), Adopted: NEMA AB 1-1999 |
| UL Standard 508 | Industrial Control Equipment |
| UL 1277 | Electrical Power and Control Tray Cables with Optional Optical-Fiber Members, 4th Edition, 2001 (2003) |
| IEEE 519 | IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power System |
| ANSI/IEEE C57.12.01 | General Requirements for Dry-Type Distribution and Power Transformers |
| DOE | 10 CFR Part 431 Efficiency Standards |
| NEMA ST20 | Dry-Type Transformers for General Application |



B. Listed and Labeled Products:

1. Provide electrical equipment and materials listed or labeled by an independent testing laboratory for the purpose for which they are to be used and provide associated testing laboratory label.

2. The independent testing laboratory shall be acceptable to the inspection authority having jurisdiction. Test Laboratory examples: Underwriters Laboratories (UL), Electrical Testing Laboratories (ETL), and Canadian Standards Association (CSA).
3. Include costs and expenses incurred for special inspections in the contract price for electrical products required to undergo a special inspection either at the manufacturer's place of assembly or at the installed location by the local inspection authority when a product is not available with a testing laboratory listing or labeling.

C. Factory Tests:
1. Perform factory tests at the place of fabrication and on completion of manufacture or assembly where specified in the individual product specification section.
a. Include the costs of factory tests in the contract price.
b. Include the costs of Engineer witness of factory tests in the contract price.

## 1.03 SUBMITTALS

A. The following information shall be provided for all electrical equipment and materials in accordance with Section 01 33 00:
1. Catalog cuts of equipment, devices, and materials requested by the individual specification sections.
a. Catalog information with technical specifications and application information including ratings, range, weight, accuracy, and other pertinent product information.
b. Edit catalog cuts to show only the items, model numbers, and information that apply.
c. Assemble catalog cuts in a folder or three ring binders with a cover sheet, indexed by item, and cross-referenced to the appropriate specification paragraph.
2. Arrangement, layout and outline drawings with dimensions and weight, as appropriate.
3. Control schematics and interconnection wiring diagrams depicting internal and external wire and cable terminations. Drawing cross-reference to specification and Contract Document drawings.
4. Certificate of Unit Responsibility for the AFDs attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this Section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
5. Voltage and current Total Harmonic Distortion (THD) calculations with line reactors or filter design to mitigate harmonics to meet IEEE-519, if applicable for AFDs.

## 1.04 DRAWINGS

A. Prepare specified drawings on 11-inch by 17-inch drafting media complete with borders and title blocks clearly identifying project name, equipment and the scope of the drawing.

B. Prepare drawings to reflect the final constructed state of the project installation or supplied equipment. Provide drawing quality, clarity, and size of presentation to permit insertion in operation and maintenance manuals.

## 1.05 PROJECT/SITE CONDITIONS

A. General:
   1. Unless otherwise specified, equipment and materials shall be sized and de-rated for the ambient conditions specified in Section 01 11 80, but not less than an ambient temperature of 40 degrees C at an elevation ranging from sea level to 3000 feet without exceeding the manufacturer's stated tolerances.

B. The following areas are designated as corrosive:
   1. None.

C. Hazardous (Classified) Areas:
   1. None.

D. Seismic:
   1. Electrical equipment and supports shall be braced in accordance with all applicable building codes.

E. Construction Materials:
   1. Refer to the individual specification section for each component for material composition and installation practices.
   2. Construction materials required for each area classification are listed in the following table that specifies the type of raceway required for each location and application by RACESPEC sheet. Unscheduled conduit shall be galvanized rigid steel conduit: RACESPEC type RMC-Steel.



| Location | Application/Condition | RACESPEC |
|---|---|---|
| Indoor non-corrosive | Exposed | RMC-Steel |
| Outdoor | Exposed | RMC-Steel |
| Concealed | Embedded in concrete structure or beneath slab-on-grade | RMC-Steel, RNC40, or RNC80, as shown |
| Underground | Instrumentation, communications and data signals encased in concrete, ductbank | RMC-Steel, RNC40, or RNC80, as shown |
| Underground | Instrumentation, communications and data signals directly buried | RMC-Steel, RNC40, or RNC80, as shown |
| Underground | Power directly buried (Non-Power Utility) | RNC40 |
| Nonhazardous | Final connection to equipment | Liquid-tight Flexible Metal Conduit |

*Notes:*

1. *Install conduit connections to control stations, enclosures, and device boxes through threaded hubs.*
2. *Install flexible conduit for final connections to devices, equipment and motors not exceeding 18 inches. Limit length to 36 inches where flexibility is required.*
3. *Mount enclosures, device boxes, control stations, and raceway systems with 1/4-inch (minimum) air space between the electrical system and supporting structure.*

## 1.06 STORAGE OF MATERIALS AND EQUIPMENT

A. Store equipment and materials in the factory-sealed container and protect with additional covering and materials to avoid physical damage or weather damage.

## 1.07 ELECTRICAL NUMBERING SYSTEMS

A. Raceway Numbers:
   1. Tag raceways with brass tags at the access locations including manholes, pull boxes, junction boxes, and at the terminations.
   2. Tag raceways with aluminum tags where subject to hydrogen sulfide atmosphere typically found at wastewater treatment facilities.
   3. Raceway numbers are derived from circuit number on the power and control single line diagrams.

B. Wire and Cable Circuit Numbers:
   1. Identify wire and cable circuit numbers at both ends. Refer to the circuit labeling method specified and shown in the drawings to label circuits.
   2. Identify lighting and receptacle branch circuits with the power source and circuit load, at source and destination locations. Identify the load, location, and circuit in typed panel schedules with corrections shown.
   3. Include copies of schematic diagrams, wiring connection diagrams, and interconnection diagrams inside of the equipment enclosure, protected in a plastic container in the equipment print holder.



# PART 2 – PRODUCTS

## 2.01 EQUIPMENT AND MATERIALS

A. General:
   1. Provide new equipment and materials free from defects. Provide material and equipment of the same or a similar type of the same manufacturer throughout the work. Use standard production materials wherever possible.

B. Paint Finish and Galvanizing:
   1. Paint installed and unpainted electrical construction materials as specified in Section 09 90 00. Galvanize products, supports, etc. as specified in the Hot-Dip Zinc Coating section.

## 2.02 RACEWAYS, BOXES, AND SUPPORTS

A. Raceways and Boxes:
   1. Pullboxes, handholes, and device boxes are generally called boxes herein. Size boxes, manholes, and handholes in accordance with the National Electrical Code. Provide separate raceways for lighting, receptacles, power, control, instrumentation, and signaling systems.

B. Boxes:
   1. Provide indoor boxes, larger than FD boxes, constructed of stainless steel.
   2. Provide boxes constructed of Grade 316L stainless steel rated NEMA-4X for corrosive areas and for outdoor locations.

C. Terminal Cabinets:

1. Provide cabinets located indoors-conditioned space with NEMA-12 rating. Provide cabinets located outdoors and in process areas with NEMA-4X rating of stainless steel. Provide cabinets with hinged doors and 2 or 3-point stainless steel quick release latches with locking features via handle or latching clasps with provisions for padlocks.
2. Provide adjustable terminal strip mounting accessories and with channel mounted terminal blocks rated 30 amperes, 600 volt AC. Provide No. 8 minimum strap-screw type terminal strip, suitable for ring tongue, locking spade terminals. Provide Phoenix Contact products with capture feature and terminal identification method per terminal, as specified.

D. Manholes, Handholes and Pullboxes:

1. Manholes, handholes and pullboxes generally called boxes herein, contain wires, cables, and conductors. Provide box dimensions where shown. Provide boxes per NEC sizing rules where the dimensions are not sized or shown.
2. Provide concrete boxes with covers designed for H-20 loading in traffic areas. Engrave box cover: "ELECTRICAL". Provided boxes with hinged, aluminum checkered plate covers with pull-handle to open in non-traffic areas.
3. Provide precast Quazite Compsolite cement/polymer products, or equal, for handholes, pullboxes, manholes, meter boxes, equipment pads, and vaults where allowed by the electric power utility and for projects where precast concrete is not specifically shown or specified.
4. Electrical manholes and/or handholes shall be installed with gravity drain piping to daylight. No French drains or gravel bottoms will be acceptable.

E. Raceway and Box Supports:

1. Provide stainless steel framing channel with end caps to support groups of conduit. Provide individual conduit supports that have one-hole stainless steel malleable iron pipe straps used with stainless steel clamp backs and nesting backs.
2. Provide stainless steel supports, channel, fittings, all-thread, and fasteners in outdoor locations, in corrosive areas, and as shown. Provide factory end-caps for supports and channels.
3. Independently support boxes by stainless steel brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden or plastic plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used for attachment.

F. Underground Marking Tape:

1. Provide low-density, polyethylene plastic, underground marking tape and install above and centered for early warning protection for digging near electrical ductbanks.
2. Provide Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal. Provide tape with nominal dimension of 6 inches wide, 4-mil thickness.
3. Provide underground marking tape 6-inch wide metallic-lined tape with red polyethylene film on top and with clear polyethylene film on the bottom of the tape for installation above and centered on direct buried cables and conduits without ductbank encasement.

4. Provide black over red marking tape clearly printed with: "CAUTION ELECTRIC LINE BURIED BELOW", or provide OSHA approved marking tape.

G. Nameplates:
   1. Provide nameplates for all boxes and enclosures with nameplate wording as shown on the drawings. Provide the tag number or box number with device functional description on device nameplate. Nameplate wording may be changed without additional cost where changes are made during the submittal process or prior to commencement of engraving.
   2. Provide machine engraved laminated white phenolic nameplates with black lettering for panel-mounted equipment with the instrument tag number/description in 3/32-inch minimum size lettering and attach to the panel or enclosure with a minimum of two self-tapping 316 stainless steel screws. Provide nameplates for power sources indicating the power loads and nameplates for power loads that indicate the power sources, in accordance with these specifications and the NEC.

H. Raceway Markers:
   1. Provide raceway markers: 0.036-inch minimum thickness, solid brass tags or aluminum tags with raceway number or the circuit number, stamped in 3/16-inch minimum height characters and attach tags to the raceway with 316 stainless steel wire. Install raceway markers inside of pull boxes, handholes, manholes, and where entering electrical equipment enclosures.
   2. Provide raceway markers indicating the power source and circuit number for lighting and receptacle raceways to the associated panelboard. Interior lighting and receptacle raceways do not require raceway markers for conduit between components.

I. Identification Tags:
   1. Provide the following:
      a. Equipment: Typical size 1-inch x 3-inch wide, white with black engraved equipment number and equipment description.
      b. Raceway/Conduit: Tags with raceway or conduit number or circuit shown.
      c. Instrument: 1.5-inch wide, aluminum tag with instrument number and description.
      d. Conductor: Power, control, or instrument cable with the circuit identified as shown; power source or power/control panel identified; power load, equipment, instrument, or device identified; purpose of the conductors identified.
      e. Fastener: nylon-coated 48-mil stainless steel wire. Manufacturer: Brady catalog number 23310 or equal with double ferrule type brass wire clamps. Manufacturer: Brady number 23312.

J. General Raceway Requirements:
   1. Provide additional pullboxes for conduit runs with greater than 360 degrees in any run between pull boxes. Limit maximum conduit runs without additional pullboxes to 400 feet, less 100 feet for every 90 degrees for the conduit run change in direction.
   2. Determine conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC requirements for size and number of pullboxes. The RACESPEC sheets with specified requirements begin on the next page.

3. Separate power conduits from signal conduits within the same ductbank by 12 inches or greater separation. Refer to drawings for signal to be installed in RMC-steel conduits instead of PVC ducts.

## 2.03 RACEWAY SPECIFICATION SHEETS (RACESPEC) - RMC-STEEL

A. Raceway Identification:
   1. RMC-Steel

B. Description:
   1. Rigid Steel Conduit

C. Compliance:
   1. ANSI C80.1, UL 6

D. Finish:
   1. Hot-dip galvanized after fabrication, inside and outside. Smooth finished surfaces.

E. Manufacturers:
   1. Allied Tube and Conduit Corp., Wheatland Tube Co., or equal.

F. Minimum size:
   1. Unless otherwise shown: 3/4-inch for exposed, 1-inch for concealed or embedded; 2-inch for ductbank encased.

G. Fittings:
   1. Hubs:
      a. Insulated throat with bonding locknut, hot-dip galvanized. The hubs shall utilize a neoprene "O" ring and shall provide a watertight connection. O-Z Gedney, CHM-XXT, or equal.
   2. Unions:
      a. Electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal. Threadless fittings are not acceptable.

H. Boxes:
   1. Indoor:
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA-12 welded steel 6 inches square and larger. Door shall have hinges with clamp locks. Boxes in process areas shall be NEMA-4 watertight. Boxes in corrosion areas shall be NEMA-4X.
      b. Conduit bodies: ferrous alloy type with screw taps for fastening covers. Gaskets shall be made of neoprene.
   2. Outdoor:
      a. Type FD cast ferrous for all device boxes and for junction boxes less than 6 inches square. NEMA-4X stainless steel nonmetallic for 6 inches square and larger.

I. Elbows:
   1. (3/4" thru 2.5")
      a. Factory fabricated or field bent.
   2. (3" thru 6")
      a. Factory fabricated.

J. Conduit Bodies:
   1. (3/4" thru 4")
      a. Malleable iron, hot-dip galvanized, unless otherwise noted. Neoprene gaskets for all access plates. Tapered threads for all conduit entrances.
   2. (5" and 6")
      a. Electro-galvanized iron or cast iron box.

K. Expansion Fittings:
   1. Expansion fittings in embedded runs shall be watertight and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4-inch movement in any direction.

L. Manufacturers:
   1. Appleton, Crouse-Hinds, Hubbell, O. Z. Gedney, or equal.

M. Installation:
   1. Rigid steel conduit shall be made up tight and without thread compound. Joints shall be made with standard couplings or threaded unions. Steel conduit shall be supported away from the structures using hot-dip galvanized malleable iron straps with nesting backs.
   2. Conduit entering boxes shall be terminated with a threaded hub as specified or standard fittings with grounding bushing.
   3. Exposed male threads on rigid steel conduit shall be coated with zinc-rich paint.



## 2.04 RACEWAY SPECIFICATION SHEETS (RACESPEC) - LFSC

A. Raceway Identification:
   1. LFSC

B. Description:
   1. Liquid-Tight Flexible Steel Conduit

C. Application:
   1. Final connection to equipment subject to vibration or adjustment.

D. Compliance:
   1. UL 360

E. Construction:
   1. Spirally wound galvanized steel strip with successive convolutions securely interlocked and jacketed with liquid-tight plastic cover.

F. Minimum size:
   1. 3/4 inch

G. Fittings:
   1. Cadmium-plated malleable iron body and gland nut with cast-in lug, brass grounding ferrule threaded to engage conduit spiral and O-ring seals around the conduit and box connection and insulated throat. Forty-five and 90-degree fittings shall be used where applicable.

H. Installation:
   1. Do not exceed 36-inch length.

## 2.05 RACEWAY SPECIFICATION SHEETS (RACESPEC) - RNC40 AND RNC80

A. Raceway Identification:
   1. RNC40 and RNC80

B. Description:
   1. Rigid Nonmetallic Conduit, heavy wall thickness for direct bury, concrete encasement or surface mounting where not subject to physical damage. DZYR per NEC Article 352.

C. Compliance:
   1. NEMA TC2, UL 651

D. Construction:
   1. Schedule 40, high-impact, polyvinyl-chloride (PVC)
   2. Schedule 80, high-impact, polyvinyl-chloride (PVC)

E. Minimum size:
   1. 3/4 inch exposed; 2-inch embedded or encased

F. Fittings:
   1. PVC solvent weld type

G. Boxes:
   1. Indoor:
      a. NEMA Class 4, nonmetallic
   2. Outdoor and corrosive:
      a. NEMA Class 4X, nonmetallic

H. Installation:
   1. PVC conduit entering fiberglass boxes or cabinets shall be secured by threaded bushings on the interior of the box and shall be terminated with a threaded male terminal adapter having a neoprene O-ring. Joints shall be made with standard PVC couplings.

2. PVC conduit shall have bell ends where terminated at manholes, handholes, or building walls. Bell ends shall terminate flush at the walls and floors and not extend or protrude.

## 2.06 CONDUCTORS, WIRE, AND CABLE

A. Provide products specified.

B. Unscheduled Conductor Sizing:
   1. Size conductors, wire, and cables in accordance with the National Electrical Code where not specified on the Drawings, and install in the minimum size raceway as specified in the RaceSpecs herein.

C. Control Wire Color Coding:
   1. Provide control wires with the following colors for the shown voltage:

| | |
|---|---|
| 120 Vac Power, line and load | Black |
| 120 Vac Control | Red |
| 24 Vac | Orange |
| 12 Vac | Brown |
| Foreign Voltage (AC) (Interlock) | Yellow |
| AC Neutrals | White |
| Ground | Green |
| 24 VDC (+ & -) | Violet |
| 12 VDC (+ & -) | Blue |
| Foreign Voltage (DC) | Violet/White or Blue/White |



D. Power Conductors:
   1. Provide power conductors with following colors for the shown voltage:

| Wire | 480Y/277V, 3Ø | 208Y/120V, 3Ø | 240/120V, 3Ø |
|---|---|---|---|
| Phase A | Brown | Black | Black |
| Phase B | Orange | Red | Orange per NEC 408.3(E) and 215.8 |
| Phase C | Yellow | Blue | Blue |
| Ground | Green | Green | Green |
| Neutral | White or Gray per NEC 210.4(D) | White | White |

   2. Provide black insulation conductors larger than #10 AWG with colored 3/4-inch vinyl plastic tape to identify the phase color at each cable termination. Tape wrap with 25 percent overlay to provide minimum of 3 inches of coverage.

E. Scheduled and Unscheduled Wire and Cable:
   1. Provide the insulation and jacket material specified in the CABLESPEC sheets for scheduled and unscheduled (not shown) conductors. Provide stranded copper conductors for all wire and cable.

F. Electrical Enclosure Conductor Ratings:

1. Provide conductors with 600-volt insulation ratings in panels and other electrical enclosures. Conductors with less than 600-volt insulation ratings are prohibited, unless specifically identified.
2. Bundle and lace conductors in panels and electrical equipment at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Provide lacing using plastic cable ties that are tensioned and cut off using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are prohibited.
3. Bundle conductors crossing hinges into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors and provide oversized plastic panel wiring duct within panels.
4. Provide slack in junction boxes, pull boxes, handholes and manholes sufficient to allow cables or conductors to be routed along the walls with the amount of slack equal to largest dimension of the enclosure.
5. Provide dedicated electrical wireways and insulated cable holders mounted and secured on stainless steel unistrut in manholes and handholes.

G. Instrument Signal Cable:

1. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Provide twisted shielded cable with individual shield for each pair. Provide twisted shielded cable multi-pair with overall shield and jacket. Provide triads wherever 3-wire circuits are required. Circuits shall not be made using conductors from different pairs or triads.
2. Install instrument, signal, and data communication circuits without splices between instruments, terminal boxes, or panels. Shields as a signal path, except for circuits operating at radio frequencies and utilizing coaxial cables are not acceptable. Common ground return conductors for two or more circuits are not acceptable.
3. Bond shields to the signal ground bus at the control panel. Isolate shields from ground and other shields at other locations by cutting short or taping. Provide terminal strips for signal leads and shield drain wires.
4. Terminate spare circuits and the shield drain wire on terminal blocks at both ends of the cable run. Shields or drain wires for spare circuit cables shall be bonded at control panel only with the other end insulated by tape cover.
5. Provide an instrument stand with terminal box mounted approximately 3 feet above grade to center or as shown. Provide terminal boxes for instrument cable with the cable and conductor labels specified.
6. Install and terminate conductors for paging, security, data communication, voice communication, and telephone systems in compliance with the manufacturer and the system utility recommendations.

H. Splicing and Terminating Materials:

1. Use an UL listed tool for the applied compression type of connectors with the correct size and type. Provide tin-plated high conductivity copper connectors. Mechanical clamp, dimple, screw-type connectors are prohibited.
2. Provide polymeric insulating material over motor terminations with high dielectric strength mastic or material to seal the ends against ingress of moisture and contamination.

3. Cover splices with electrical products designed for the application, and insulate with a heat-shrinkable sleeve or boot.

I. Fire Stop Sealant Materials:
   1. Provide non-combustible silicone sealant for sealing apertures and cable through-penetrations for electrical conductors meeting UL 263 4-hour time-temperature requirements.
   2. Manufacturer: STI Inc., Pensil Silicone Sealants PEN300 SpecSeal Firestop, or equal.

J. Circuit Numbering Marking System:
   1. Identify each power, control, and signal conductor at each terminal connection. Machine print the letters and numbers with black on white alphanumeric characters representing the circuit numbering system.
   2. Identify conductors, including spares. Provide cable markers and wire markers for distribution and utilization equipment circuits identifying the power source and circuit source from which it is served.
   3. Provide the identification system of vinyl power cable strap-on cable markers, vinyl multi-conductor control cable strap-on cable markers, and vinyl or polyolefin wire slip-on sleeves and encircle the conductor.
   4. Provide conductor marker used in outdoor, damp, or wet locations on heat-shrinkable polyolefin shrinkable marking sleeves covered with clear heat-shrink sleeve or clear tape cover.
   5. Print conductor markers using the Brady Marker "XC PLUS", the Brady LS2000 printer with the Brady sleeve wire marking system, or Engineer accepted equal.

K. Terminal Blocks:
   1. Provide terminal blocks with the following features:
      a. Voltage rated: 600 volts.
      b. Current rated: match largest conductor connected to the assembly.
      c. Integral marking strips.
      d. Terminal block assemblies: provide with mounting channels, barriers, and end clamps.
      e. Power and grounding terminal blocks: solderless box lug type.
      f. Control and signal terminal blocks. Manufacturer: Allen-Bradley 1492-HM1GY, NEMA type, 30-ampere.
      g. DIN-rail mount for direct wiring into terminal blocks.
      h. Pre-printed snap-in markers.



## 2.07 CABLE SPECIFICATION SHEETS (CABLESPEC)

A. CABLESPEC Sheets
   1. The following CABLESPEC sheets are included in this section:

| Type | Volt | Product | Purpose |
|---|---|---|---|
| MIC | 600 | SP-OS: MULT-PR#16 Shielded (TC) with Individual Pair Shields and Overall Cable Shield | Instrument |
| SIC | 600 | P-OS: 1-PR#16SH OR 1-TR#16SH (TC) | Instrument |
| XHHW | 600 | XLP Insulated Industrial Grade Conductor | Power cable |

| Type | Volt | Product | Purpose |
|---|---|---|---|
| THWN-2 | 600 | Building Wire, Control Wire | Lights, receptacles, control wire |
| MEPR/CPE | 600 | Multi-Conductor Jacketed Cable<br>Power Cable Example: 3/C #500 KCMIL with NEC Size Ground | Power |
| CAT6 | 300 | 4-PAIR, UNSHIELDED TWISTED PAIR CAT 6 CABLE | Network Communication |

## 2.08 CABLE SPECIFICATION SHEETS (CABLESPEC) – MIC

A. Cable System Identification:
   1. MIC

B. Description:
   1. Multiple twisted, shielded pairs, 16 AWG, with overall shield instrumentation cable, UL listed, with number of pairs as shown.

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B8

E. Insulation:
   1. 15 mil, 90 degree C, polyvinylchloride (PVC) with 4 mil nylon conduit or jacket

F. Lay:
   1. Twisted on a 2-inch lay

G. Shield:
   1. 100 percent, 1.35 mil aluminum-Mylar tape with 7-strand tinned copper drain wire

H. Overall Shield:
   1. 2.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire

I. Jacket:
   1. 45 mil polyvinylchloride (PVC)

J. Flame Resistance:
   1. UL 1277

K. Manufacturer(s):
   1. Okonite, Okoseal-N type SP-OS; or Cooper Industries-Belden equal

L. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01

2. Testing:
    a. Megger test: use Form in Section 01 99 90

## 2.09 CABLE SPECIFICATION SHEETS (CABLESPEC) – SIC

A. Cable System Identification:
    1. SIC

B. Description:
    1. Single twisted, shielded pair or triad, 16 AWG, instrumentation and signal cable, UL listed

C. Voltage:
    1. 600 volts

D. Conductor Material:
    1. Bare annealed copper; stranded in accordance with ASTM B8

E. Insulation:
    1. 15 mil, 90 degree C, polyvinylchloride (PVC) with 4 mil nylon conduit or jacket

F. Lay:
    1. Twisted on a 2-inch lay

G. Shield:
    1. 100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire

H. Jacket:
    1. 45 mil polyvinylchloride (PVC)

I. Flame Resistance:
    1. UL 1277

J. Manufacturer(s):
    1. Okonite, Okoseal-N type P-OS; or Cooper Industries-Belden equal

K. Execution:
    1. Installation:
        a. Install in accordance with Section 26 05 00.01
    2. Testing:
        a. Megger Test: use Form in Section 01 99 90

## 2.10 CABLE SPECIFICATION SHEETS (CABLESPEC) – XHHW

A. Cable System Identification:
    1. XHHW

B. Description:
   1. Industrial grade single conductor
   2. Sizes: 14 AWG through 750 kcmil as shown

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded per ASTM B8

E. Insulation:
   1. NEC Type XHHW-2, 90 degrees C dry or wet, Cross-Linked Polyethylene (XLP) per ICEA S-66-524 and UL-44, Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue

F. Jacket:
   1. None

G. Flame Resistance:
   1. UL 83

H. Manufacturer(s):
   1. Okonite, X-Olene; Cablec, Durasheath XLP; or equal.

I. Uses Permitted:
   1. Power, control, lighting and outlet circuits.

J. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01.
   2. Testing:
      a. Test in accordance with paragraph 26 05 00.01-3.02 and Section 26 05 00.01.



## 2.11 CABLE SPECIFICATION SHEETS (CABLESPEC) – THWN-2

A. Cable System Identification:
   1. THWN-2

B. Description:
   1. Single conductor lighting and receptacle type indoor branch circuit conductor. Sizes: 12 AWG through as shown.

C. Voltage:
   1. 600 volts

D. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B3 or B8

E. Insulation:
   1. THWN/THHN, 90 degrees C dry, 75 degrees C wet, polyvinylchloride (PVC) with nylon jacket per UL 83.
   2. May substitute XHHW2 with XLP insulation without a jacket.

F. Jacket:
   1. Nylon

G. Flame Resistance:
   1. UL 83

H. Manufacturer(s):
   1. Okonite, Okoseal-N, series 116-67-XXXX; or equal.

I. Uses Permitted:
   1. Lighting, receptacle, appliance circuits and control, no other location permitted

J. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01
   2. Testing:
      a. Megger Test: use Form in Section 01 99 90



## 2.12 CABLE SPECIFICATION SHEETS (CABLESPEC) – MEPR/CPE

A. Cable System Identification:
   1. MEPR/CPE

B. Description:
   1. Multiconductor Power Cable with ground conductor sized for the circuit or NEC required custom larger ground conductor sized for multiple-sets of conductors in one circuit
   2. Multiconductor Control Cable with 14-AWG minimum conductor size

C. Power Cable:
   1. Green ground conductor sized in accordance with the NEC

D. Ground Conductor Size:
   1. Multiple cable runs of multiconductor power cable shall have the ground conductor sized in accordance with NEC 250-95

E. Control Cable Type:
   1. ICEA Method 1, E-2:
      without white neutral conductor,
      without green ground conductor

F. Control Cable Identification:
   1. Conductors color coded per ICEA and conductors numbered

G. Voltage:
   1. 600 volts

H. Conductor Material:
   1. Bare annealed copper; stranded in accordance with ASTM B8, coated in accordance with ASTM B33

I. Insulation:
   1. For Power Cable: RWN/RHH, 90 degrees C dry, 75 degrees C wet, composite of ethylene propylene rubber (EPR) and chlorinated polyethylene (CPE) per ICEA S-68-516 and UL 44
   2. For Control Cable: FR-EP (XHHW-2), 90 degrees C dry or wet, ethylene propylene rubber based per ICEA s-68-516 and UL 44.

J. Jacket:
   1. Chlorinated Polyethylene (CPE)

K. Flame Resistance:
   1. IEEE 383

L. Manufacturer(s):
   1. Okonite; Cablec; or equal

M. Execution:
   1. Installation:
      a. Install in accordance with Section 26 05 00.01
   2. Testing:
      a. Megger Test: use Form in Section 01 99 90



## 2.13 CABLE SPECIFICATION SHEETS (CABLESPEC) – CAT6

A. Cable System Identification:
   1. CAT6

B. Description:
   1. IEC Category 6 UTP; TIA/EIA-568-B.2 Category 6
   2. NEC CMR (riser) rated
   3. UL 444 – Standard for Safety Communications Cables compliant
   4. UL1685 flame rating compliant

C. Conductor Material:
   1. Solid Bare Copper
   2. 23AWG

D. Insulation:
   1. Material: Polyolefin
   2. Color Coded conductor insulation

E. Jacket:
   1. LSZH PVC – Low Smoke Zero Halogen Polyvinyl Chloride
   2. Sequential Footage Marking: every two feet along jacket
   3. Color: Black

F. Manufacturer(s):
   1. Cooper Industries – Belden 7940T
   2. Commscope: Systimex 5071A
   3. Or equal.

G. Execution:
   1. Applications:
      a. Network communications <= 10Gbps
   2. Installation:
      a. Install in accordance with associated equipment manufacturer's instruction.
   3. Testing:
      a. Test in accordance with paragraph 3.05.



## 2.14 WIRING DEVICES

A. Unless specified otherwise, provide UL approved wiring ivory devices for the current and voltage ratings specified and comply with NEMA WD-1 with provisions for back wiring and side wiring with captive held binding screws.

B. Heavy Duty 120v Receptacles:
   1. Single Phase: Duplex 20-amp, NEMA 5-20R accepting NEMA 5-15P and 5-20P plugs. Cooper 5362, Hubbell 5362, or equal.
   2. Ground Fault Interrupting: Ground fault interrupting (GFI) receptacles: duplex, 20 amp, NEMA 5-20R, specification grade that accepts NEMA 5-15P and 5-20P plugs. Provide GFI receptacles outdoors and as shown, UL listed with provisions for testing and resetting. Manufacturer: Hubbell GF-5352-I, or equal.
   3. Three-Phase Receptacles and Boxes: Cooper Series 309 watertight pin & sleeve receptacles, plugs, and back boxes, or equal.

C. Switches:
   1. Indoor Switches: Quiet AC type, heavy duty, specification grade in accordance with rated capacities as required. Match the switch color and the receptacles color. Manufacturer: Cooper, Hubbell, or equal.
   2. Switches for Outdoor and Corrosive Areas: Provide 20-ampere, push-type switches; Cooper Tap-Action, Hubbell PressSwitch, or equal.

D. Device Plates: Provide device plates with switches and receptacles that match the area classification location.
   1. Indoor, Architecturally Finished Areas: Provide switch and receptacle device plates of stainless-steel finish. Manufacturer: Crouse-Hinds, Appleton, or equal in.
   2. Indoor, Non-Finished, Non-Corrosive: Provide switch and receptacle device plates of stainless steel finish. Manufacturer: Appleton, Crouse-Hinds, or equal.

3. Indoor, NEMA-12 Areas: In areas designated NEMA-12, or other areas specified provide hinged covers with neoprene gaskets. Manufacturer: Hubbell, Cooper, or equal.
4. NEMA 4X - Corrosive: In areas designated NEMA-4X, Corrosive, or other areas specified provide corrosion-resistant/marine-duty stainless steel type covers. Manufacturer: Hubbell, or equal.
5. In-Use Covers: In areas designated NEMA-4X, Corrosive, or other areas specified, and in outdoor areas, provide in-use type weatherproof lift covers that maintain weatherproof rating with plug installed for equipment that is cord connected with plug and receptacle. Covers shall be cast aluminum. Manufacturer: Outdoor, NEMA 4X areas: In-use covers shall be Hubbell WP7, WP8, WP26, or equal. Corrosive areas; Manufacturer: TayMac Corporation 20510, Carlon E9UXXXX, Hubbell WP826XXX, or equal.
6. Wet/Corrosive Switch Covers: In outdoor, areas, wet areas, areas designated NEMA-4X, Corrosive, or other areas specified, provide weatherproof, corrosion-resistant covers for switches to maintain weatherproof rating during operation of switch. Covers shall have flexible bubble of silicone or neoprene rubber for switch operation. Manufacturer: Cooper, Hubbell, or equal.
7. Hazardous Areas: Device plates in hazardous areas shall be, rated NEMA 7, suitable for use outdoors and in wet areas. Manufacturer: Appleton, Crouse-Hinds, or equal.

E. Pilot Devices:
1. Provide heavy-duty push buttons, selector switches and indicating lights: 30 mm, oil-tight, NEMA 4X. Indicating lights shall be light emitting diode (LED) type lamps. Unless otherwise shown, provide push-to-test type indicating lights. Provide diode isolating type pilot indicating lights specified for remote-test. Provide red indicating lamps for “RUN” indication and green indicating lamps for “STOP”.
2. Provide 120VAC control units: Heavy-duty type Allen-Bradley 800H, or equal. For 24VDC: Allen-Bradley 800T, Square-D Class 9001 Type J, or equal.

F. Load-Switching Control Relays:
1. Heavy-duty, machine tool type for switching load such as solenoids, actuators, contactors, motor starter coils, and other devices used for remote interlocking.
2. Contacts: 4-pole and field interchangeable to either normally open or normally closed and capable of accepting a 4-pole contact block adder.
3. AC relays: NEMA A600 contact ratings and electrical clearances for up to 600 volts.
4. DC relays: NEMA P300 contact ratings and electrical clearances of up to 250 volts.
5. Manufacturer: Allen Bradley Bulletin-700, Square D Class 8501 Type X, or equal.

G. Logic-Level Relays
1. Logic-Level switching solid-state logic and signal circuits:
   a. Minimum of three SPDT, silver cadmium oxide contacts rated 10-amperes-resistive at 120VAC or 28VDC.
   b. Plug-in type with heavy-duty, barrier-protected screw terminal sockets.
   c. Clear polycarbonate dust cover with clip fastener.
   d. AC models: neon lamp indicator wired in parallel with coil.
   e. Manufacturer: Idec Series RH, Square D Class 8501, or equal

H. Timing Relays:
   1. Multi-function, micro-controller based, socket mounted timing relay.
   2. Single functions:
      a. Delay on Make
      b. Delay on Break
      c. Recycle (on time first, equal recycle delays)
      d. Single shot
      e. Interval
      f. Trailing edge single shot
      g. Inverted single shot
      h. Inverted delay on break
      i. Accumulative delay on make
      j. Retriggerable single shot
   3. Dual functions:
      a. Delay on make/delay on break
      b. Delay on make/recycle (on time first, equal recycle delays.)
      c. Delay on make/interval
      d. Delay on make/single shot
      e. Interval/recycle (on time first, equal recycle delays)
      f. Delay on break/recycle (on time first, equal recycle delays)
      g. Single shot/recycle (on time first, equal recycle delays)
      h. Recycle – both times adjustable (on time first)
      i. Recycle – both times adjustable (off time first)
      j. Interval/delay on make
      k. Accumulative delay on make/interval
   4. Time delay range, switch selectable:
      a. Single function 0.1 second to 1,705 hours in 8 ranges.
      b. Dual function 0.1 second to 3,100 minutes in 8 ranges.
      c. Setting accuracy +/- 1 percent or 50 milliseconds, whichever is greater.
      d. Repeat accuracy +/- 0.1 percent or 16 milliseconds, whichever is greater.
   5. Output: Two Form-C electromechanical isolated contacts rated 10-amperes resistive at 240VAC and 1/3-horsepower at 120 or 240VAC; double pole double threw: DPDT. Mechanical life: 10,000,000 operations and electrical life: 1,000,000 operations at full load.
   6. Mounting: Magnal Plug 11-pin socket
   7. Environment: -20 degrees C to +65 degrees C.
   8. ABB/SSAC multifunction type TRDU time delay relay with dip-switch function setting with 12VDC, 24VAC, 120VAC, 240VAC inputs as required; Agastat, STA series; IDEC or Engineer accepted substitute.

I. Elapsed Time Indicators:
   1. Elapsed time indicators shall be panel mounted, non-resettable five-digit, hour indicator, rated 120 volts, 60 Hz.

## 2.15 GROUNDING SYSTEM

A. Provide electrical system grounding electrode conductors, equipment grounding conductors for equipment grounding and raceways, grounding electrodes, grounding electrode conductors, connections, and bonding in compliance with the National Electrical Code-Article 250 and the National Electrical Safety Code.

B. Provide annealed bare copper, concentric stranded grounding conductors. Provide the minimum sizes per NEC Article 250 for grounding conductors or service entrance conductors, if not sized on the drawings.

C. Bond grounding conductors entering enclosures together to metallic enclosure and to metallic raceways terminating at the enclosure. Clean the conductor and enclosure metal surface at the point of connection prior to making equipment grounding connections or bond connections.

D. Provide ground grid components of #4/0 AWG bare copper conductors connected to 10-foot ground rods installed at the four corners of a building, an equipment pad, or as shown on the Drawings.

E. Make connections grounding conductor connections to equipment and ground rods by bolted clamps, compression connectors, or exothermic weld connections in accordance with manufacturer's installation and testing instructions. Make connections to buried grounding connections using compression connectors or exothermic weld connections. Make connections at the ground grid test wells using bolted clamps.

F. Connect the ground grid to the following with grounding conductor specified herein or connect to the ground grid with grounding conductor as shown on the drawings:
   1. Building steel columns with #4/0 AWG bare copper
   2. Electrical ductbank #4/0 embedded conductor with #4/0 bare copper
   3. Electrical distribution or utilization equipment metal enclosures with #4/0 AWG green insulated copper
   4. Metal enclosure not containing electrical distribution with #4 AWG green insulated copper
   5. Pump/motor frames with #4 AWG bare or insulated
   6. Lightning and surge arresters using #4 AWG bare or insulated
   7. Fences and gates with #4 AWG bare or insulated
   8. Ground rods with #4/0 AWG bare copper
   9. Power utility service entrance equipment with #4/0 bare copper
   10. Equipment ground plate with #4/0 AWG bare copper.
   11. Other equipment: provide #1 AWG green insulated copper. Provide 3/4" conduit protection where subject to damage.

G. Ground Rods:
   1. Ground rods: copper-clad steel, 3/4-inch diameter and 10-feet long, with threaded end for connectors or installation tools.

H. Compression Connectors:
   1. Compression connections: cast copper.

2. Manufacturer: Thomas & Betts Company, or equal.

I. Bolted Connectors:
   1. Bolted connectors: copper. Manufacturer: Burndy, O. Z. Gedney, or equal.

J. Exothermic Connectors:
   1. Exothermic connections copper products. Manufacturer: Cadweld process or equal.

K. Equipment Ground Plate:
   1. Provide equipment ground plates embedded flush in equipment pads to provide a bolted connection between a grounding conductor from the equipment frame to the ground grid.
   2. Provide ground plates of copper alloy construction and 1/2 inch, threaded bolt connections and integral #4/0 welding stud. Manufacturer: Cadweld Series B-162, or equal.

L. Raceway Ground:
   1. Install metallic conduits to provide a continuous ground path. Use insulated grounding bushings and bonded to the ground grid system in compliance with Article 250 of the National Electrical Code.
   2. Provide an equipment-grounding conductor with green insulation in all metallic and non-metallic conduit, raceway, wireway, gutter, or ductbanks.
   3. Provide an equipment grounding conductor with green insulation for size up to #6 AWG and provide green color insulation tape band for conductor size #4 AWG and larger.



## 2.16 POWER, CONTROL, AND METERING EQUIPMENT

A. Panelboards:
   1. Provide panelboards: circuit breaker, dead front type with bus bar construction composed of individually mounted circuit breakers with screw-connection, designed to be removed without disturbing other breakers. Provide lockable, hinged door-in-door construction for flush mounted panels and hinged-trim covers for surface mounted panels.
   2. Provide tin-plated copper buss and with the current rating as shown on the panel schedules sized in accordance with UL 67 and withstand rating equal to the interrupting rating of the smallest circuit breaker in the panel. Series rated products are prohibited. Silver plated equipment is prohibited.
   3. Provide panelboards with a separate ground bus and a full capacity neutral bus. Mount neutral bus on insulated standoffs. Provide removable link connector from the neutral bus to the ground bus. Provide listed and labeled panelboard for service entrance disconnect as shown.

B. Combination Motor Starters:
   1. Provide NEMA rated for the horsepower for combination motor starters, minimum size 1, with motor circuit protector and solid-state type overload relay. Provide a reset button located on the unit door exterior.
   2. Provide adjustable motor circuit protector with magnetic only trip setting adjustable over a range of 600 to 1300 percent of full load current of the motor served. Field

adjust motor circuit protector setting per NEC and manufacture's recommendations. Provide 22,000 symmetrical ampere interrupt rating, where not shown on the power single line diagrams.

3. Provide solid-state adjustable overload relay to latch in the open position. Provide adjustable trip settings with minimum adjustable range from 85 to 115 percent of full load current of motor served. Field adjust overload setting per NEC and manufacture's recommendations.
4. Provide control power transformers with two primary fuses rated at 100,000 amperes at 600VAC and one secondary fuse rated at 10,000 at 250VAC and sized at 125 percent of the control circuit full load current. Ground the non-fused leg of the secondary circuit.
5. Provide switchboard type MTW or SIS control circuit conductors rated 90 degrees C above ambient temperature. Conductors shall be identified with tag numbers.
6. Provide motor contactor "Run" status contact and "Overload" alarm contact. Provide "Hand-Off-Auto" (HOA) and other shown selector switches with a "Auto Mode" status contact wired to terminal block.
7. Provide heavy-duty selector-switches and pushbutton and indicating lights with rating to match enclosure type. Provide control devices rated at 600VAC, 10-ampere continuous with
8. Provide start/stop pushbuttons with "Run" and "Stop" indicating lights including other control devices as shown. Provide push-to-test transformer type pilot lights or LED pilot lights. Lens color as shown on the drawings or specified herein.

C. Circuit Breakers:

1. Provide circuit breakers: molded-case type provided for the current ratings and pole configurations as shown or as specified on the panelboard schedule and with a minimum interrupting current rating as shown on drawings or schedules, but not less than 22,000 AIC for 240 volt rated devices or 42,000 AIC for 480 volt rated devices. Series rated branch, main, or other devices are prohibited.
2. Provide circuit breakers listed in accordance with UL 489 for the service specified and load terminals with solderless connectors. Provide bolt-on type circuit breakers. Provide circuit breakers with machine-printed, circuit number labels indicting the load served.

D. Manual Starters:

1. Provide manual starters with horsepower rated, quick-make, quick-break, toggle mechanism with overloads in each phase. Provide NEMA-12 enclosures indoor and NEMA-4X stainless steel enclosures outdoor, process areas, and corrosive areas. Provide label for power source and load as shown.

E. Variable Frequency Motor Controllers:

1. Provide 480 Vac rated adjustable frequency drive motor controller systems using insulated gate bipolar transistors (IGBT) for pulse width modulation technology (PWM).
2. The terms AFD (adjustable frequency drive), ASD (adjustable speed drive), VFD (variable frequency drive), and VSD (variable speed drive) are interchangeable for the purposes of this specification.

3. The AFDs specified in this section shall be the product of a single vendor and mounted in the specified cabinet enclosure. The AFDs shall be UL 508 listed and shall conform to the requirements specified in NEMA ICS 2, 6, 7 and 7.1.
4. Unit Responsibility:
   a. The Contractor shall assign unit responsibility for the adjustable frequency drives in this section as specified. The Contractor shall submit letters of certification with the shop drawings from the AFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower."
5. Refer to the drawings for control and monitoring requirements including special interlocking requirements.
6. System Requirements:
   a. The AFD system shall convert 460 volt, 60-Hertz nominal input to a suitable voltage and frequency to cause a premium efficient, inverter duty, squirrel-cage induction motor to run at a speed proportional to an external input analog 4 to 20 ma dc or digital input command as specified for the required AFD speed range.
   b. The AFD system shall include rectifier units, inverter units, control circuitry, protective equipment, input line reactors and output load reactors and other filters and accessories as necessary to provide the specified functions to meet voltage and current harmonics at the specified point of common connection and to mitigate the motor reflected voltage wave. Unless otherwise specified, the point of common connection for AFDs shall be the 480 distribution bus (motor control center, distribution panel, etc.) immediately upstream of the AFD.
   c. The AFD system torque requirement shall match the pump torque requirement. Verify the pump type and select variable torque (VT) or constant torque (CT) as specified in the AFD Schedule. Select 6-Pulse units for pump motors.
   d. AFD Schedule:



| Equipment Name & Tag Number | Drive Number | Drive Horse Power | Drive Speed Range | Driven Equipment Specification | AFD Type | AFD Enclosure & Mounting | Distance (ft) from AFD to Driven Equipment Motor |
|---|---|---|---|---|---|---|---|
| Recirculation Pump 1 (P-212) | VFD-212 | 20 | 900-1800 | 43 23 80.15 | VT 6-pulse | NEMA-1 Gasketed, Wall Mount | 100 |
| Recirculation Pump 2 (P-222) | VFD-222 | 20 | 900-1800 | 43 23 80.15 | VT 6-pulse | NEMA-1 Gasketed, Wall Mount | 100 |
| FOG Tank HW Loop Pump (P-310) | VFD-310 | 5 | 900-1800 | 23 21 23 | VT 6-pulse | In Motor Control Center | 100 |
| Main Loop Pump 1 (P-410) | VFD-410 | 10 | 900-1800 | 23 21 23 | VT 6-pulse | NEMA-1 Gasketed, Wall Mount | 100 |
| Main Loop Pump 2 (P-420) | VFD-420 | 10 | 900-1800 | 23 21 23 | VT 6-pulse | NEMA-1 Gasketed, Wall Mount | 100 |

7. Provide AFD in NEMA enclosures with fan cooling and conformal coating protection on circuit boards for corrosive atmosphere protection:
    a. Provide enclosures with AFDs and custom control as required for the project and as indicated on the drawings. Each drive shall be designed for stand-alone operation and multiple drives shall not utilize shared components. Review the project site location, elevation, temperature, humidity, plant atmosphere, and load current-torque requirements to size the AFD and its associated enclosure with requirements specified herein and the control and monitoring devices and interlocks as indicated.
    b. Enclosures shall be designed for indoor service. Each AFD system shall be mounted in a NEMA 250 internally force ventilated enclosure with UL approved Class 1 filters on ventilation openings. Enclosures shall be fabricated from 12-gage minimum thickness sheet steel with an interior frame or formed to provide a rigid structure.
    c. Provide enclosure size to allow entry of power source and motor load cables as indicated on the drawings. Submit drawing of the source and load power cable location within the enclosure and indicated barriers from control and instrument wiring.
    d. Door width shall not exceed 30 inches and shall be hung on removable-pin hinges, with three-point latch hardware, and handle latch for 3/8-inch-shackle padlock.
    e. AFD systems enclosures shall be finished with corrosion protection coatings inside and outside for hydrogen sulfide atmospheres. The electrical and electronic assemblies shall have conformal coatings.
8. AFD Assemblies:
    a. AFDs shall include the following assemblies:
        1) Power disconnect using a thermal magnetic circuit breaker or fused disconnect sized for the specific application by the manufacturer.
        2) Line input harmonic filter, as required, for harmonic mitigation.
        3) A load reactor for dV/dT mitigation or motor terminator units for addressing dv/dt effects at the motor
        4) Rectifier, direct current bus filter, and inverter.
        5) Control circuitry interface with Operator Interface Unit
        6) Output protection including phase overload
    b. AFDs shall include the following features:
        1) Fused control circuit transformer and microprocessor for system logic sequencing functions. Provide fuses with blown fuse indicator lamps.
        2) Accept 4 to 20 mAdc digital command input speed reference signal.
        3) A 4 to 20 mAdc output signal proportional to inverter output frequency for the speed range specified.
        4) Adjustable minimum/maximum frequency limits:
            a) Minimum frequency shall be adjustable from 6 to 40 Hertz.
            b) Maximum frequency shall be adjustable from 48 to 90 Hertz.
        5) Adjustable and independent timed linear acceleration and deceleration functions, adjustable from 6 to 20 seconds.
        6) Current limiting.

7) Automatic restart.
8) Control Wiring:
   a) 600 volt stranded copper
   b) 90 degrees C color-coded insulation
   c) No. 16 AWG
9) Wiring Identification and Termination:
   a) Crimp type wire lugs with sleeve type markers at each termination point and numbered terminal blocks for external connections.
10) Electrically isolated discrete output contacts for ready, running, remote mode status and trouble alarm.
11) Conformal coated terminal blocks for control and signal wires entering and leaving the controller.
12) Control Power:
   a) Provide a 120 Vac, triple fused, control power transformer for cooling fans and external control circuits when required. Control circuits shall be isolated from power circuits by distance and by insulated barriers.
13) Provide 120 Vac or 24 Vdc as required for Operator Interface Unit.

9. Manufacturer: Cutler-Hammer SV9000, ABB ACQ-580, or equal.

F. Safety Disconnect Switches:
1. Provide safety disconnect switches:
   a. Motor horsepower rated, heavy-duty, non-fusible
   b. Safety type rated 600 volts AC
   c. Ratings and fuse size as shown
   d. Rating and fuse size as required by the utilization equipment manufacturer
   e. Disconnect "open status" switch rated 1-ampere
   f. Switch operator with a positive, quick-make, quick-break mechanism
   g. NEMA-12 indoor conditioned space, or as shown
   h. NEMA-4X stainless steel below grade, process areas, outdoors, corrosive areas, or as shown
   i. Tinplated copper products. Silver-plated products are prohibited.
   j. Manufacturer: Square-D, GE, Allen-Bradley and Cutler Hammer or approved equal.

G. Low Voltage Transformers
1. Transformers rated:
   a. 15 kVA and greater shall be 3 phase or as indicated.
   b. Voltage, frequency, number of phases and kVA as indicated.
   c. Conform to ANSI/IEEE C57.12.01, DOE 10 CFR Part 431 Efficiency Standards, NEMA ST20, and ANSI/UL 506.
2. Manufacturers:
   a. ABB
   b. Eaton Cutler-Hammer
   c. Siemens

d. or equal.

3. Transformer Insulation
   a. 15 kVA and above: Not exceed 115 degree C temperature rise.
4. Transformer Coils
   a. Copper
      1) 15 kVA and above: Impregnated with varnish.
5. Transformer Taps
   a. Transformers 15 kVA and above shall be provided with two 2-1/2 percent full capacity taps above normal voltage and four 2-1/2 percent full capacity taps below rated voltage on the primary winding.
6. Transformer enclosures
   a. Indoor over 15kVA:
      1) Drip proof, ventilated enclosures.

H. Electrical Safety Matting
   1. Safety matting shall be provided for added protection of operations staff and workers to cover concrete surfaces in front of electrical equipment indoors.
      a. Matting shall meet ASTM D178 specifications for manufacture of Type II, Class 2: 1/4" thickness matting.
      b. Flame and oil resistant tested per ASTM standards.
      c. ASTM certification engraved or stamped on the back surface of the matt.
      d. Matting shall be tested and certified for industrial use. Matt rolls shall be proof testing over the entire surface at 20,000 VAC, and a dielectric test voltage of 30,000 VAC.
      e. The Contractor shall provide matting in the existing electrical rooms in front of all new electrical enclosures.
      f. The Contractor shall provide matting in the front of all interior control panels.
      g. Single piece rolls are preferred to be used in front of long sections of electrical equipment including, but not limited to, switchboards, switchgear, motor control centers, panelboards and control panels.
      h. Matting shall be a minimum of 48" wide corrugated black for interior areas.



## 2.17 LED INTERIOR/EXTERIOR LIGHTING

A. SPECIAL WARRANTY: Provide a Special Warranty for all LED lighting that shall include the following:
   1. The written 5-year on-site replacement includes parts, material, fixture finish and workmanship. Provide on-site fixture replacement includes transportation, removal, and installation of new products.
   2. The fixture finish shall include failure or substantial deterioration such as blistering, cracking, peeling, chalking or fading.
   3. The replacement material warranty shall include defective or non-starting LED source assemblies and on power supply units.
   4. The replacement warranty shall include lighting fixtures producing inadequately maintained illuminance levels at the end of the warranty period, as prorated from levels expected at end of useful life.

5. The warranty period shall begin on the date of Substantial Completion.
6. The Contractor shall provide the Owner with appropriate signed 5-year warranty certificates.
7. The Owner shall receive these certificates prior to final payment.

B. Lighting materials, including fixtures, accessories, and hardware, shall conform to the requirements specified on the Light Fixture Schedules on the project drawings.

C. Lighting fixtures shall be provided where shown on the drawings. The drawing's light fixture placement is diagrammatical. The fixture layout shall be coordinated with the various trades to provide access to the fixture and to avoid installed equipment interference. Raceways and wire shall be provided from the fixtures and switches to the lighting panel in accordance with the NEC.

D. The project drawings indicate the operation and control methods and the circuits for the lighting systems.

E. LED Lighting Requirements
1. LED lighting shall be a functioning unit with all components including light source, lamps, power supply, control interface and components required for operation and shall be assembled by the lighting manufacturer or supplier.
2. Lighting fixtures shall be UL or ETL listed and labeled. Lighting testing shall be per IESNA LM-79 AND LM-80 procedures.
3. Lighting fixtures shall comply with ANSI chromaticity standard for classifications of color temperature. Refer to the specified LED lamp color and color temperature or the manufacturer's literature.
4. LED drivers shall have reversed polarity protection, open circuit protection and require no minimum load. Drivers shall operate at a minimum 80 percent efficiency and have a class A noise rating.

F. Exterior Lighting Poles
1. Provide lighting poles with pole cap, hand holes, ground lug, and the necessary fixture mounting hardware.
2. TYPE Site/Area poles are shown on the contract drawings.



## 2.18 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
1. Operating and maintenance information as specified in Section 01 78 23.
2. One 11" x 17" set of drawings in a protective covering and shipped with the equipment in the internal equipment pocket at the time of equipment delivery to the project site.
3. Record documents as specified in Section 01 78 39.
4. Certificates of final electrical inspection and approval from the Code Authority Having Jurisdiction (AHJ) as specified in paragraph 26 05 00.01-1.01 A 4.

## PART 3 – EXECUTION

### 3.01 GENERAL

A. Construction:
   1. Perform the work specified by Contract Documents in accordance with these specifications.
   2. Coordinate the location of electrical material or equipment with the work and adjust conduit location to accommodate equipment in accordance with the accepted submittal drawings from the manufacturer.

B. Housekeeping:
   1. Protect electrical equipment from dust, water and damage. Cover the exterior to keep dry. Electrical distribution equipment such as motor control centers, switchgear, switchboards, panelboards, and other power source buses shall be clean and free of dust and dirt.
   2. Protect electrical equipment temporarily exposed to weather, debris, liquids, or damage during construction as specified in Shipment, Protection, and Storage section. Touch up scratches on equipment as specified in Coating Systems section before final acceptance.
   3. Wipe clean and vacuum equipment on the inside prior to acceptance testing and energization and again prior to detailed inspection and acceptance of the work.

C. Installation:
   1. Perform the installation work specified in accordance with these specifications.
      a. Splices are not allowed except by permission. Submit proposed splice locations to the Engineer for review prior to installation. Splices and terminations are subject to inspection prior to and after insulating and may require re-termination after inspection. Underground splices will not be allowed.
      b. Lighting and receptacle circuits may be in the same conduit in accordance with derating requirements of the NEC. Lighting and receptacle circuits in conduits with power or control conductors is prohibited.
      c. Adhere to the NEC raceway fill limitations. Provide separate conduits for signal and instrument conductors and cables.
      d. Install power conductors derived from uninterruptible power supply systems in separate raceways.
      e. Provide terminations at 460-volt motors by bolt-connecting the lugged connectors and insulating. Alternately, provide Tyco Electronics GelCap Motor Connection Kit by Raychem.
      f. Install pre-approved in-line splices and tees with tubular compression connectors and insulate. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin splicing kits.
      g. Provide self-insulating tubular butt-splice type of compression connectors for terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads.
      h. Adjust motor circuit protectors in accordance with manufacturer's instructions and NEC requirements.

i. Adjust motor overload device in accordance with manufacturer's instructions and NEC requirements.

D. Conductors, Wire, and Cable Installation:
   1. Identify conductors at each connection terminal and at splice points with the identification marking system specified.
   2. Install wire and cable into raceways, conduit, cable trays, or wireways without damaging or putting undue stress on the insulation or jacket. Provide manufacture's recommended and UL Listed pulling compounds lubricants for pulling wire and cable. Grease is prohibited.
   3. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Provide wire or cable support where wire or cable exits a raceway. Provide reusable stainless steel Kellums grips or equal product where cable support is required and where loads are removable.
   4. Scratch-brush the contact areas and tinplate the connection where flat bus bar connections are made with tinplated or unplated flat bus bar. Provide non-oxide material approved for the function. Torque bolts to the bus manufacturer's recommendations.
   5. Adhere to raceway fill limitations defined by NEC and the following: Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits.
   6. Install pre-approved in-line splices and tees made with tubular compression connectors and insulated as specified for terminations and for motor terminations. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin or equal splicing kits.
   7. Conductors in all handholes and manholes shall have adequate slack to be tied up around the perimeter of the vault and will be suspended by insulators around the vault's perimeter as needed to support the cable.

E. Raceway Installation:
   1. Provide additional pullboxes for conduit runs with greater than 360 degrees in any run between pullboxes. Limit maximum conduit runs without additional pullboxes to 400 feet, less 100 feet for every 90 degrees for the conduit run change in direction.
   2. Determine conduit routing that conforms to the installation requirements set forth herein and in accordance with the NEC requirements for size and number of pullboxes.
      a. Install exposed conduit either parallel or perpendicular to structural members and surfaces.
      b. Route two or more exposed conduits in the same general routing parallel with symmetrical bends.
      c. Install exposed conduit on supports spaced not more than 10 feet apart.
      d. Install conduits out from the wall using framing channel where three or more conduits are located in parallel run.
      e. Install conduits between the reinforcing steel in walls or slabs that have reinforcing in both faces. Verify installation method for conduits larger than 2-inch with Engineer prior to installation.

f. Install conduit in slabs that have only a single layer of reinforcing steel, under the reinforcement.
g. Install conduits with large radii under the slab in a one-sack concrete slurry.
h. Route conduit clear of structural openings and shown future openings.
i. Provide conduit roofs or wall penetrations with flashing sealed watertight and fire-stop, as required to maintain the structural rating.
j. Grout conduit into any openings cut into concrete and masonry structures.
k. Cap conduits during construction to prevent entrance of dirt, trash, and water.
l. Terminate exposed conduit stubs for future use with pipe-caps and provide couplings and pipe-plugs where flush with the slab.
m. Determine concealed conduit stub-up locations from the manufacturer's shop drawings.
n. Terminate conduit in equipment with conduit couplings with pipe-plugs flush with structural surfaces for empty conduit.
o. Install conduit horizontally with at least 7-feet headroom clearance.
p. Terminate conduit with fittings that ensure that the NEMA rating of the enclosure and provide conduit hubs, as required heretofore.
q. Connect underground metallic or nonmetallic conduit that turns out of concrete, masonry, or earth to a 90-degree elbow of PVC-coated rigid steel conduit before emergence. Taped or painted RMC-steel or RNC is prohibited.
r. Provide conduit crossing structural joints with structural movement with O-Z "Type DX" or Crouse-Hinds "Type XJG-SA," aluminum, bonded, weather-tight expansion fitting of the same size and type as the conduit.
s. VFD motor feeder circuits shall be routed a minimum of 12 inches from any control conduits. Should they cross they shall cross at 90 degrees.

F. Underground Raceway Installation:
1. Provide underground conduit installations that conform to the following requirements:
a. Direct bury underground conduits that are not shown to be installed in an electrical ductbank.
b. PVC coated RMC-steel elbows for underground to above ground transitions.
c. Underground conduit bend radius: not less than 2 feet minimum at vertical risers nor less than 3 feet elsewhere for up to 2-inch diameter conduit.
d. Determine conduit manufacturer’s bending radius requirement for 3-inch and larger diameter conduit and use factory “long radius” ells.
e. Underground ductbanks and direct-buried conduits: 2-feet minimum earth cover, except where shown otherwise.
f. Concrete encased conduit:
1) Minimum concrete thickness of 2 inches between conduits 2.5-inch and smaller.
2) 3 inches between 3-inch conduit and larger or per NEC requirements.
3) 1-inch between conduit and reinforcing.
4) 3 inches over reinforcing.

5) Embed #4/0 bare ground in the concrete encasement and installed with direct buried raceways.
6) Standard detail or typical details shown supersede these general requirements.
7) Provide 3-pounds of red-oxide dye-color per sack of cement for in the concrete encasement for electrical ductbanks.
8) Provide 467-ASTM coarse aggregate size with 3-cement sacks per cubic yard concrete.
9) Provide concrete with 28-day, 2000-psi compressive strength unless specified at higher value in the cast-in-place concrete specification.

G. Low Voltage Transformers
1. Bond transformer enclosures and neutrals together and connect to the ground grid.
2. Install transformers on walls at locations shown on the Drawings.
3. Make connections to transformers with flexible conduit.
4. Adjust tap settings to provide proper voltage at panelboards.
5. Ground transformer in conformance with the NEC.

H. LED Lighting
1. Lighting circuit raceways and conductors shall be sized by the contractor, where the circuits are not shown on the drawings.
2. Raceways and wire shall be provided from the fixtures and switches to the lighting panel in accordance with the NEC.
3. Photoelectrical cells, where specified, shall be oriented toward the north.
4. Labels and marks, except the UL label, shall be removed from exposed parts of the fixtures. Fixtures shall be cleaned when the project is ready for acceptance.
5. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values or use torque values specified in UL 486A and UL 486B.
6. Verify normal operation of each fixture.
7. Interrupt the power supply to demonstrate emergency lighting operation to battery power source or alternate power source. Retransfer to normal power supply.
8. Replace damaged fixtures.

I. Electrical Equipment Labeling – Arc Flash
1. Electrical equipment shall have field marked signs and labeling to warn qualified persons of the potential electric arc flash hazards per NEC Article 110.16 Flash Protection. These labels will be provided by the Contractor.

J. Report
1. Provide a short circuit and coordination study on the electrical power distribution system as specified and as described in Section 6.1 of NETA ATS. The studies shall be performed in accordance with IEEE Standards 141 and 242 and shall utilize the ANSI method of short circuit analysis in accordance with ANSI C37.010.
2. The studies shall be performed using actual equipment data for the equipment. The coordination study shall use the data from the same manufacturer of protective relay devices as being provided by the switchgear manufacturer.

3. For new equipment, the Contractor shall provide copies of final reviewed equipment submittals upon request by the Study Firm.
4. Any power distribution equipment outages shall be scheduled in advance and coordinated with the Authority to limit process outages as required per plant process capacities.

## 3.02 TESTING

A. Provide electrical equipment acceptance tests in accordance with the latest version of NETA Acceptance Testing Specification for electrical distribution and utilization equipment to demonstrate that all electrical equipment is functioning as designed.

B. Test lighting system for proper function. Test wiring devices for correct connections. Test outlet grounding and polarity using a plug-in test device. Test motor control stations and control devices for proper function.

C. Test power, control, instrument, and signal conductors to verify free from grounds. Megger test all conductors with the test voltage appropriate to the conductor insulation voltage. Use a 600 or 1,000-volt megohmmeter for resistance measurements for 600VAC rated insulation and all motors. Test between conductors and from conductor to ground. Insulation with resistance of less than 10-megohms is not acceptable. Record the insulation resistance measurements in a format similar to or on the Form 26 05 00.01-A in Section 01 99 90.

D. Pre-test conductors prior to installation, as appropriate. Replace damaged conductors. Test all conductors after installation.

E. Measure motors insulation resistance before they are connected. For 50-horsepower and larger motor, measure the motor insulation resistance at the time of delivery and after they are connected. Insulation resistance values less than 10 megohms are not acceptable. Complete the Installed Motor Test Form: 26 05 00.01-B in Section 01 99 90, for each motor after installation.

F. Harmonic Testing
   1. The Testing Firm shall perform a harmonics acceptant test with all AFD motor controllers operating to verify compliance with IEEE-519 of less than 5 percent voltage THD and 12 percent current THD at the defined point of common connection when running from Power Utility power source with a BMI-Dranetz or equal harmonic test set that provides a hard-copy record of the test results.
   2. The test shall also be run with power sourced from the standby generator where such a power source is being used at the project site. THD shall be limited to a maximum level of 8 percent voltage THD on standby generator operation.
   3. Submit the test performance to the Engineer per latest version NETA ATS Acceptance Testing Specifications.

## 3.03 FUNCTIONAL CHECKOUT

A. Prior to energization of equipment, perform a functional checkout of the control circuit. Prior to functional testing, adjust and make protective devices operative. Energizing each control circuit and operating each control, status, alarm, protective device, and each

interlock to verify that the specified action occurs. Submit a description of his proposed functional test procedures prior to the performance of functional checkout.

B. Verify motors are connected to rotate in the correct direction by momentarily energizing the motor. Prior to motor rotation test, confirm that the motor, the driven equipment, nor personnel will be damaged by reverse operation.

## 3.04 GROUNDING SYSTEM TESTS

A. Test each grounding connection to determine the ground resistance per the IEEE Standard 81. Submit a plot of ground resistance readings for each isolated ground rod or ground mat to the Engineer on 8-1/2 x 11-inch size graph paper.

B. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test. Make measurements at 10-foot intervals, beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

C. A grounding system that shows greater than 2-ohm resistance, for the flat portion of the plotted data, is considered inadequately grounded. Add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurements meet the 2-ohm requirement. Additional ground rods and ground grid work will be paid for as extra work. Use of salts, water, or compounds to attain the specified ground resistance is prohibited.



## 3.05 SHORT CIRCUIT STUDY

A. The Contractor shall be responsible to obtain and verify all data needed to perform the study. As a minimum, the short circuit study shall include the following:

1. One-Line Diagram
    a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
    b. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.
    c. Power, voltage ratings, impedance, primary and secondary connections of all transformers.
    d. Type, manufacturer, and ratio of all instrument transformers energizing each relay.
    e. Nameplate ratings of all motors and generators with their subtransient reactances. Transient reactances of synchronous motors and generators and synchronous reactances of all generators.
    f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors.
    g. circuit elements such as transformers, cables, breakers, fuses, reactors, etc.
    h. Emergency as well as normal switching conditions, as applicable.
    i. The time-current setting of existing adjustable relays and direct-acting trips, as applicable.

B. Calculations

1. Determine the paths and situations where short circuit currents are the greatest.
2. Study shall address bolted faults and calculate the 3-phase and line-to-ground short circuits of each case.
3. Calculate the maximum and minimum fault currents.

## 3.06 ARC FLASH HAZARD ANALYSIS

A. The Contractor shall be responsible to obtain and verify all data needed to perform the study. The arc flash analysis study shall include the following IEEE Standard 1584 nine step analysis process:

1. Collect system and installation data.
2. Determine modes of operation.
3. Determine bolted fault current.
4. Determine arc fault current.
5. Determine protective device characteristic and arc fault duration.
6. Document system voltages and equipment class.
7. Select working distances.
8. Calculate incident energy.
9. Calculate the arc flash protection boundary.

## 3.07 PROTECTIVE DEVICE COORDINATION STUDY

A. As a minimum, the coordination study for the power distribution system shall include the following on 5-cycle, log-log graph paper:

1. Time-current for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the complete protective relay settings shall be specified.
2. Time-current curves for each device shall be positioned to provide for maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the Engineer shall be notified as to the cause.
3. Time current curves and points for cable and equipment damage.
4. Circuit interrupting device operating and interrupting times.
5. Indicate maximum fault values on the graph.
6. Sketch of bus and breaker arrangement.



## 3.08 IMPLEMENTING PDCS SETTINGS AND ARC FLASH SIGN INSTALLATION

A. The Study Firm/Testing Firm shall work with the Contractor to implement the protective device coordination study settings on new and existing equipment as required in this Section, based on the Engineers accepted Protective Device Coordination Report specified herein and submit a final amended report of the Record As-Built electrical equipment protective device settings subsequent to start-up and testing.

B. The Study Firm/Testing Firm shall work with the Contractor for implementing the Arc Flash Hazard warning labels installation requirements for electrical equipment as specified in NEC Article 110.16 Arc-Flash Hazard Warning , and NFPA 70E requirements.

## 3.09 RECORD DOCUMENTS

A. Provide Record Drawings and documents maintained and annotated during construction. Submit drawings in accordance with Section 01 78 39 and the following.

B. Include addendum items, requests for information, change orders, and field changes posted or drawn on the Record Drawings. Include the following drawings with the Record Drawings:

1. Interconnection Diagrams specified herein.
2. Original Submittal Drawings specified herein.

C. Schedule a meeting with the Engineer in the Engineer's office to review the Record Drawings at the end of the project. Make corrections to the Record Drawings prior to re-submitting the Record Drawings to the Engineer.

D. Submit Record Drawings and Operations and Maintenance (O&M) Manuals as specified in Sections 01 78 23 and 01 78 39, to be included in the completed project Record Document Set for the Authority.

**END OF SECTION**

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SECTION 26 32 13.15

DIESEL FUEL SYSTEM

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies a Diesel Fuel System comprised of a Diesel Fuel Storage System and Diesel Fuel Supply System.

1. Diesel Fuel Storage System consisting of a 12,000-gallon, insulated, outdoor, fire rated, projectile resistant, aboveground fuel storage tank with a white permacrete finish, with leak detection, with level monitoring devices, and related accessories
2. Diesel Fuel Supply System consisting of a duplex fuel oil pump system, fuel oil filter system, fuel oil unloading system and fuel oil piping containment and leak detection system.

B. Equipment List:

| Item | Equipment Number |
|---|---|
| Fuel Tank | |
| Duplex Fuel Oil Pump System | VCP-504 |
| Fuel Oil Filter System | VCP-503 |
| Fuel Oil Unloading System | VCP-500 |



### 1.02 GENERAL REQUIREMENTS

A. A single supplier shall be responsible for supplying an integrated fuel storage tank and fuel system consisting of all items in this specification.

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid or on the effective date of the Agreement if there were no Bids.

C. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

D. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| NESC | National Electrical Safety Code |
| NFPA 1 | Uniform Fire Code |
| NFPA 30 | Flammable and Combustible Liquids Code |
| NFPA 70 | National Electrical Code |
| NFPA 780 | Installation of Lightning Protection Systems |
| UL 142 | Steel Aboveground Tanks for Flammable and Combustible Liquids |
| UL 2085 | Protected Aboveground Tanks for Flammable and Combustible Liquids |

## 1.04 QUALITY ASSURANCE

A. Fuel storage system components shall be tested and listed for the following:
   1. NFPA 1:
      a. The requirement for two-hour (firewall) test
   2. UL 142:
      a. Aboveground steel tanks for flammable and combustible liquids
   3. UL 2085:
      a. Two-hour furnace fire test and two hour simulated pool fire test for insulated and protected tanks
   4. UL 2085 and UFC Test Standard (Article 79 or Appendix A-II-F-1):
      a. For both Vehicle Impact Protection and Projectile Resistance:
   5. UL 2085:
      a. Protected aboveground tanks for flammable and combustible liquids
   6. UL 2085:
      a. Non-Metallic Secondary Containment protected tanks for flammable and combustible liquids with secondary containment Emergency Venting by "Form of Construction"



## 1.05 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00:
   1. Bill-of-material
   2. Layout drawings
   3. Schematic and wiring diagrams
   4. Color chips for selection
   5. Supports and anchors for pipe, fuel oil unloading system, duplex fuel oil pump system, and fuel oil filter system
   6. Structural calculations for design of hurricane hold down restraints
   7. Brazing certificates
   8. Welding certificates
   9. The secondary containment manufacturer shall supply a complete design submittal including layout drawings, catalog sheets, material data and pipe stress and end load calculations in accordance with ANSI B31.3 latest edition. The calculations shall be stamped by a registered professional engineer.
   10. Plan for connecting to existing fuel oil loop and containment pipe.

B. The following product data shall be provided in accordance with Section 01 33 00:
   1. Operating and maintenance as specified in Section 01 78 23.
   2. Manufacturer's catalog data for equipment, devices, materials, and systems provided under this section.
   3. Catalog data assembled in a folder with each page clearly marked with the item and reference number to the specification.
   4. Factory and Field quality-control reports
   5. Record Drawings of locations of pipe, fuel oil unloading system, duplex fuel oil pump system, fuel oil filter system, wiring diagrams and schematics of all control panels.

## 1.06 MANUFACTURERS WRITTEN WARRANTY.

A. Provide 30 year warranty for Diesel Fuel Storage Tank starting with substantial completion.

B. Provide 18 month warranty for all other items in the Diesel Fuel Storage System not including the Fuel Storage Tank and the Fuel Supply System.



# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. The Owner and Engineer believe the following candidate manufacturers are capable of suppling equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular will comply manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products with the requirements of this Section. Candidate manufacturers include Analytical & Combustion Systems, Bethel, CT. The Fuel Oil System shown on the drawings is based on the named supplier as the Basis of Design, all changes required in an alternate supplier will be the responsibility of the Contractor.

## 2.02 FUEL FUEL STORAGE SYSTEM

A. The primary steel tank shall be rectangular in shape with all openings from the top only and have continuous welds on exterior seams, manufactured in accordance with UL listing requirements and UL 142. The primary steel tanks shall have an emergency vent system per NFPA 30 Code requirements.

B. The primary steel tank shall be pressure tested at 5 psig for 24 to 48 hours and pressurized at 5 psig during concrete encasement. The outer surface shall be covered by a minimum of 1/4" thick styrofoam insulation panels.

C. The secondary containment shall consist of a 30-mil thick high-density polyethylene membrane enclosing the steel tank and insulation material.

D. The primary steel tank and the secondary containment shall be encased in six inches of monolithic reinforced concrete with minimum design strength of 4,000 and 5,000 psi at 28 days, depending on tank size. Concrete encasements with seams and designs that use two layers of steel with insulation material between them will not be approved.

E. The diesel storage system shall include the following features:
   1. Top only openings. Include openings as identified on Drawings.
   2. The tank shall include an impervious barrier to contain leaks from primary tank. A leak detection access tube shall be located between the inner tank and secondary barrier. In the event of a leak, a positive space shall be available to permit leaked fludid to flow to the detection tube.
   3. Concrete Exterior:
      a. Monolithic pour on top, bottom, ends, and sides without cold joints or heat sinks (heat transfer points).
   4. Exposed Metal:
      a. Powder coated to inhibit corrosion.
   5. Ovefill/spill containment. The tank shall include a minimum of 7 gallon internal overfill/spill containment surrounding the fill pipe, which is U.L. listed. The container shall include a normally-closed plunger valve to release spilled product into the main tank.
   6. Overfill protection. Overfill protection shall be provided by a direct reading level gauge at tank visible from fill pipe and audible high level alarm activate dby a float switch at the fuel oil unloading system.
   7. Concrete support legs
   8. Provide hurricane hold down restraints to prevent tank from floating in a flooding event.
   9. Lightning Protection:
      a. Two bolts and cable connectors for connecting grounding conductors in accordance with NFPA 780 to two 10-foot copper clad steel ground rods.
   10. Signs:
      a. Required labeling and warning signs.
         1) Flammable
         2) No Smoking
         3) Product identification
   11. Fittings to be supplied as shown on the drawings and as per jobsite requirements. All fittings to be located on the top centerline of the tank.
   12. Fill Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom.
   13. Pump Suction Tube: Install a foot valve on the bottom of the pump suction tube, terminate pump suction tube 4” from bottom of tank.
   14. Filtration Suction Tube: Install a foot valve on the bottom of the filtration suction tube, terminate filtration suction tube 2” from bottom of tank.
   15. Return Tube(s): Extension of fitting into tank, terminating 6 inches above tank bottom and on opposite of tank from pump suction tube.
   16. Primary and secondary tank vents with tank vent protectors.
   17. Tank Vent Protectors
      a. Fuel oil storage Tank Vent Protectors shall be the full size of the vent pipe in accordance with NFPA 30 Flammable and Combustible Liquids Code and NFPA 31 Standard for the Installation of Oil-Burning Equipment.

b. It shall be of aluminum construction and provided with standard pipe threads.

c. Provide a tank vent protector as manufactured by Preferred Utilities Mfg. Corp., Danbury, CT.

18. Striker Plates: Inside tank, 1/8" thick minimum thickness on bottom below fill, vent, sounding, gage, and other tube openings.

19. Lifting Lugs: For handling and installation.

20. External Stairs, Platforms, and Handrails (PER OSHA FALL PROTECTION IS REQUIRED FOR SURAFACES >4 FEET – FALL PROTECTION INCLUDES HARNASSES/PLATFORMS ETC….): Provide a full-length OSHA approved steel platform for access to all tank fittings and manway.

a. Platform shall be 24" wide, have 42" high handrails with 4" high kick plates and 1" x 3/16" steel grating. Platform shall be at the same elevation as the top of the tank.

b. Platform provided with stairs. Stair treads to be 18" wide and have smooth foot and handrails.

c. Platform and stairs to be finished same as tank exterior.

d. Provide 42" high handrails with 4" high kick plates and 1" x 3/16" steel grating along the perimeter of Tank.

e. Platform and stairs to be constructed to OSHA standards.

F. Leak Detection and Level Monitoring

1. Provide a Pneumercator TMS-2000 or equal fuel tank monitoring system (monitoring system) with intrinsically safe remote probes in the fuel tank. Locate panel on tank as shown on the Drawings. Panel power input circuit shall be rated for 120 Vac. Provide the following complete with two signal cables to the remote fuel tank:

a. One level probe, with a float that slides up and down the probe, which monitors the fuel level.

b. One leak detection probe for monitoring a fuel leak within the interstitial space between the tank primary and secondary containment structures.

2. Fuel Level Monitoring:

a. Provide level gauge on the tank that shows the level of fuel in the tank.

b. Level shall be remotely displayed at the monitoring system LCD screen.

c. Level float relay shall provide a low level alarm when the tank reaches 15 percent tank fuel capacity for local and off-site monitoring.

d. Level float relay shall provide a high level float alarm when the tank reaches 95 percent tank fuel capacity at the monitoring system panel and for off-site monitoing.

3. Fuel Leak Detection:

a. Leak detector located in the fuel tank interstitial space, between the primary and secondary containments shall provide an alarm when leaking fuel is detected.

b. Provide leak detection alarm for local and off-site monitoring.

## 2.03 DIESEL FUEL SUPPLY SYSTEM

A. Duplex Fuel Oil Pumping System: Provide a factory packaged pre-engineered, pre-wired, and pre-plumbed fuel oil transfer pump system to supply the existing generators and fuel

loop as shown on the drawings. Fuel system shall be rated for installation outdoors. Requirements for the fuel system are provided below:

1. Duplex internal gear pump with cast iron house.
2. Containment basin sized to contain leaks from piping and components. Includecontainment basin leak detection switch.
3. Isolation ball valves on suction and discharge of each pump and check valves on the discharge of each pump.
4. Duplex strainers with 40 mesh baskets on suction of each pump.
5. Relief valves sized to relieve full outlet flow of each pump. Valve shall be piped to the return line according to NFPA 30.
6. Compound gauge on the suction of each strainer rated from 30" vacuum to 15 psig. Provide isolation ball valve on each gage.
7. Pressure gauge on the discharge of each pump. Provide isolation ball valve on each gage.
8. Flow sensing switch on discharge of each pump to energize the lag pump should the lead pump fail.
9. Automatic lead/lag system.
10. Microprocessor-based control with color touchscreen displaty in a NEMA 4X enclosure.
11. Flow range 540 gal/hr
12. Discharge pressure 50 psig
13. System shall be Model ATPSF-200SP-460-30-Z1808-D-DP-L-TG1 as manufactuered by Preferred Utilities MFG Corporation, or approved equal.

B. Fuel Oil Filter System: Provide a factory packaged pre-engineered, pre-wired, and pre-plumbed fuel oil filter system to filter unwanted material such as water, suspended rust, dirt and other contaminants in the stored fuel oil. Fuel filter system shall be rated for installation outdoors. Requirements for the fuel filter system are provided below:

1. System shall include a primary filter, secondary fileter, simplex strainer, leak deteror switch, pump and motor assembly, hand-off-auto switch, control panel with color touch screen and differential pressure switch and gauge.
2. Flow: 1200 GPH
3. Pressure: 25 psig
4. Power: 120V/60Hz/1phase
5. Positive displacement type pump with cast iron housing
6. Motor: ¾ HP, TEFC
7. Strainer: Simplex with 100 mesh perforated basket
8. Microprocessor-based control with color touchscreen displaty in a NEMA 4X enclosure.
9. Automatic controls with adjustable run time
10. Indication and alarms
    a. Control power on,
    b. Pump run,
    c. Excess water in fuel,
    d. Filter saturated, filter water level high

e. System basin leak detected

11. System shall be Model PF-505 as manufactuered by Preferred Utilities MFG Corporation, or approved equal.

C. Fuel Oil Unloading System: Provide a factory packaged pre-engineered, pre-wired, and pre-plumbed fuel oil unloading system for filling fuel storage tank. Fuel oil unloading system shall be rated for installation outdoors. Requirements for the fuel oil unloading system are provided below:

1. Be in accordance with NFPA 31.
2. Cabinet shall be free standing with 304 stainless steel support
3. Cabinet shall be NEMA 4X constructed of 304 stainless steel
4. Provide a minimum of 5 gallons containment with a leak proof drain connection on the bottom of the spill container.
5. Provide an overfill alarm station integral to cabinet. Station shall include overfill alarm light, alarm horn, and pushbutton silence.
6. All components ineterior to the cabinet shall be explosion proof to prevent the ignition of fuel oil vaports in spill container.
7. Oil fill connection shall include a type “W” watertight fill cap (if tank below fill port use type W, if tank is pumped fill use dry disconnect with series 1611AN adapter and series 1711D coupler).
8. The fill station shall include a Preferred FA-L Caution Sign. The Caution Sign shall read as follows: CAUTION WHEN ALARM BELL SOUNDS OIL TANK FILLED TO CAPACITY DO NOT OVERFILL.
9. Provide permanently mounted and prominently displayed inside the Fill Station a durable nameplate displaying the main oil storage tanks inventory capacity in US Gallons
10. System shall be Model 2-SS-3-3-F as manufactuered by Preferred Utilities MFG Corporation, or approved equal.

D. Pipe, tubes, and fittings

1. All piping materials shall be in accordance with NFPA 30, NFPA 31 and Chapter 13 of the International Mechanical Code.
2. The system shall be designed for fuel oil in accordance with the following conditions:
   a. carrier pipe fluid temperature not to exceed 150 deg. F,
   b. carrier pipe pressure not to exceed 50 psi,
   c. containment pipe pressure not to exceed 10 psi.
3. Above ground Steel Pipe: ASTM A53 or ASTM A106, grade B seamless black steel, Schedule 40, with welded connections.
4. Carrier Pipe: Carrier pipe shall be schedule 40 carbon steel, ASTM A106, Grade B, or seamless. All joints shall be butt welded for sizes 2 1/2 inches and greater and socket or butt welded for 2 inches and below. Where possible, straight sections shall be supplied in 40-foot random lengths with 4 inches of piping exposed at each end for field joint fabrication.

5. Containment Pipe: The secondary containment shall be 10 guage fabricated out of carbon steel, in accordance with ASTM A-135 Grade B or ASTM A-53 Grade B, to the thickness specified below:
    a. The carbon steel containment pipe shall have a factory installed cladding on straight sections shall consist of multiple layers of underground helical windings of continuous glass reinforcements applied at a winding angle of 58° to 62°. The cladding on fittings shall consist of either a chopped spray-up polyester resin/fiberglass reinforcement composite or wrapping of glass cloth fully saturated with a two-part catalyst adhesive.
6. Fittings at the tank or equipment, shutoff valves and other fuel oil flow and control devices may be screwed or flanged.
    a. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    b. Gasket Materials: Asbestos free, ASME B16.20 metallic or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
    c. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.
7. Secondary Containment Piping
    a. All Below ground secondary containment piping systems shall be an engineered and totally prefabricated DOUBLE-PIPE type containment system. Carrier pipe shall be protected from the exterior environment by the secondary containment.
    b. The system supplier shall have at least 10 years of experience in the manufacture of secondary contained pipe systems having a factory integrated complete cable leak detection/location/alarm system.
    c. All straight sections, fittings and other accessories shall be factory prefabricated to job dimensions.
    d. Secondary steel containment & joints completed at the factory shall be 100 percent air-tested with reports. The system shall be manufactured to allow the placement/replacement of the leak detection cable in the secondary containment.
    e. The containment shall be drainable, dryable and air pressure testable. Contractor fabricated systems, whether built on site or off site, shall not be acceptable.
    f. A trained factory representative with 5 or more years certified experience with the piping supplier shall provide technical field support during critical periods of installation, including final check out of the PAL-AT leak detection/location system.
8. Leak Detection
    a. The secondary containment system manufacturer shall furnish a PAL-AT cable type leak detection/location system, integrated into the Preferred Utilities Master Control Panel.
    b. The piping shall be designed to allow pulling of the leak detection cable into the containment pipe, both during and after piping installation. Containment pull ports shall be located a maximum of 500 feet apart for straight runs and reduced by 150 feet for every 90o change in direction.
    c. The leak detection/location system shall consist of a microprocessor-based panel capable of continuous monitoring of a sensor string for leaks/faults.

d. The unit shall have a sensing range of 2000 feet per cable with up to eight cables per panel.

e. The alarm unit(s) shall operate on the principle of pulsed energy reflection and be capable of mapping the entire length of the sensor cable and storing the digitized system map in nonvolatile memory. The alarm units shall provide continuous indication that the sensor cable is being monitored.

9. Pipe Supports: Supports shall be carbon steel.250" thick plate and shall be designed and factory installed by the secondary containment manufacturer. Support spacing shall be determined by the manufacturer based on pipe diameter, pipe material and operating temperature of the product pipes.
   a. In all cases, pipes within the secondary containment shall be supported at not more than 10-foot intervals. These supports shall be designed to allow for continuous airflow and drainage of the secondary containment in place.
   b. The supports shall have a 3/4" ID Type 304 flared end stainless steel guide tubes that facilitate cable pulling and prevent cable damage during pulling operations.
   c. No plastic supports will be allowed.
10. Subassemblies
   a. End seals and other subassemblies shall be designed and factory prefabricated to prevent the ingress of moisture into the system.
   b. All subassemblies shall be designed to allow for complete draining of the secondary containment.
11. Field closure
   a. All field joints shall be air tested prior to any coating or joint covering. A double layer 24” & 36” wide heat shrink shall be applied over the exposed steel containment at all field joints or any field repairs.
   b. A FRP rock guard shall be installed over the final field joint closure to protect against damage during backfill. No Backfilling of joints is permitted prior to inspection by piping system manufacture field tech.
12. Acceptable manufacturers subject to compliance with the specifications:
   a. Perma Pipe
   b. Insul Tek
   c. Rickwil



E. Piping Specialties
   1. Flexible Connectors: Comply with UL 2039.
      a. Metallic Connectors:
         1) Manufacturers:
            a) American Flexible Hose Co., Inc.
            b) Flexicraft Industries.
            c) Metraflex Company.
            d) Or Equal
         2) Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
         3) Maximum Length: 18 inches.

b. Nonmetallic Connectors: Comply with UL 2039
    1) Manufacturers:
        a) Preferred Utilities
        b) American Flexible Hose Co., Inc.
        c) Flexicraft Industries.
        d) Metraflex Company.
        e) Or Equal.
    2) Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.

2. Joints and Joing Materials
    a. All piping joints and connections shall be made per the requirements of the NFPA 30 and NFPA 31 Code.
        1) All threaded joints and connections shall be made tight with lubricant or pipe joint compound approved for use with fuel oil.
        2) Unions requiring gaskets or pickings, right or left couplings, and sweat fittings employing brazing material having a melting point of less than 1,000F shall not be used in oil lines.
        3) Cast-iron fittings shall not be used in oil lines.
    b. Threaded Joints:
        1) Threads shall conform to ASME B1.20.1.
        2) Joint Compound: Applied to male threads only and suitable for fuel oil.
    c. Welded Joints:
        1) All joint surfaces shall be cleaned by approved procedure.
        2) 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.

3. Manual Fuel Oil Shutoff Valves
    a. General Requirements for Metallic Valves, NPS 2 and Smaller:
        1) CWP Rating: minimum 250-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 the valve schedule.
    b. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger:
        1) CWP Rating: minimum 150-psig.
        2) Flanged Ends: Comply with ASME B16.5 for steel flanges.
        3) Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
    c. One-Piece, Bronze Ball Valve with Bronze Trim:
        1) Manufacturers:
            a) BrassCraft Manufacturing Company; a Masco company.
            b) Conbraco Industries, Inc.; Apollo Div.
            c) Watts Co.

d) Or Equal

2) Body: Bronze, complying with ASTM B 584.
3) Ball: Chrome-plated brass.
4) Stem: Bronze; blowout proof.
5) Seats: Reinforced TFE; blowout proof.
6) Packing: Separate pack-nut with adjustable-stem packing threaded ends.
7) Ends: Threaded, flared, or socket as indicated in the valve schedule.
8) CWP Rating: 600-psig.

d. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
1) Manufacturers:
a) BrassCraft Manufacturing Company; a Masco company.
b) Conbraco Industries, Inc.; Apollo Div.
c) Watts Co.
d) Or Equal
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 pack-nut design with adjustable-stem packing.
7) Ends: Threaded, flared, or socket as indicated in the valve schedule.
8) CWP Rating: 600-psig.

4. Speciality Valves
a. Pressure Relief Valves:
1) Manufacturers:
a) Preferred Utilities Manufacturing Company
b) Watson and McDaniel
c) Anderson Greenwood; Division of Tyco Flow Control.
2) Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3) Body: Brass or bronze.
4) Springs: Stainless steel, cadmium plated steel, interchangeable.
5) Seat and Seal: Bronze, Stainless Steel.
6) Maximum Inlet Pressure: 300-psig.
7) Relief Pressure Setting: 15% above operating pressure (set in field).
8) Gasketed adjustment screw cap (machined bronze)

b. Anti-siphon valve
1) Per NFPA 30, furnish and install at the high point of the oil suction line, from each fuel oil tank a UL listed and labeled Anti-Siphon Valve(s).
2) Valves that do not have an Underwriters Laboratory certification, listing and label and do not conform to local, State and Federal Fire Codes shall not be acceptable.
3) Anti-siphon valves supplied without a UL label shall be removed and a U.L. certified valve installed at the contractor expense.

4) Valve(s) shall be sized to meet the flow requirements and shall be equipped with a spring sized according to vacuum head to match the vertical distance between the highest oil storage level of the main tank and the inlet to the fuel oil pumps.
5) Valves with cast iron bodies or Angle check valves designed for back pressure applications are not acceptable.
6) Valve shall be a Preferred Utilities Model A.

c. Foot Valve
1) Provide and install at the bottom of the tank suction stub a single-poppet foot valve suited for service in which drip tight shutoff is required.
2) The body shall be constructed of unleaded bronze with a spring-loaded poppet assembly.
3) The foot valve shall be complete with an inlet basket style strainer with a minimum open area ratio of 3 to 1 versus the nominal pipe size.
4) The foot valve shall be a Preferred Utilities Model 60.

d. Fire Safety Lever Gate Valve
1) Furnish and install valves where shown on the Contract Drawings. Valves shall be quick closing, spring loaded, lever gate type, held open by a wire with fusible link arranged so that the valve will automatically close if the link melts. Fusible link shall be set at 165° F.
2) The valve shall be equipped with an automatic fuel shut-off limit switch assembly. Switch assembly shall be wired to the Fuel Oil Management System to provide "Fire" and "Loss of Fuel Supply" alarms and interlock fuel oil pump set operation when the valve is closed. When the valve is closed, shut down the fuel oil pumps.
3) The valve shall be a Preferred Utilities Model 110 Oil Lever Gate Valve with an Automatic Fuel Shut-off Limit Switch Assembly or approved equal.



## 2.04 WIRING

A. Conductors shall be identified with tag numbers as specified in Section 26 05 00.

## 2.05 NAMEPLATES

A. Nameplates shall be provided in accordance with the requirements of Section 26 05 00.

## 2.06 FOUNDATION

A. A cast-in-place slab and foundation design is shown on the Drawings based on the basis of design. Any changes to the basis of design shall require the Contractor to include a slab and foundation designed per the Uniform Building Code for the weight of the tank, fuel, and for the project seismic forces with the slab designed to drain the surface water away from the tank.

## PART 3 EXECUTION

### 3.01 CONNECTION TO EXISTING FUEL OIL PIPE LOOP

A. The new fuell storage tank and fuel supply system will replace an existing fuel storage tank and fuel supply system and connect to an existing fuel oil pipe loop. Work associated with connecting to the existing loop shall be performed by experienced individuals who engage in this type of work on a regular basis. Do not interrupt fuel oil service to facilities occupied by Owner unless permitted under the following conditions:
   1. Notify Engineer no fewer than 7 days in advance of proposed interruption of fuel oil service.
   2. Do not proceed with interruption of fuel oil service without the Engineers written permission. The Authority will not grant permission to interrupt fuel oil service if a hurricane or snow storm is in the forecast.

B. Connect to existing system and test all piping in accordance with NFPA 31 and 37.

C. Provide a plan for connecting to the existing system prior to start of work. The plan at a minimum shall include the following information:
   1. Schedule of all activities from preparation of interruption of service to resumption of fuel oil service.
   2. Qualifications of individuals performing the work.
   3. Identification of all valves required for isolation of fuel oil loop.
   4. Disposal of fuel oil in existing fuel oil loop.
   5. Cleaning of existing fuel oil loop.
   6. Tools and techniques for cutting into and connecting existing fuel oil loop and containment pipe.
   7. Disposal plan for flushing water and cleaning substances used.



### 3.02 INSTALLATION

A. Electrical wiring and fuel piping to the storage system shall be installed in accordance with the requirements of the NFPA-70 (NEC) and the National Electrical Safety Code (NESC) and the local code requirements. Electric conduits and wiring connected to the storage tank shall be explosion proof in accordance with NEC Class-I, Division 1 and local standards.

B. Provide a #2/0 bare grounding cable and lugs and connect the cable to the two grounding lugs welded to the nipples on tank. Connect the cables to two 10-foot ground rods and connect to the facility ground grid.

C. Install fuel system components according to manufacturers installation instructions and all requirements of NFPA and local building and fire codes. .

D. Fuel Pipe Installation
   1. The installation contractor shall install the system in accordance with the directions furnished by the manufacturer and as approved by the engineer.

2. The secondary containment shall be air tested at 10 psig and the product piping shall be hydrostatically tested to 50 psig or 1½ times the operating pressure, whichever is greater. The test pressures shall be held for not less than one hour.
3. The contractor shall strictly adhere to the installation guidelines supplied by the system supplier and shall always keep the secondary containment system clean and dry during the installation process.
4. Backfill
   a. For underground piping, a four (4) inch layer of Type A fill material as defined in 31 23 00 and shall be placed and tamped in the trench to provide a uniform bedding for the containment pipe.
   b. The entire trench shall be evenly backfilled with a similar material as the bedding in six (6) inch compacted layers to a minimum height of six (6) inches above the top of the piping system.
   c. The remaining trench shall be backfilled as required in 31 23 00.

## 3.03 TESTING

A. Diesel Fuel system shall be fully tested prior to shipment. Testing shall include pressure and vacuum pressure testing from 25" Hg to rated discharge pressure. Pressure testing shall be maintained for four hours. Pump operational testing shall performed to demonstrate typical system operation, relief valve, and system instrumentation. Test documentation shall include motor amps, flow and discharge pressure.

B. Equipment, devices, and circuits shall be tested in accordance with Section 26 05 00.

C. Piping: Minimum hydrostatic test pressures measured at highest point in system:
   1. Fuel-Oil, Double-Containment Piping:
      a. Carrier Pipe: Hydrostatically tested to a minimum of 50 PSIG or 1½ times the operating pressure, whichever is greater for a minimum of 1-hour.
      b. Containment Conduit: Pneumatically tested at 15 psig for minimum of 1-hour.
   2. Suction Piping: Minimum 20-in. Hg for minimum 1-hour.
   3. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10-psig.

D. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.

E. Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than four different depths while filling tank and checking against gage indication.

F. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.

G. Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Test day tank level control sequence and alarms

J. Bleed air from fuel-oil piping using manual air vents.

K. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections, repair and retest per code.

## 3.04 MANUFACTURER SERVICES

A. On-Site Inspections and Training
   1. Provide a factory-trained manufacturer's representative at the Site for the following activities. Specified durations do not include travel time to or from Site.
      a. Installation inspections
         1) Manufacturer's representative shall visit the project site prior to the shipment from the factory to verify site arrangement and application.
         2) Assist, supervise, and inspect the Contractor's activities during installation.
         3) Provide four inspection hours.
         4) Provide a completed Form 43 05 11-A, Section 01 99 90.
      b. Component test phase inspections
         1) Assist, supervise, and inspect the Contractor's activities during the component test phase specified in Section 01 45 20 and this section.
         2) Provide four inspection hours.
      c. System test phase inspections
         1) Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 20.
         2) Provide eight inspection hours.
      d. Operational test phase inspections
         1) Assist, supervise, and inspect the Contractor's activities during the operational test phase specified in Section 01 45 20.
         2) Provide eight inspection hours.
      e. Training Sessions
         1) Comply with procedures described in Section 01 79 00.
         2) Provide a minimum of eight hours classroom training for each training session.
         3) Conduct two training sessions, one training session per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff.
         4) Certify completion of training on Form 43 05 11-B, Section 01 99 90.



**END OF SECTION**

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# DIVISION 31
# EARTHWORK

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SECTION 31 09 16.20

PILE LOAD TESTS, COMPRESSIVE, LATERAL AND UPLIFT LOADS

## PART 1 GENERAL

### 1.01 SUMMARY

A. The Contractor shall provide all equipment, labor, materials and incidental items necessary to perform the pile load tests as shown on the Contract Drawings, specified or otherwise as approved to complete work.

B. The following index of this Section is presented for convenience:

C.





### 1.02 PAYMENT

A. There is no separate payment provision for this Section.

B. Test piles, driven in locations where production piles are required and that have passed the load test requirements and have not been loaded to failure, may be incorporated in the structure upon approval by the Engineer, and payment for such Test piles, will be made at the unit price bid for piling work in the Contract.

## 1.03 RELATED SECTIONS

A. Not Used

## 1.04 REFERENCES

A. ASTM D1143 - Test Method for Piles Under Static Axial Compressive Load

B. ASTM D3689 - Test Method for Individual Piles Under Static Axial Tensile Load

C. ASTM D3966 - Test Method for Piles Under Lateral Loads

D. Connecticut State Building Code

## 1.05 DESCRIPTION

A. Performance Requirements
   1. Pile load tests shall conform to the Connecticut State Building Code and this specification. Where the requirements of this specification are more rigorous, they shall be adhered to.
   2. The working load of the piles shall be as specified herein or shown on the Contract Drawings.
   3. Tested piles which pass the load tests and are within tolerance at permanent locations shall be reset for use as permanent piles. The Contractor shall obtain the Engineer's approval for each pile so tested and so reset.
   4. Piles which do not meet the requirements for the working load of the piles shall be rejected and additional testing shall be performed on other piles at no additional cost to the Authority.

B. Seismic Monitoring
   1. When driving piling, the Contractor shall provide the monitoring stations at locations specified in the relevant pile Specification Sections.

C. Compressive Pile Load Test
   1. Compressive pile load tests shall be in accordance with ASTM D1143 and IBC. The load tests at locations shown on the Contract Drawings or specified herein shall be made on test piles placed to the tip elevation and/or driving resistance used for establishing lengths of piles, unless otherwise directed by the Engineer. Loading, testing and recording of data shall be under the direct supervision of the registered Professional Engineer engaged by the Contractor. A report shall be submitted in accordance with Article 1.06., Submittals.
   2. Load Tests:
      a. The Contractor shall drive test piles of the same size and materials as the permanent piles. Test piles shall be driven with the same equipment and in the same manner as the permanent piles.
      b. In cases where test piles will develop resistance during testing by non-bearing materials to be excavated, the test pile shall be cased off in that material(s).
      c. Permanent piles may be used as reaction piles.

3. The Contractor shall provide all equipment, instruments, personnel, accessories and appurtenances required for the tests. The Contractor shall place reaction piles and beams, as required, to transmit load into the test pile. Calibrated pressure gauges shall be used to determine the actual load placed on the test pile. Calibrations shall have been made within three (3) months of load testing.
    a. The Contractor shall prepare complete detailed shop drawings showing how the test will be performed, how the reaction piles will be placed, and how the jacking beams will be anchored to the test piles and the reaction piles.
    b. The Contractor's shop drawings shall include date and calibration curves on all instruments and accessories used in the tests.
    c. The entire test setup and test procedure shall be subject to the approval of the Engineer.
    d. A table of pile loads and test pressures for each test shall be submitted.
    e. A foundation stability analysis where dead weights are used for test reactions shall be submitted.
4. Test loads shall be applied by direct weight or by means of a hydraulic jack. The loading platform or box shall be carefully constructed to provide a concentric load on the pile.
    a. If direct weight is employed, the loading increments shall be applied without impact or jar. The weight of the loading platform or box shall be obtained prior to the test, and this weight shall be considered as the first increment of load.
    b. If a hydraulic jack is employed, equipment for maintaining each increment of desired load constant under increasing settlement shall be provided. The gauge and the jack shall be calibrated as a unit and have a rated capacity to achieve twice the maximum test pile load.
5. The test load shall be twice the proposed working load of the pile. The standard loading procedure of ASTM D1143 shall be used except as follows: the test load shall be applied in 7 increments at a load of 50 percent, 75 percent, 100 percent, 125 percent, 150 percent, 175 percent, and 200 percent of the proposed working load.
    a. After the proposed working load has been applied, and for each increment thereafter, the test load shall remain in place until there is no measurable settlement (0.001 inches) in a 2-hour period.
    b. The total test load shall remain in place until settlement does not exceed 0.001 foot in 48 hours.
    c. The total test load shall be removed in decrements not exceeding 25 percent of the total test load at not less than 1 hour intervals.
    d. The rebound shall be recorded after each decrement is removed, and the final rebound shall be recorded 24 hours after the entire test load has been removed.
6. Under each load increment, settlement observations shall be made and recorded at 1/2 minute, 1 minute, 4 minute, and each 4 minutes thereafter after application of load increment, except in the instance of the total load where, after the 4-minute reading, the time interval shall be successively doubled until the final settlement limitation is reached and the load is removed.
7. The maximum allowable pile load shall be such that 50 percent of the applied load shall not cause a net settlement of the pile of more than 0.01 inch per ton of total applied load or shall be 50 percent of the applied load which causes a gross settlement of 1 inch, whichever is less.

D. Pile Lateral Load Tests

1. Pile lateral load tests shall be in accordance with ASTM D3966 and IBC. The load tests at locations shown on the Contract Drawings or specified herein shall be made on test piles placed to the tip elevation and/or driving criteria used for establishing lengths of piles, unless otherwise directed by the Engineer. Loading, testing and recording of data shall be under the direct supervision of the registered Professional Engineer engaged by the Contractor. A report shall be submitted in accordance with Article 1.10, Submittals.
2. The proposed testing apparatus and structures to be used in making the pile load tests shall be designed by the Professional Engineer engaged by the Contractor. The Contractor shall prepare complete detailed working drawings showing how the lateral load test will be performed including the layout of reaction, jack, and test pile. The drawings shall include date and calibration curves of all equipment and instruments. The entire test setup and procedure will be subject to the approval of the Engineer.
3. Piles shall be tested as free-head piles. Lateral load tests shall be conducted in accordance with Section 6.1 of ASTM D3966 until either 1 inch of gross lateral movement has occurred or the test load has reached 200 percent of the design load. For both cases, the allowable lateral pile load shall be 50 percent of the test value.
    a. Reaction for the lateral load test may be an adjacent pile.
    b. Movement shall be measured with dial gages to the nearest 0.001 inch referenced to a beam which is supported at least 10 feet away from the test pile and reactions.
    c. For H-piles, the direction of the test shall be as specified herein or shown on the Contract Drawings.

E. Pile Uplift Load Tests

1. Pile uplift load tests shall be in accordance with ASTM D3689 and IBC. The load tests at locations shown on the Contract Drawings or specified herein shall be made on test piles placed to the tip elevation and/or driving resistance used for establishing lengths of piles, unless otherwise directed by the Engineer. Loading, testing and recording of data shall be under the direct supervision of the registered Professional Engineer engaged by the Contractor. A report shall be submitted in accordance with the requirements of this Section.
2. The proposed testing apparatus and structures to be used in making the pile load tests shall be designed by the Professional Engineer engaged by the Contractor. The Contractor shall prepare complete detailed working drawings showing how the uplift load test will be performed including the layout of reaction, jack, and test pile. The drawings shall include date and calibration curves of all equipment and instruments. The entire test setup and procedure will be subject to the approval of the Engineer.
3. Uplift (tensile) load tests shall be conducted in accordance with Section 7.2 of ASTM D3689 until the test load has reached 200 percent of the design load unless failure occurs first. The allowable uplift load shall be 50 percent of the last load increment before failure or of the test load for a completed test.
    a. Apply tensile test loads in line with the central longitudinal axis of the pile.
    b. Movement shall be measured with dial gages to the nearest 0.001 inch referenced to a beam which is supported at least 8 feet away from the test pile and reactions.

## 1.06 QUALITY ASSURANCE

A. Qualifications
   1. The work shall be performed by the Contractor or a specialty subcontractor employed by the Contractor and having minimum of 5 years of experience in performing pile load tests and installation of the specified piling system under similar subsurface conditions.

## 1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Approval by the Engineer shall not relieve the Contractor of his complete responsibility for the adequacy of the pile load test setup. Submittals shall include, but not be limited to:
   1. Full description of test method and equipment.
   2. Load type and loading equipment.
   3. Safety devices.
   4. Calibration equipment.

B. The Contractor shall also submit a complete report to the Engineer at the completion of each pile load test. The Contractor shall engage the services of a Professional Engineer, subject to the approval of the Commissioner, licensed in the State of New York, experienced in pile load testing and load test analysis for the supervision of load test procedures and preparation of the report. The report shall include, but not be limited to:
   1. Pile identification and location.
   2. A description of the pile driving equipment.
   3. Driving records for both test piles and reaction piles.
   4. Complete test data.
   5. Analysis of test data.
   6. Recommended allowable design loads based on the pile test reports.
   7. Description of subsurface conditions.
   8. Recommended pile installation criteria.



## 1.08 DELIVERY, STORAGE, AND HANDLING

A. Not Used

## 1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

## 1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Not Used

### 2.02 MATERIALS / EQUIPMENT

A. Compressive Load Testing Apparatus: The proposed testing apparatus and structures to be used in making the pile load tests shall be designed by a Professional Engineer licensed in the State of Connecticut engaged by the Contractor.
   1. Load tests shall be performed by a method that will maintain constant concentric load under increasing settlement.
   2. Settlement observations shall be made by means of dial extensometers. A minimum of three (3) extensometers shall be used. The extensometers shall provide readings to the nearest 0.001 inch. In addition, settlement observations shall be taken using an engineer's level reading to 0.001 feet properly referenced to a well-established benchmark.

### 2.03 FABRICATION / ASSEMBLING / FINISHES

A. Not Used

### 2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

## PART 3 EXECUTION

### 3.01 EXAMINATION / PREPARATION

A. Examination of the Site
   1. Prior to starting operations, an examination of the site shall be performed in accordance with the relevant pile Specification Sections.

B. Schedule of Operation
   1. Load tests of piles shall be scheduled sufficiently in advance of production pile driving to prevent delay in the progress of the work.
   2. No production piles shall be driven until the load test report is approved by the Engineer.

### 3.02 IMPLEMENTATION

A. Installation of Production Piles
   1. The method of installing the permanent piles shall be the same as that used to install the test piles, except where a change in procedure is ordered by the Engineer.
   2. The installation procedure established in the test program shall not be changed without the written approval of the Engineer.

## 3.03 FIELD TESTING / QUALITY CONTROL

A. Witnessing
   1. The pile installation and test program will be witnessed by the Engineer designated for controlled inspection.
   2. The Engineer designated for controlled inspection shall keep records for confirmation of the test pile driving. The Contractor shall cooperate with the Engineer so that all necessary data may be obtained. The data will include the following:
      a. Type and dimensions of the pile.
      b. Location and pile number.
      c. Type and size of hammer.
      d. Steam or air pressure used to activate hammer.
      e. Type and dimensions of the cushion block.
      f. Actual number of blows per minute delivered by the hammer.
      g. Number of blows required for each foot of penetration, and blows per inch for last six (6) inches.
      h. Elevation of ground.
      i. Elevation to which the pile penetrated under its own weight and under the weight of the hammer.
      j. Final elevation of tip of pile.
      k. Length of delays due to splicing or for any other reason and elevation of pile tip at such time.
      l. Location of pile splices.
      m. Such other information as the Engineer may deem necessary.
   3. The Engineer designated for controlled inspection will be employed by the Engineer.



## 3.04 STARTUP / DEMONSTRATION

A. Not Used

## 3.05 ADJUSTING / PROTECTION / CLEANUP

A. Clean Up
   1. Upon completion of the test program, the Contractor shall remove all equipment, and remove or cutoff piles not in permanent locations or rejected and restore the site to a condition satisfactory to the Engineer.
   2. Test piles and reaction piles which are driven at non-permanent pile locations shall be removed or cutoff at least 18 inches below the bottom of the foundation and abandoned.

**END OF SECTION**

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SECTION 31 10 00

SITE CLEARING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope: This section specifies site preparation which consists of clearing, grubbing and demolition.

B. Existing Conditions: The Contractor shall determine the actual condition of the site as it affects this portion of work.

C. Protection: Site preparation shall not damage structures, landscaping or vegetation adjacent to the site. The Contractor shall repair, or replace any damaged property.

## PART 2 PRODUCTS

A. NOT USED

## PART 3 EXECUTION

### 3.01 CLEARING AND GRUBBING

A. Unless otherwise specified, the Contractor shall remove obstructions such as brush, trees, logs, stumps, roots, heavy sod, vegetation, rock, stones larger than 6 inches in any dimension, broken or old concrete and pavement, debris, and structures where the completion of the work require their removal.

B. Material that is removed and is not to be incorporated in the work shall be disposed of off the site.

### 3.02 DEMOLITION AND REMOVAL

A. Structures: Demolition and removal of structures consist of removal of abandoned superstructures, foundation walls, footings, slabs and any other structures. Excavations caused by existing foundations shall be cleared of waste, debris and loose soil, and refilled as specified.

B. Pavement: When portions of asphalt pavements and concrete pads are to be removed and later construction is to be connected, edges shall be saw cut, on a neat line at right angles to the curb face.

C. Salvage: The Owner has the right to salvage any items scheduled for removal. The Contractor shall notify the Construction Manager 5 days prior to any salvage or demolition work to determine the disposition of items to be removed. The Construction Manager will mark items to be salvaged. Such items shall be properly disconnected, removed from their foundations, cleaned, and stored at a location on the plant site as specified.

## 3.03 UTILITY INTERFERENCE

A. Where existing utilities interfere with the prosecution of the work, the Contractor shall relocate them in accordance with the General Conditions of the Contract Documents.

**END OF SECTION**

SECTION 31 23 00

EXCAVATION AND FILL

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This section specifies earthwork which consists of excavation, filling, grading, and disposal of excess material.

B. Definitions:
   1. Compaction: The degree of compaction is specified as percent compaction. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.
   2. Excavation Slope: Excavation slope shall be defined as an inclined surface formed by removing material from below existing grade.
   3. Embankment Slope: Embankment slope shall be defined as an inclined surface formed by placement of material above existing grade.



### 1.02 QUALITY ASSURANCE

A. References:
   1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ASTM C136 | Standard Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D1556 | Test Method for Density of Soil in Place by the Sand-Cone Method |
| ASTM D1557 | Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in. (457-mm) Drop |
| ASTM D2419 | Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate |
| ASTM D3017 | Test Method for Moisture Content of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth) |

B. Tests:

1. The Construction Manager will take samples and perform moisture content, gradation, compaction, and density tests during placement of backfill materials to check compliance with these specifications. The Contractor shall remove surface material at locations designated by the Construction Manager and provide such assistance as necessary for sampling and testing. The Construction Manager may direct the Contractor to construct inspection trenches in compacted or consolidated backfill to determine that the Contractor has complied with these specifications. Payment for inspection trenches shall be as specified in the General Conditions of the Contract Documents.
2. Tests will be made by the Construction Manager in accordance with the following:

| Test | Standard Procedure |
|---|---|
| Moisture content | ASTM D3017 |
| Gradation | ASTM C136 |
| Density in-place | ASTM D1556 |
| Moisture-density relationships | ASTM D1557 |



## 1.03 SUBMITTALS

A. Samples of fill materials to be used shall be submitted 2 weeks in advance of use. Samples shall consist of 0.5 cubic feet of each type of material.

## PART 2 PRODUCTS

## 2.01 FILL MATERIALS

A. Type A:

1. Type A material shall be a clean gravel-sand mixture free from organic matter and shall conform to the following gradation:

| U.S. standard sieve size | Percent finer by weight |
|---|---|
| 6 inch* | 100 |
| No. 4 | 30-80 |
| No. 40 | 10-55 |
| No. 200 | 0-8 |

**use a maximum 3-in. size for fill placed within 6 in. of concrete slabs or footings*

B. Type B:

1. Type B material shall be a select granular material free from organic matter and of such size and gradation that the specified compaction can be readily attained. Material shall have a sand equivalent value determined in accordance with ASTM D2419 of not less than 20 and shall conform to the following gradation:

| U.S. standard sieve size | Percent by weight passing |
|---|---|
| 3 inch | 100 |
| No. 4 | 35-100 |
| No. 30 | 20-100 |

2. The coefficient of uniformity shall be 3 or greater.
3. The material may be an imported quarry waste, clean natural sand or gravel, select trench excavation or a mixture thereof.

C. Type C:
1. Type C material shall be unclassified material which is free from peat, wood, roots, bark, debris, garbage, rubbish or other extraneous material. The maximum size of stone shall not exceed 6 inches. If the material excavated from the site meets these requirements, it may be classified as Type C.

D. Type D:
1. Type D material shall be granular material commonly known as pea gravel and shall conform to the following gradation:

| U.S. standard sieve size | Percent by weight passing |
|---|---|
| 1/4 inch | 100 |
| No. 8 | 0-5 |

E. Type E:
1. Type E material shall be crushed rock commonly known as drain rock and shall conform to the following gradation:

| U.S. standard sieve size | Percent by weight passing |
|---|---|
| 1-1/2 inch | 100 |
| 3/4 inch | 30-75 |
| 1/2 inch | 15-55 |
| 1/4 inch | 0-5 |

2. Type E material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.

F. Type F:
1. Type F material shall be crushed rock and shall conform to the following gradation:

| U.S. standard sieve size | Percent by weight passing |
|---|---|
| 1-1/2 inch | 87-100 |
| 3/4 inch | 45-90 |
| No. 4 | 20-50 |
| No. 30 | 6-29 |
| No. 200 | 0-12 |

2. Type F material shall be composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.

G. Type G:
1. Type G material shall be pervious backfill. Pervious backfill material shall conform to the following gradation:

| U.S. standard sieve size | Percent by weight passing |
|---|---|
| 2 inch | 100 |
| No. 50 | 0-100 |
| No. 100 | 0-8 |
| No. 200 | 0-4 |

H. Type H:

1. Type H material shall be 6-inch riprap. Riprap shall be graded rock having a range of individual rock weights as follows:

| Weight of stone | Percent smaller by weight |
|---|---|
| 10 pounds | 100 |
| 5 pounds | 80-100 |
| 2 pounds | 45-80 |
| 1 pound | 15-45 |
| 1/2 pound | 5-15 |
| Below 1/2 pound | 0-5 |

2. Specific gravity shall be between 2.5 and 2.82.

I. Type I:

1. Type I material shall be 12-inch riprap. Riprap shall be graded rock having a range of individual rock weights as follows:

| Weight of stone | Percent smaller by weight |
|---|---|
| 160 pounds | 100 |
| 100 pounds | 80-100 |
| 50 pounds | 45-80 |
| 20 pounds | 15-45 |
| 5 pounds | 5-15 |
| 1 pound | 0-5 |

2. Specific gravity shall be between 2.5 and 2.82.

J. Type J:

1. Type J material shall be unclassified material and may be obtained from excavation on site. The material may contain extraneous material such as demolition waste, unsuitable material excavated from beneath structures, and clearing and grubbing debris up to 50 percent by volume. Extraneous material shall be thoroughly mixed and the maximum size of organic particles shall be 6 inches.

## PART 3 EXECUTION

### 3.01 GENERAL

A. Control of Water:

1. The Contractor shall keep excavations reasonably free from water during construction. The static water level shall be drawn down a minimum of 1 foot below

the bottom of excavations to maintain the undisturbed state of natural soils and allow the placement of any fill to the specified density. Disposal of water shall not damage property or create a public nuisance. The Contractor shall have on hand pumping equipment and machinery in good working condition for emergencies and shall have workmen available for its operation. Dewatering systems shall operate continuously until backfill has been completed to 1 foot above the normal static groundwater level.

2. Groundwater shall be controlled to prevent softening of the bottom of excavations, or formation of "quick" conditions. Dewatering systems shall not remove natural soils. The Contractor shall control surface runoff to prevent entry or collection of water in excavations.
3. Release of groundwater to its static level shall be controlled to prevent disturbance of the natural foundation soils or compacted fill and to prevent flotation or movement of structures or pipelines.

B. Overexcavation:

1. Where the undisturbed condition of natural soils is inadequate for support of the planned construction, the Construction Manager will direct the Contractor to overexcavate to adequate supporting soils. The excavated space shall be filled to the specified elevation with backfill. The overexcavated space under footings may be filled with concrete. The quantity and placement of such material will be paid for as extra work.

C. Surplus Material:

1. Unless otherwise specified, surplus excavated material shall be disposed of off site, by the Contractor, in accordance with applicable ordinances and environmental requirements.
2. If the quantity of surplus material is specified, the quantity specified is approximate. The Contractor shall satisfy himself that there is sufficient material available for the completion of the embankments before disposing of any material inside or outside the site. Shortage of material, caused by premature disposal of any material by the Contractor, shall be replaced by the Contractor.
3. Material shall not be stockpiled to a depth greater than 5 feet above finished grade within 25 feet of any excavation or structure except for those areas designated to be preconsolidated. For these areas, the depth of stockpiled material shall be as specified. The Contractor shall maintain stability of the soil adjacent to any excavation.

D. Borrow Material

1. If the quantity of acceptable material from excavation is not sufficient to construct the embankments required by the work, the quantity of material needed to complete the embankments shall consist of imported borrow conforming to specified requirements.

E. Hauling:

1. When hauling is done over highways or city streets, the loads shall be trimmed and the vehicle shelf areas shall be cleaned after each loading. The loads shall be watered after trimming to eliminate dust.

F. Haul Roads:

1. The Contractor shall construct haul roads required to transport materials on site. Alignment of haul roads shall be selected to avoid interference with plant operations. Haul roads shall be removed after completion of embankment construction.

G. Finish Grading:

1. Finished surfaces shall be smooth, compacted and free from irregularities. The degree of finish shall be that normally obtainable with a blade-grader.
2. Finished grade shall be as specified by the contours plus or minus 0.10 foot except where a local change in elevation is required to match sidewalks, curbs, manholes and catch basins, or to ensure proper drainage. Allowance for topsoil and grass cover, and subbase and pavement thickness shall be made so that the specified thickness of topsoil can be applied to attain the finished grade.
3. When the work is an intermediate stage of completion, the lines and grades shall be as specified plus or minus 0.5 foot to provide adequate drainage.
4. If the soil is to be cultivated or straw is to be incorporated into the surface, rocks larger than 2-1/2 inches in maximum dimension, roots and other debris on the surface of the slope shall be removed and disposed of prior to cultivation or placement of straw.

H. Control Of Erosion:

1. The Contractor shall maintain earthwork surfaces true and smooth and protected from erosion. Where erosion occurs, the Contractor shall provide fill or shall excavate as necessary to return earthwork surfaces to the grade and finish specified.



## 3.02 CLASSIFICATION OF FILL

A. Fill material shall be placed in horizontal layers and compacted with power-operated tampers, rollers, idlers, or vibratory equipment. Material type, maximum layer depth, relative compaction, and general application are specified in Table A. Unless otherwise specified, fill classes shall be used where specified in Table A under general application.

**Table A, Fill Classifications**

| Fill class | Material type | Maximum uncompressed layer depth, inches | Minimum relative compaction, percent | General application |
|---|---|---|---|---|
| A1 | A | 8 | 95 | Bedding for pipe, initial pipeline backfill; slabs on grade (other than specified for Class E1) |
| B1 | B | 8 | 95 | Structure and subsequent pipeline backfill |
| B2 | B | 8 | 90 | Site fill |
| C1 | C | 8 | 90-95 | Subsequent pipeline backfill; compaction as specified |
| C2 | C | 8 | 90 | Site fill, embankments and dikes |
| D1 | D | - | 95 | Bedding for tanks and pipe, initial and subsequent tank and pipeline backfill |
| E1[a] | E | 8 | - | Fill under slabs for structures and tank slabs with pressure relief valves |
| F1[b] | F | 12 | 95 | Structure backfill, pipeline bedding, initial and subsequent pipeline backfill |

**Table A, Fill Classifications**

| Fill class | Material type | Maximum uncompressed layer depth, inches | Minimum relative compaction, percent | General application |
|---|---|---|---|---|
| G1 | G | 8 | 95 | Bedding for plastic pipe, initial and subsequent pipeline backfill |

*a. Compaction of layers shall be accomplished in two passes of equipment with complete coverage across the width of the field.*

*b. Material shall not be used for bedding or initial backfill for plastic pipe.*

*c. Fill material shall be grouted as specified in paragraph 3.08.*

*d. Asphalt and concrete slabs from demolition may be placed at the bottom of the fill side by side to form a continuous pad. Clearing and grubbing is not required unless shrubs are taller than 3 feet. Mucking of the subgrade and keying or benching of adjoining embankments is not required.*

## 3.03 EARTHWORK FOR STRUCTURES

A. Structure Excavation:

1. The bottom shall not be more than 0.15 foot above or below the lines and grades specified. If the elevation of structure excavation is not specified, the excavation shall be not more than 0.15 foot above or below the elevation specified for fill material below the structure. Slopes shall vary no more than 0.5 foot from specified grade unless the excavation is in rock where the maximum variation shall be 2 feet.
2. Should the excavation be carried below the lines and grades specified on the drawings or should the bottom of the excavation be disturbed because of the Contractor's operations and require overexcavation and backfill, the Contractor shall refill such excavated space to the proper elevation in accordance with the procedure specified for backfill. The cost of such work shall be borne by the Contractor.
3. Unless otherwise specified, excavations shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services, and for inspection, except where concrete is specified to be placed directly against excavated surfaces.

B. Foundation Treatment:

1. Rock foundations for concrete or masonry footings shall be excavated to sound material. The rock shall be roughly leveled or cut to steps and shall be roughened. Seams in the rock shall be grouted under pressure as directed by the Construction Manager and paid for as extra work.
2. When footings are to be supported on piles, excavations shall be completed to the bottom of the footings before any piles are drilled or driven therein. When swell or subsidence results from driving piles, the Contractor shall excavate, or backfill the footing area to the grade of the bottom of the footing with suitable material as specified. If material under footings is such that it would mix into the concrete during footing placement or would not support the weight of the fluid concrete, the Contractor shall replace the material with suitable material, install soffit forms or otherwise provide a suitable platform on which to cast the footing as directed by the Construction Manager. This shall be paid for as extra work.
3. Whenever any structure excavation is substantially completed to grade, the Contractor shall notify the Construction Manager who will make an inspection of the foundation. No concrete or masonry shall be placed until the foundation has been inspected by the Construction Manager. The Contractor shall, if directed by the

Construction Manager, dig test pits and make test borings and foundation bearing tests. If the material tested is undisturbed soil, the cost thereof will be paid for as extra work. If the material tested is backfill material, the cost thereof will be paid as specified in the General Conditions of the Contract Documents.

C. Structure Backfill:
   1. Unless otherwise specified, structure backfill shall be Class A1.
   2. After completion of construction below the elevation of the final grade, and prior to backfilling, forms shall be removed and the excavation shall be cleaned of debris.
   3. Structure backfill shall not be placed until the subgrade portions of the structure have been inspected by the Construction Manager. No backfill material shall be deposited against concrete structures until the concrete has developed a strength of not less than 2500 pounds per square inch in compression, or until the concrete has been in place for 28 days, whichever occurs first.
   4. Backfill material shall be placed in uniform layers and shall be brought up uniformly on all sides of the structure.
   5. Unless otherwise specified, backfill around and above pipelines within the excavation line of any structure shall be the same as that specified for structures.

## 3.04 EARTHWORK FOR PIPELINES AND CONDUITS

A. General:
   1. Earthwork for pipelines and conduits is specified in Table A; in the standard details; and in the following paragraphs.

B. Pipeline Excavation:
   1. The bottom of the trench shall be carried to the specified lines and grades with proper allowance for pipe thickness and for bedding as specified.

C. Pipeline Backfill:
   1. Bedding: The Contractor shall not proceed with backfill placement in excavated areas until the subgrade has been inspected by the Construction Manager. All pipe shall have a minimum thickness of bedding material below the barrel of the pipe as specified. Bedding material shall be placed in the bottom of the trench, leveled and compacted. Bell holes shall be excavated at each pipe joint to permit proper inspection and uniform bearing of pipe on bedding material.
      a. After the pipe has been laid to alignment and grade, unless otherwise specified, additional bedding material shall be placed in layers the full width of the trench and compacted up to the specified level. Bedding shall be placed simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. The material shall be carefully placed and compacted around the pipe to ensure that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Contractor shall use particular care in placing material on the underside of the pipe to prevent lateral movement during backfilling.
   2. Initial Backfill: After pipe has been properly bedded, Contractor shall place and compact initial backfill as specified. Initial backfill, where specified below the springline of the pipe, shall be placed and compacted in accordance with paragraph 3.04 Pipeline Backfill for additional bedding material.

3. Subsequent Backfill:
    a. General: Backfill material, placement and compaction above the pipe zone shall be as specified. Backfill above the pipe zone shall not commence until pipe zone backfill has been inspected and accepted by the Construction Manager.
    b. Improved Areas: Unless otherwise specified, select granular backfill (Class A1) shall be used under all paved and unpaved roadways and paved and unpaved roadway shoulders, roadway embankments, and in all public right-of-ways and easements. The trench shall be backfilled to an elevation which will permit the placement of the specified surface or paving. Paving shall be as specified in Section 32 12 16. Other surfaces shall be restored, including compaction, to the condition existing prior to construction including restoration of yard areas.
    c. Unimproved Areas: Class C1 backfill shall be used for all trenches in pastureland, cultivated land, undeveloped land, and for other unimproved areas where specified. Class C1 backfill shall not be used in any public right-of-way. Trench excavation which meets the requirements of Type C material may be used. The Contractor shall maximize the use of fine-grained materials (e.g., sand, silty sand, sandy silt) as Class C1 backfill.
        1) For Class C1 backfill, the trench above the pipe zone shall be backfilled to within 12 inches of original ground surface. The top 12 inches of soil shall be removed and stored in such a manner that it will not become mixed with unsatisfactory soils. After the trench has been backfilled, the stored topsoil shall be replaced at a uniform depth in its original area compacted to its original condition. The Contractor shall leave the backfilled trench neatly mounded not more than 6 inches above existing grade for the full width of the Class C1 backfill area.



## 3.05 EARTHWORK FOR EMBANKMENTS

A. Foundation Preparation:

The surface of the foundation shall not contain standing water and shall be free of loose material, foreign objects and rocks greater than 6 inches in maximum dimension. Immediately prior to placement of embankment fill material, the foundation surface shall be scarified to full depth and moisture condition to within 2% optimum and recompacted to at least 95 percent of dry density (ASTM D698). After the preparation has been completed, the Contractor shall promptly place and compact the first lift of embankment on the foundation to prevent damage to the surface. If the foundation surface is damaged, the Contractor shall repair the surface to the specified condition. In any areas where materials become soft or yielding, such materials shall be removed, disposed of, and replaced with specified material. The surface of the embankment shall be maintained to permit travel of construction equipment. Ruts in the surface of any layer shall be filled and leveled before compacting.

B. Embankment Fill:

1. Rocks, broken concrete, or other solid materials, which are larger than 4 inches in greatest dimension, shall not be placed in embankment areas where piles are to be placed or driven.
2. Fill material having a sand equivalent value less than 10 shall be placed in the lower portions of embankments and shall not be placed within 2.5 feet of finished grade.
3. When the embankment material consists of large, rocky material, or hard lumps, such as hardpan or cemented gravel which cannot be broken readily, such material

shall be well distributed throughout the embankment. Sufficient earth or other fine material shall be placed around the larger material as it is deposited so as to fill the interstices and produce a dense, compact embankment.

4. Unless otherwise specified, the embankment shall be raised to form an approximately horizontal plane extending transversely to the final slopes. The embankment shall be crowned at all times during construction so that water will drain readily off the embankment.
5. The temporary differential elevation between any two adjoining zones of the embankment due to construction operations shall not exceed 24 inches.
6. If the compacted surface of any layer of material is too smooth to bond properly with the succeeding layer, the surface shall be scarified. If required, the surface shall be sprinkled or otherwise moisture conditioned before the succeeding lift is placed. Any surface crust formed on a layer of fill material that has been dumped and spread shall be broken up by harrowing and, if required, the full depth of the affected layer shall be moisture conditioned immediately prior to rolling.

C. Embankment Tolerances:

1. General: Embankment slopes within 4 feet of shoulder grade shall vary less than 0.5 foot from the designated slope. Slopes beyond 4 feet from shoulder grade shall vary less than 1 foot from the designated slope. Measurements for variance shall be made perpendicular to the slope. Slopes which are 6 to 1 or flatter shall vary less than 0.2 foot from the designated slope.
   a. If embankments are constructed of rock greater than 12 inches in diameter, the slopes more than 4 feet below shoulder grade may vary up to 2 feet from the designated slope.
2. Roadway Embankment Tolerances: The excavated surface shall be less than 0.08 foot above or below the grades specified after deducting for the roadway pavement thickness.
   a. Vertical alignment tolerances permitted on the roadway surface shall not exceed plus or minus 0.30 feet from the vertical alignment specified, with the provision that within the tolerance range local surface irregularities shall not exceed 0.15 feet as measured by the gap between the roadway surface and a 10-foot straightedge placed on any flat graded surface. On vertical curves, the same standards will apply except that an additional gap allowance will be made for the road surface curvature over the 10-foot length of the straightedge.
   b. Horizontal alignment tolerances permitted shall not exceed plus or minus 1 foot providing the departure is relatively uniform over any specific length of the roadway.
   c. Roadway median strips shall be graded to drain and shall not vary more than 0.1 foot from the specified grade.



## 3.06 SUBGRADE FOR PAVEMENT

A. The prepared subgrade shall be scarified to full depth and moisture condition to within 2% optimum and recompacted to at least 95 percent of dry density (ASTM D698).

## 3.07 SITE FILL

A. Unless otherwise specified, site fill shall be Class C2 fill. If the existing slope in an area to be filled is greater than 5:1, the Contractor shall bench the area prior to filling.

**END OF SECTION**

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SECTION 31 23 19

DEWATERING

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section includes dewatering/groundwater control work complete with design, construction, operation, and abandonment of dewatering/groundwater control systems, protection of personnel and structures, and environmental protection and restoration.

### 1.02 GENERAL

A. Perform dewatering work as necessary to lower and control groundwater levels and hydrostatic pressures to permit removal of structural concrete from the lowest level base slab with re-construction to be performed. Control of surface and subsurface water, ice and snow are part of dewatering requirements.

B. Contractor shall obtain and pay for all required permits and inspections for dewatering construction in accordance with the provisions of State of Connecticut, and local government agencies having jurisdiction. No additional claim for compensation shall be allowed because of the Contractor's failure to obtain or pay for such permits and inspections.

C. Dewatering operations shall conform to the requirements of federal, state, and local agencies having jurisdiction.



### 1.03 QUALITY ASSURANCE

A. Contractor's professional engineer shall be responsible for the complete design of all structures and methods proposed for dewatering the project site, including the implementation of materials, tools and equipment proposed for use in the Work. Temporary wiring for the dewatering system shall comply with applicable portions of the National Electrical Code.

### 1.04 SUBMITTALS

A. Submit proposed dewatering plan and methods, including proposed equipment to be used. Identify scheduling or sequencing requirements. Submittal shall be sealed and signed by the Contractor's professional engineer who is currently registered and licensed in the state of Connecticut.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS

A. Control of groundwater shall be accomplished in a manner that will preserve the strength of foundation soils, will not cause instability of excavated slopes, and will not result in damage to existing structures. Where necessary to this purpose, water will be lowered in advance of excavation, demolition of base slab concrete; by wells, well points, or similar methods. Open pumping will not be permitted if it results in boils, loss of fines,

softening of the subgrade, or slope instability. Wells and well points will be installed with suitable screens and filters so that pumping of fines does not occur. Discharge will be arranged to facilitate sampling by Engineer.

B. Take all steps necessary, during the Work of this Section, to protect surrounding property and adjacent buildings, private water supplies, roads, drains, sewers, structures, and appurtenances. Adequate measures shall be taken to protect such property and construction from the effects of dewatering operations.

C. Groundwater monitoring wells should be installed to verify control of groundwater levels.

## PART 3 EXECUTION

### 3.01 INSPECTION

A. Prior to beginning work, Contractor shall verify, in the field, the location, type and capacity of existing drainage facilities and conditions which will affect work of this Section. No allowances shall be made for conditions found during progress of dewatering operations because of Contractor's failure to verify such conditions.

B. Contractor shall field verify existing structures and utilities at the Work site which are scheduled to remain and which may be affected by Work of this Section. Contractor shall be responsible for any damage to existing structures and/or utilities caused because of his Work and shall repair such damage at his expense to the satisfaction of Engineer.



### 3.02 PREPARATION

A. Contractor shall review the soils report prior to bidding and shall consider this in the design of their dewatering/groundwater control system(s). Contractor shall also obtain necessary additional soils and/or groundwater flow information that they deem necessary for an adequate dewatering system design.

### 3.03 INSTALLATION

A. Provide an adequate localized dewatering system to lower and control groundwater to permit demolition of concrete at new pump pits, construction of structures, exterior excavations, and placement of fill materials under dry conditions. Install sufficient dewatering equipment to pre-drain water-bearing strata above and below bottom of structure foundations, drains, sewers, and other excavations. Excavations and site shall be kept dry until construction has been completed and/or structures have been backfilled. Drainage ditches shall not be placed within the area to be occupied by any structure.

B. Reduce hydrostatic head in water-bearing strata below structure foundations, drains, sewers and other excavations to extent that water level and piezometric water levels in construction areas are below prevailing base slab and excavation surface.

C. Prior to excavation or removal of base slab concrete below normal groundwater levels, place system into operation to lower water levels as required and operate it continuously 24 hours a day, 7 days a week, until drains, sewers and structures have been

constructed, including placement of structural concrete, fill materials, and until dewatering is no longer required.

D. Dispose of water removed in a manner to avoid endangering public health, property, and portions of Work under construction or completed. Dispose of water in a manner to avoid inconvenience to others engaged in Work about the site. Provide sumps, sedimentation tanks, and other flow control devices as required by governing authorities.

E. Provide standby equipment on site, installed and available for immediate operation to maintain dewatering on a continuous basis in an 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 Work as may be required to restore damaged structures and foundation soil at no additional expense to Owner.

## 3.04 PERFORMANCE

A. Contractor shall maintain reduced groundwater elevations below the concrete base slab to facilitate removal of concrete at new pump pits and other excavation work, free of water during the preparation of the subgrade and until completion of the Work. No ground or surface water shall be discharged into sanitary sewers. No Work shall be constructed under water or water pressure.

B. Provide and maintain adequate dewatering equipment to remove and dispose of all surface or groundwater entering excavations, trenches or other parts of the Work. Structure and excavations shall be kept dry continually until construction is complete. Dewater by lowering and maintaining the groundwater level beneath structures and excavations at distance of not less than 12 inches below the bottom of the structure or excavation. Drainage system methods shall not cause damage to wells or adjacent property. Outlet drainage piping and conduit shall be kept clean and free from sediment. Contractor is responsible for condition of all pipes, conduits, and structures, which are used for drainage.

C. Sumps and pump wells used as a part of the dewatering system shall be protected, sheathed, and braced to protect the construction and systems while in use. Cover tops of well casings to prevent animals and debris from entering and extend 2 to 3 feet above grade. Sumps and wells, when abandoned, shall be either removed and/or backfilled and compacted.

D. Methods used in drilling wells associated with dewatering or groundwater control systems are the responsibility of Contractor and shall be acceptable to Engineer. Drilling methods shall insure proper placement of well materials and not involve displacement of earth formations. Accomplish drilling with equipment of proper type and in good condition.

E. Equipment for pumping and pumping methods associated with dewatering and/or groundwater control systems are the responsibility of Contractor and shall be acceptable to Engineer. Contractor shall construct or furnish adequate discharge piping to conduct and dispose of water to prevent damage to existing structures or property. Pumping equipment shall be of proper type and size for the Work and be in good condition. Provide anchors and supports for pumping equipment.

F. Upon completion of dewatering Work, abandon and/or fill holes, trenches, ditches, and other earth excavations created by the Work of this Section. Fill, backfill, and grade to restore excavations and earth banks to lines and levels indicated on the Plans. Earth fills shall be compacted to a density equal to that of surrounding undisturbed earth.

**END OF SECTION**

SECTION 31 41 00

SHORING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This section specifies requirements for sheeting, shoring, and bracing of trenches greater than 5 feet in depth.

B. Design Requirements:
   1. The Contractor shall design sheeting, shoring, and bracing in accordance with Article 6 of CT/OSHA and the Connecticut State Labor Code. The standards of design referred to in the Labor Code shall be those of CT/OSHA.
   2. Horizontal strutting below the barrel of a pipe and the use of pipe as support are not acceptable.



### 1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| CT/OSHA | State of Connecticut Construction Safety Orders |
| -- | Connecticut State Labor Code |

## PART 2 PRODUCTS

### 2.01 GENERAL

A. The Contractor shall submit as product data to the Owner information required by Connecticut State Labor Code. Information shall be provided in accordance with Section 01 33 00 of this project manual.

## PART 3 EXECUTION

### 3.01 GENERAL

A. The construction of sheeting, shoring, and bracing shall not disturb the state of soil adjacent to the trench and below the excavation bottom.

B. Trench sheeting below the top of a pipe shall be left in place.

### 3.02 SEQUENCE

A. Trench excavation shall not be started until the design for trench support has been accepted by the Owner.

**END OF SECTION**

SECTION 31 64 10

FOUNDATION CAISSONS

## PART 1 GENERAL

### 1.01 SUMMARY

A. The Contractor shall furnish all labor, equipment, materials and services to install casings, placement of reinforcing steel, anchor bolts and concrete fill for the foundation caissons. The foundation caissons dimensions, materials and locations shall be as shown on the Contract Drawings and as specified herein.

B. The following index of this Section is presented for convenience:

C.





### 1.02 PAYMENT

A. In addition to the payment provisions of Section 01 27 00, Measurement and Payment, the following payment terms and conditions will apply to this specific section only.

B. Measurement: The quantities of foundation caissons in linear feet to be measured for payment of the unit price bid will be the actual length of caissons driven or installed and left in place in conformity with the Contract Documents. The linear footage of caisson to

be measured for payment shall be the length in place below the top of caisson to the horizontal bearing surface at the bottom of the caisson diameter.

C. Payment: Payment for all foundation caisson work will be made at the unit price bid for the foundation caissons. The unit price bid shall include the cost of furnishing all labor, materials, equipment and incidentals necessary to complete the work specified in this Section.

D. No Separate Payment:
   1. No separate payment will be made for drilling, casing, concrete, steel reinforcement, removing damaged caisson casings, surveys and related drawings, caisson cut-offs and their disposal off-site. The costs thereof shall be included in the unit price bid for foundation caissons.
   2. No separate payment will be made for excavating for caisson installation, replacing unsuitable materials or for furnishing, placing and compacting fill and backfill material; the costs thereof shall be included in the unit price bid for foundation caissons.

## 1.03 RELATED SECTIONS

A. Requirements from the following Sections are also referenced in this Section:
   1. Section 03 30 00 - Cast-in-Place Concrete
   2. Section 05 05 23.01 - Welding
   3. Section 05 12 00 - Structural Steel Framing
   4. Section 31 09 16.20 - Pile Load Tests, Compressive, Lateral and Uplift Loads.

## 1.04 REFERENCES

A. Definitions:
   1. No additional definitions or terms are used in this Section.

B. Reference Standards:
   1. ASTM A36 - Carbon Structural Steel.
   2. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   3. ASTM C9 - Test Method for Compressive Strength of Cylindrical Concrete.
   4. ASTM C31 - Practice for Making and Curing Concrete Test Specimens in the Field.
   5. ASTM C33 - Concrete Aggregates.
   6. ASTM C42 - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   7. ASTM C94 - Ready-Mixed Concrete.
   8. ASTM C143 - Test Method for Slump of Hydraulic Cement Concrete.
   9. ASTM C150 - Portland Cement.
   10. ASTM C231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Test Method.
   11. AWS D1.1 - Structural Welding Code.
   12. ACI 211.1 - Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

13. ACI 301 - Standard Specification for Structural Concrete.
14. ACI 305R - Hot Weather Concreting.
15. ACI 306R - Cold Weather Concreting.
16. Connecticut State Building Code

## 1.05 DESCRIPTION

A. Performance Requirements
   1. Furnishing and installation of the caissons shall conform to the Connecticut State Building Code and the Contract Documents.
   2. Caisson design loadings, concrete strengths, reinforcing, diameters and wall thicknesses of steel casings shall be as stipulated in the Contract Documents.
   3. Caissons shall be installed so that the casings are socketed into undisturbed rock.
   4. Casings shall have the strength and rigidity to maintain the required excavation lines against earth and water pressures.
   5. Casings may be vibrated, driven or drilled into place by methods that will minimize disturbance of soil and the casing.

B. Load Tests
   1. All available samples and information relating to boring records and subsurface conditions are expressly excluded and not a part of the Contract and are available for information purposes only. It shall be the Contractor's responsibility:
      a. To make application for inspection and review of these data.
      b. To obtain any additional subsurface data he may desire.
   2. Load tests, when required by the Contract Documents, shall be performed in accordance with Section 31 09 16.20 - Pile Load Tests, Compressive, Lateral and Uplift Loads.
   3. Perform caisson load tests at locations shown on the Contract Drawings or required by the Contract Documents. Magnitude of the test loads shall be accurately determined and controlled.

C. Concrete Testing
   1. The Contractor shall engage the services of an independent testing laboratory, approved by the Commissioner, for performing the concrete testing. Concrete shall be sampled and tested in accordance with the following requirements. Additional tests for slump, air content, temperature, or compressive strength shall be made when required by the City or the Engineer.
   2. Slump shall be measured in accordance with ASTM C143. One slump test shall be made for each truck load of concrete during the first third of the load.
   3. Air content shall be measured by the pressure method using ASTM C231. Concrete shall have an air content between 3 and 6 percent. Air entrainment shall be tested for each truck load of concrete.
   4. Concrete, Air and Water Temperatures: Air temperature shall be measured at the start and end of each pour. Concrete temperature shall be measured for each truck

load of concrete. Water temperature, when concrete is placed under water, shall be measured at the start of the pour.

a. Concrete, air and water temperatures (when concrete is placed underwater) shall be measured with a Fahrenheit thermometer.

b. Concrete, as placed, shall have a maximum temperature of 90 degrees F and a minimum of 45 degrees F.

c. Air temperature at the time of placing shall be a maximum of 100 degrees F and a minimum of 40 degrees F.

5. Concrete Compressive strength test cylinders shall be cast and cured in accordance with ASTM C31 and shall be tested in accordance with ASTM C39. Four concrete compression cylinders shall be prepared for each truck load of concrete, two for testing at 7 days and two for testing at 28 days. Concrete shall have a compressive strength, after 28 days, as stipulated in the Contract Documents.

6. Concrete Cores: The City and the Engineer reserve the right to require core tests of hardened concrete in accordance with the ASTM C42, if the 28-day compressive strength of the concrete is below that stipulated in the Contract Documents. Such core tests shall be at the Contractor's expense.

a. Core samples shall have an outside diameter of 4 inches minimum and be capable of being trimmed to a finished length of at least 8 inches, unless otherwise approved by the Engineer. Cores taken for other purposes shall be of a size and extent as directed by the Engineer.

b. Concrete cores shall have a compressive strength after 28 days as stipulated in the Contract Documents. If the final compressive test results are below those shown or specified, the City may require modification or complete replacement of the foundation at the Contractor's expense.

D. Rock Testing

1. Testing of rock below founding level of the caisson shall consist of drilling with a pneumatically-activated 1.5 inch to 2.0 inch diameter steel star-bit. The depth of test drilling shall be 5 feet minimum or deeper, as directed by the Engineer. The drilling shall be done with a uniform pressure on the drill.

2. The time shall be recorded for each 6 inches of drill penetration. Changes in rate of drilling, abrupt drops, or any evidence of soft rock, voids, etc., shall be noted and recorded. All caissons shall be test drilled.

3. The Engineer will approve test holes and authorize subsequent concrete placement or initiate redesign procedures.

## 1.06 QUALITY ASSURANCE

A. Qualifications

1. The work shall be performed by a General Contractor or a specialty Subcontractor specializing in the specified foundation system and having experience installing the specified foundation system under similar subsurface conditions.

## 1.07 SUBMITTALS

A. The Contractor shall submit Shop Drawings and material specifications for the approval of the Engineer. Submittals shall include, but not be limited to:

1. Caisson location plan, size and numbering system.

2. Caisson location survey during installation.
3. Procedures for placement of concrete by tremie method or pumping.
4. Details of all connections, anchorage, splices, etc.
5. Shop drawings and procedure for fabricating and setting preassembled reinforcing steel cages and support frames.
6. Caisson installation techniques and equipment.
7. Caisson installation sequence.
8. Final caisson location survey.
9. Sample of caisson record form.

B. The Contractor shall also submit the following:
1. Material certification for casing and reinforcing steel.
2. Load test report (if required).
3. Name of concrete testing laboratory.
4. Concrete mix design.
5. Concrete test results.
6. Water test report.
7. Test drilling report.

C. Project Record Documents
1. Upon completion of installation of all caissons, the Contractor shall submit to the City, mylars of drawings showing types and installed location of all caissons, including obstructed, damaged and additional caissons, as related to their column lines, center of footings or other reference points and lines, percentage out of plumb, the cutoff elevation, and length below cutoff for each caisson.
2. Mylars shall be the same size as the Contract Drawings.



## 1.08 DELIVERY, STORAGE, AND HANDLING

A. Product Handling
1. Materials shall be protected to prevent damage and corrosion during handling and shipping.
2. Care shall be taken to prevent materials from becoming contaminated with grease, oil, dirt, or other unsuitable matter during handling and shipping.

## 1.09 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. Not Used

## 1.10 SPECIAL WARRANTY PROVISIONS / GUARANTEE PERIODS

A. Not Used

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. Not Used

### 2.02 MATERIALS / EQUIPMENT

A. Casings
   1. Casings used by the Contractor, shall be of structural steel plate of thickness as stipulated in the Contract Documents, conforming to ASTM A36, and shall be suitably reinforced to withstand installation loads without deforming, ovaling, or curling of the leading edge.
   2. Casings may be either continuous, butt-jointed, or telescoping and shall conform to the shapes, lines, and dimensions as called for on the Contract Drawings.
   3. Casings shall be sufficiently strong to carry the deadweight and lateral pressure of the concrete without deflection or bulging, and sufficiently tight to prevent leakage of mortar.
   4. Casing shall be seated into the top of the rock and extend up to the top of caisson.

B. Reinforcing Steel
   1. Reinforcing steel shall be deformed billet steel bars, Grade 60, in accordance with ASTM A615.

C. Concrete for Caissons
   1. Concrete for caissons shall be done in accordance with Section 03 30 00 - Cast-in-Place Concrete and the following requirements.
   2. Concrete for caissons shall have a minimum 28-day compressive strength as stipulated in the Contract Documents. The concrete shall be pumpable with a slump between 6 inches and 7 inches.
   3. All materials for concrete shall conform to the following requirements unless otherwise approved in writing by the Engineer.
      a. Cement shall conform to ASTM C150, Type II low alkali.
      b. Coarse and fine aggregates shall conform to ASTM C33. Maximum size of coarse aggregate shall be limited to one-third of the smallest inside diameter of the pump or pipeline.
      c. Aggregate obtained from a continuously operating pit, quarry, or similar source with a satisfactory 2-year history of conformance with ASTM C33, need not be tested in accordance with ASTM C33. Aggregates from any other source shall not be used without prior tests to show conformance to ASTM C33.
      d. Water for concrete shall be from a municipal water supply, potable, and free of impurities harmful to setting, strength, development, or durability of the concrete.
      e. All concrete used for caissons shall conform to the requirements for ready-mixed concrete given in ASTM C94.
      f. Each mix shall be designed in accordance with Section 03 30 00 - Cast-in-Place Concrete.

g. Information regarding mix design and testing, water source, aggregates, and concrete supplier shall be submitted to the Engineer for approval prior to placing concrete.

## 2.03 FABRICATION / ASSEMBLING / FINISHES

A. Joints
   1. Welding of joints shall be performed in accordance with the requirements of:
      a. AWS D1.1 Structural Welding Code.
      b. Relevant sections of IBC and Connecticut State Building Code
      c. Section 05 05 23.01 - Welding.
   2. All shop and field welding shall be performed by certificated welders under the immediate supervision of a representative of a standard testing agency or an inspection agency reporting directly to and under the control of the Owner. The Contractor shall submit the name of such agency to the Commissioner for approval before starting work. The costs of all welding inspections shall be borne by the Contractor.
   3. Weld testing shall be in accordance with Section 05 05 23.01 – Welding and Section 05 12 00 – Structural Steel Framing.

## 2.04 SOURCE QUALITY CONTROL / SHOP TESTS

A. Not Used

# PART 3 EXECUTION

## 3.01 EXAMINATION / PREPARATION

A. Examination of the Site
   1. Prior to starting caisson installation operations, the Contractor, the City and the Engineer shall make a joint inspection of the accessible existing structures, pavement and improvements adjacent to the caisson installation site to examine and document their present condition.
   2. Photographs and measurements shall be taken by the Contractor to record any conditions that may become the subject of possible damage claims.
   3. The Contractor shall prepare a report of such conditions, verified by the photographs, and signed by the personnel of the Contractor, City and Engineer participating in the investigation.

## 3.02 IMPLEMENTATION

A. Product Handling
   1. The top of any caisson hole should be covered when excavation work is discontinued or finished. The hole shall not be left open for any reason. The cover shall be substantial and strong enough to prevent any person from falling into the hole.
   2. The caisson shall be properly barricaded or fenced and lit to ensure safety to the public.

B. Excavation

1. Caissons shall be founded on rock. The socket shall be cut into the rock and the bottom leveled so bearing is obtained on horizontal surfaces of the specified shaft diameter. The Engineer shall make final determination of drilled caisson depth in the field.
2. Bottoms of excavations shall contain no more than 1/2 inch loose material.
3. Penetration shall be obtained by approved methods such as drilling, coring, chipping, and chopping. Blasting will not be permitted.
4. The Contractor may use any approved method to remove or drill through obstructions that does not undermine or endanger adjacent caissons or other facilities. Blasting will not be permitted.
5. All excavated materials shall be kept away from each open caisson excavation to avoid contamination of the excavation bottom after final cleanout.
6. Excavated materials shall be the responsibility of the Contractor and shall be disposed of as specified in the Contract Documents.

C. Caisson Records

1. Detailed records in a form approved by the City and Engineer shall be kept by the Contractor for each caisson.
2. Forms shall include shaft diameters, depths of test holes, top and bottom elevation, bearing strata description, water conditions, concrete strength, concrete volume, rock elevations, dates and times of excavation and concrete placement and other pertinent information.
3. A complete tabulation of all records pertinent to approved caissons shall be delivered to the City by the Contractor.

D. Reinforcing Steel Installation

1. The reinforcing steel shall be preassembled into cages as shown on the Contract Drawings. All bars shall be bent cold, unless otherwise permitted by the Engineer. Reinforcing bars shall be preassembled into cages by tying to produce the required spacing and rigidity for handling and placing. The Contractor may use additional reinforcing steel than that shown on the Contract Drawings and/or structural steel to fabricate a support frame for the rebar cages in order to achieve the accuracy and rigidity required in lifting and setting the caisson reinforcing. Welding to reinforcing bars in cages will not be permitted. The Contractor shall submit to the Engineer for approval the method of fabricating the preassembled reinforcing steel cages.
2. Reinforcing steel shall not be placed in a caisson excavation until the excavation has been inspected and approved by the Engineer. Following approval, the reinforcing steel shall be placed to the correct elevation. The bottom of the hole shall be checked to ensure that no loose material has entered the caisson during placement of the reinforcing cage.
3. Reinforcing steel shall be provided with spacers so as not to touch either the sidewall of the excavation or the casing and the reinforcing shall be completely encased in the concrete. Before reinforcing bars are placed, the surfaces of the bars and metal supports shall be cleaned of any heavy, flaky rust, loose mil scale, dirt, grease, or any other deleterious material. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete. Main bars shall have the minimum cover shown on the Contract Drawings. Reinforcing cages shall be accurately placed and secured in position so that they will

not be displaced during the placing of concrete. Rustproof metal chains, metal hangers, metal spacers or other satisfactory supports may be used. Precast concrete solid blocks may be used at the bottom of the hole for supporting reinforcing bars.

E. Concrete Placement

1. There shall be no interruption in work after inspection of the excavation. If an interruption in work occurs after inspection, the Engineer may require additional inspection of the excavation.
2. Concrete shall be placed underwater, or under specially prepared slurries, by pumping or the tremie method. Equipment and procedures to be used shall be submitted in writing to the Engineer, at least two weeks prior to utilization, for approval.
3. Before beginning underwater placement, the bottom of the caisson excavation shall be jetted or stirred to place any loose material in suspension.
4. The pump line tremie pipe shall have a seal consisting of a recoverable inflated ball, or approved equal, that seals the bottom of the pipe until the pipe reaches the hole' bottom and enough concrete has been placed to seal off water flow into the tremie pipe. During tremie placement, the tremie pipe shall be maintained with a minimum of 6 feet of embedment in the concrete. If the seal is lost, the pipe shall be withdrawn, the ball seal replaced, and the tremie operation restarted.
5. Tremie operation shall continue until a minimum of one-third cubic yard of concrete is pumped over the top of the casing. Excess concrete shall be removed to the top of the casing and screeded to a level surface.
6. Top surfaces of concrete shall be coated with a set retarder, approved by the Engineer, in accordance with the manufacturer's instructions. After the concrete has achieved final set, the retarded surface concrete shall be removed.
7. Tops of caissons and embedded reinforcing steel shall be protected against damage and shall be cured and protected to prevent moisture loss and temperature extremes in accordance with ACI 301, Chapter 12. Curing compounds shall not be applied to surfaces to which more concrete is to be bonded.
8. Concreting shall be continuous. If the placement of concrete is interrupted, special procedures may be required prior to continuation, such as the installation of dowels, as determined by the Engineer.



F. Hot Weather Concreting Requirements

1. Hot weather concreting requirements shall conform to ACI 301 and the recommendations of ACI 305R. All concrete shall be delivered to the forms at all times at the coolest temperature which is practicable under the weather conditions but consistent with the temperature requirements herein. Concrete placement will not be permitted when, in the opinion of the Engineer, the hot weather conditions prevent proper placement and consolidation.
2. When the temperature of steel, forms, or ground surfaces exceeds 120 degrees F, these shall be sprayed with water to reduce their temperature just prior to placing concrete.
3. When the ambient air temperature equals or exceeds 95 degrees F, belts, pump lines, and chutes shall be shaded and pump lines shall be covered with burlap kept continuously damp as necessary to maintain the temperature of the concrete within specified requirements.

4. The maximum temperature of concrete when placed shall not exceed 90 degrees F; however, once the placement has started it may continue even if the concrete temperature rises above 90 degrees F. If concrete temperatures are expected to exceed 90 degrees F during placement, preparation shall be made to transport, place, consolidate, and finish the concrete at the fastest possible rate.
5. Random concrete temperature readings will be taken at the end of pump lines or conveyor belts, or in buckets, buggies, or other conveyances when used.

G. Cold Weather Concreting Requirements
1. Cold weather concreting shall comply with the requirements of ACI 301 and ACI 306.1.
2. All concrete materials and all reinforcement, forms, fillers, and ground with which the concrete is to come in contact shall be free from frost, snow, and ice. Contact surfaces shall not be more than 10 degrees F cooler than the minimum placing temperature of the concrete.

H. Alignment Tolerance
1. The alignment tolerances for caissons, anchor bolts, base plates, and reinforcing steel shall be as follows:
   a. Deviation of the axis of any drilled caisson from the vertical shall not exceed 2.0 inches in 8.0 feet.
   b. The center of the installed caisson from stated location of center of the caisson shall be less than 3 inches.
2. Whenever a caisson excavation deviates in location or plumbness by more than the tolerances given above, the corrective measures to be taken, such as enlargement of caissons, installation of additional reinforcing steel, or replacement with additional caissons, shall be determined by the Engineer.
3. Center of anchor bolt cluster to center of caisson shall be plus or minus 1 inch.
4. Deviation of base/anchor bolt cluster from desired orientation shall be less than 2 degrees.
5. Reinforcing steel shall be placed in accordance with ACI 301.

I. Casing Cutoff
1. All casings shall be cutoff to true planes at the elevation shown on the Contract Drawings or specified in the Contract.
2. Casings requiring a final cutoff elevation below the existing or excavated ground surface shall have reinforcing steel installed and filled with concrete to the cutoff elevations.
3. Cutoffs are the property of the Contractor and shall be disposed of off-site.

J. Caisson Survey
1. The Contractor shall engage the services of a licensed surveyor, approved by the Commissioner, for the performance of the survey work. The Contractor shall, at such times so as not to interfere with the progress of the installation, make surveys of the installed caissons. The installed location of each caisson shall be established by survey and shown on drawings prepared for this purpose.
2. Copies of the drawings shall be submitted by the Contractor in accordance with the provisions as hereinafter specified in this Paragraph and in Paragraph K, Analysis

and Corrective Measures below. Survey information may be submitted on several drawings, each covering a partial area only, as the job progresses, in order to expedite the approval of the work.

3. Upon completion of all caisson installation, the Contractor shall submit to the City, mylars of drawings showing installed location of all caissons as related to their column lines, center of footings or other reference points and lines, percentage out of plumb, the cutoff elevation, and length below cutoff for each caisson. Mylars shall be the same size as the Contract Drawings.

K. Analysis and Corrective Measures

1. The analysis and redesign work called for herein will be performed by the Engineer.
2. The Engineer will analyze the conditions at each caisson to determine whether corrective measures are required. If corrective measures are not required, approval will be given for proceeding with the work.
3. The Engineer will determine the corrective measures required to keep caisson loads within the allowable limits. Corrective measures, for any caissons installed beyond the allowable alignment tolerances specified in Article 3.08, Alignment Tolerance, will be determined by the Engineer.
4. If corrective measures involve the installation of additional caissons, the Engineer will prepare supplemental drawings showing the details of the required corrective work.
5. Cost of Additional Work:
   a. The cost of installing additional caissons (as called for on the supplemental drawings for the corrective measures), shall be borne by the Contractor in the case of rejected, defective or damaged caissons.
   b. The cost will be borne by the City in the case of obstructed caissons ordered by the Engineer abandoned or in the case of modifications required because of the presence of obstructions.
   c. Payment for corrective work necessitated by obstructed caissons will be made in accordance with the applicable unit prices.



## 3.03 FIELD TESTING / QUALITY CONTROL

A. Inspection

1. All inspections will be performed by the Engineer designated for controlled inspection.
2. The following are the mandatory hold points which require prior notification of the Engineer:
   a. Casing installation.
   b. Rock socket.
   c. Placement of reinforcing steel and placement and orientation of the anchor bolt cage (if required).
   d. Concrete placement.
3. The Contractor shall provide and operate a personnel hoist cage and hoisting equipment to facilitate the examination of the caisson excavations. The Contractor shall also provide air testing equipment in accordance with the Specifications and a portable air blower to introduce fresh air at the excavation bottom.

4. The Contractor shall cooperate with the Engineer to ensure the expeditious and safe examination of caisson excavations.
5. Inspection of each caisson shall include:
    a. Location of caisson.
    b. Dimensions and alignment of caisson.
    c. Bearing strata, inspect rock socket.
    d. Test drilling.
    e. Cleanout of caisson.
    f. Placement of reinforcing steel and anchor bolts (if required).
    g. Placement of concrete.
    h. Removal of obstructions detrimental to the proper construction of the caissons.
    i. Loss of ground. Monitor caisson excavation to check for base heave.
6. Examination of the bottom of the excavation is required:
    a. Whenever any obstruction or hard rock is encountered.
    b. After completion of the excavation and before placement of reinforcing steel and concrete.
    c. After lower reinforcing is in place, but prior to placing of concrete.

## 3.04 STARTUP / DEMONSTRATION

A. Not Used

## 3.05 ADJUSTING / PROTECTION / CLEANUP

A. Not Used

**END OF SECTION**

# DIVISION 32
# EXTERIOR IMPROVEMENTS

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SECTION 32 12 16

ASPHALT PAVING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies paving consisting of aggregate base, asphaltic concrete, and associated materials.

### 1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ASTM D1557 | Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in (457-mm) Drop |



B. Testing:

1. Testing will be conducted by the Construction Manager to determine compliance with the specified degree of compaction and moisture content.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Aggregate Base:

1. Aggregate base shall conform to CTDOT Article M.05.01.

B. Liquid Asphalt:

1. Liquid asphalt for tack coats and treatment of aggregate base shall be Grade MC 250 and shall comply with CTDOT Article M.04.

C. Asphalt Concrete:
   1. Base Course shall comply with CTDOT Article M.04, HMA S0.5, Class 1.
   2. Surface Course shall comply with CTDOT Article M.04, HMA S0.375, Class 2.

D. Traffic Line Paint:
   1. Traffic line paint shall be a white latex traffic paint 21209 by Glidden, Vin-L-Stripe acrylic epoxy traffic paint W-801 by Dunn-Edwards, or equal.

## PART 3 EXECUTION

### 3.01 GENERAL

A. Construction shall conform to the details, dimensions and grades specified. Maximum variations in finished grade of paving shall be plus or minus 0.05 feet.

### 3.02 AGGREGATE BASE PLACEMENT

A. Subgrade:
   1. The subgrade shall be compacted a minimum density of 90 percent of the maximum dry density as determined by the Modified A.A.S.H.T.O. Method T-180-57.
   2. All holes or depressions made by the removal of material, as described, shall be filled with suitable material and the whole surface compacted uniformly by rolling the entire area with an approved power roller weighing not less than 10 tons.

B. Aggregate Base:
   1. Placing of aggregate base shall comply with CTDOT M.05.01 Relative compaction shall be a minimum of 95 percent as determined using methods set forth in ASTM D1557.



### 3.03 ASPHALT CONCRETE PAVEMENT

A. Asphalt Concrete:
   1. Placement of asphalt concrete pavement shall comply with CTDOT M.04. Berms shall be shaped and compacted with an extrusion machine.

B. Tack Coat:
   1. tack coat shall be applied to all vertical surfaces of existing pavement; to curbs, gutters, and construction joints against which asphalt concrete will be placed; to pavements to be surfaced; and where specified at the approximate rate of 0.05 gallons per square yard. Application shall comply with CTDOT M.04. Immediately prior to placing asphalt concrete, additional tack coat shall be applied to areas where the tack coat has been damaged.
   2. Immediately prior to construction of asphalt concrete berms, a continuous tack coat shall be applied to the pavement surface. Application of the tack coat shall not cause a slip or weakened plane between the two joined surfaces.

C. Traffic Line Painting:
   1. Traffic lines shall be painted on pavement surfaces where specified. Surfaces are to be free of contaminants that may interfere with adhesion. Thinning and coverage

shall be as recommended by the manufacturer, but coverage shall not exceed 400 square feet per gallon. Traffic lines shall be of uniform width with the edges straight and even. Traffic shall be restricted from the area until the paint has dried.

**END OF SECTION**

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SECTION 32 92 19

SEEDING

## PART 1 - GENERAL

### 1.01 SCOPE

A. This section covers placing and grading topsoil, turf establishment, preparation for seeding, seeding, and mulching. The Contractor shall provide all materials, labor, and equipment to complete all landscape work in accordance with the drawings and specifications.

### 1.02 GENERAL

A. All seeded work shall be performed by a landscape contractor or nursery having demonstrated experience in the installation of seeding material on projects of similar size and who employs only experienced personnel who are familiar with the required work and who shall provide adequate supervision by a qualified foreman at all times when the work is in progress.

B. Finish Grades and Soil Conditions
   1. Shall be subject to approval before commencing work under this section.

C. Certificates of Inspection
   1. All shipments of seeding material shall be inspected at the nursery or at the growing site by the authorized Federal and State Agencies. All necessary inspection certificates shall accompany the invoice for each shipment.
   2. Any seeding material which indicates signs of inspects, their eggs or larvae, and diseases shall be rejected and immediately removed from the project and shall be replaced with proper materials within one working day, weather permitting. Removal and replacement shall be at the expense of the Contractor.



### 1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 23:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The ENGINEER shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Sample

1. Samples of topsoil, Humus, Peat Moss, Mulch, and Filler Fabric shall be submitted for analysis and testing; they shall be submitted in approved containers, appropriately labeled as to kind of material and its sources.

C. Test Reports and Certificates

1. Shall be submitted as specified in Master Specification Section 01 33 23, Submittals.

D. Certification

1. Certificates of inspection for seeding materials and material certificates for landscape materials shall be submitted in project Submittals section.

E. Seeding Schedule

1. The proposed seeding schedule shall be submitted indicated dates for each type of landscape work during normal seasons for such work in the area of the site. Once accepted, dates shall be revised only if accepted in writing and after documentation of reasons for delays.

F. Maintenance Instructions

1. Instructions shall be submitted which recommend procedures to be established by the Engineer for maintenance of landscape work for one full year. Maintenance procedures shall be performed by the Contractor for recommended procedures.

G. Landscape Foreman

1. The Contractor shall submit to the Engineer in writing the name of the landscape foreman to be in attendance at the project site during progress of the work. Should a change in foremanship be necessary during any period in the progress of the work, the Engineer shall be notified promptly and the name of the new foreman submitted.



## 1.04 SUBSTITUTIONS

A. If a seed is found not to be available, the Contractor shall notify the Engineer. The Engineer will select a reasonable alternate or inform the Contractor of the availability of the original seed. If a substitution is selected, it shall be of the same value, and quality as the original seed.

## 1.05 WARRANTY

A. Guaranteed Period

1. All seeded areas shall be subject to one year correction period which shall commence upon the date of Final Acceptance by the Engineer. Any turf planted during this period, which dies or partially dies (25% or more) shall be replaced at the Contractor's expense. Replacements made under the Contractor's warranty shall be covered by a like warranty for a period of one year after completion of the replacement. Rejection of seeds by the Engineer will be final. When notified by the Engineer that certain seeded areas require replacement, the replacements shall be made within 30 days of notification, providing the 30 day period falls within the planting season.

B. Replacements

1. All replacements shall be of the same kind as originally seeded and shall be made at no extra cost. The Contractor shall repair any damage, including ruts in seeded areas incurred in making replacements.
2. At the direction of the Engineer, replacements may be seeded at the start of the next planting and digging season.

C. Notification

1. The Engineer will conduct additional inspections, and will notify the Contractor of any turf that dies or requires replacement during the one-year warranty period. The Contractor shall provide and coordinate seeding of replacements.

D. Final Warranty Inspection

1. At the conclusion of the warranty period, the Contractor and Engineer shall conduct a final warranty inspection at a time mutually agreeable. It will be the Contractor's responsibility to notify the Engineer in writing requesting the inspection. The Owner will assume full responsibility after Final Warranty Inspection Approval.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials

1. Packaged materials shall be delivered in containers showing weight, analysis, and name of manufacturer. Materials shall be protected from deterioration during delivery and while they are stored at the site.

## 1.07 PROJECT CONDITIONS

A. Time of Seeding

1. The Contractor shall perform seeding activities only during periods within the planting season when weather and soil conditions are suitable for each species to be planted and in accordance with local accepted practice.
2. Seeding shall be performed between April and June 1 or August 15 and October 15, except as otherwise authorized by the Engineer.

B. Soil and Drainage Conditions

1. The Contractor shall notify the Engineer in writing of all soil or drainage conditions, which the Contractor considers detrimental to growth of seeding material. The Contractor shall state conditions and submit a proposal for correcting conditions, if feasible, including change in cost, if any.
2. If rock, underground construction work, tree roots, or obstructions are encountered in the excavation of plant pits, alternate locations may be selected by the Engineer. Where locations cannot be changed as determined by the Engineer, the cost required to remove the obstructions to a depth of not less than 6 inches (15.2 cm) below the required pit depth shall be submitted. Work will proceed only after acceptance by the Engineer. Fragmented bedrock that can be reasonably removed shall not be considered an obstruction.

C. Sequencing

1. Landscape work shall progress as rapidly as portions of the site become available, working within seasonal limitations for each kind of landscape work required. Final grades shall have been established, top soil spread, and bound to subgrade, fills and backfills allowed to settle, and any required mechanical compaction completed before commencing work in any area.

D. Job Conditions

1. All existing trees and other plant material to remain shall be clearly designated and marked under the direction of the Engineer shall be properly protected by means of fencing or by another approved manner. Any existing tress or plant material designated to remain that is subsequently damaged by operations under this Contract shall be replaced with plant material of the same size and kind at the Contractor's expense.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

A. Topsoil

1. In accordance with Section 50.02 of the City of New Haven Technical and Material Specifications, latest edition.

B. Fertilizer

1. In accordance with Section 50.05 of the City of New Haven Technical and Material Specifications, latest edition.

C. Mulch

1. In accordance with Section 50.07 of the City of New Haven Technical and Material Specifications, latest edition.

D. Seed

1. In accordance with Section 50.05 of the City of New Haven Technical and Material Specifications, latest edition.

E. Water

1. Water shall be furnished by the Contractor. The Contractor shall also provide all necessary hoses, hose connections, temporary pipe, and other equipment necessary for watering.



## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. General

1. Prior to grading and tilling, vegetation that may interfere with operations shall be mowed, grubbed, and raked. The collected material shall be removed from the site. The surface shall be cleared of stumps, stones larger than 3 inches (7.62 cm), roots, cable, wire, and other materials that might hinder the work for subsequent maintenance.

2. Locations of underground utilities shall be determined prior to any excavation. Work shall be performed in a manner which will avoid possible damage. Hand excavation will be used as required. Grade stakes shall be maintained until removal is mutually agreed upon by parties concerned.
3. Landscaping work shall not be started until substantially all earthwork has been completed. Backfills and fills shall be allowed to settle and finish grading completed immediately before the work is started. All surface and subsurface construction debris shall have been removed completely.

B. Placing Topsoil
1. In accordance with Section 50.04 of the City of New Haven Technical and Material Specifications, latest edition.

C. Grading
1. Established grades, as indicated on the drawings, shall be maintained in a true and even condition. Eroded areas and areas having inadequate drainage, as indicated by the ponding of water, shall be filled. Ruts, deep tracks, dead furrows, and ridges shall be eliminated.

D. Tilling
1. The area to be seeded shall be thoroughly tilled to a depth of at least 3 inches by discing, harrowing, or other accepted methods until the soil is well pulverized and smoothed by harrowing, floating, or dragging. After completion of the tilling operation, the surface shall be cleared of all stones, stumps, or other objects larger than 1-1/2 inches (3.8 cm) in thickness or diameter, and of roots, wire, grade stakes, and other objects that might be a hindrance to maintenance operations. Paved areas over which hauling operations are conducted shall be kept clean and dirt that may be brought upon the surface shall be removed promptly.
2. Any objectionable undulations or irregularities in the surface resulting from tillage or other operations shall be removed before seeding begins. Bed preparation shall be performed only during periods when satisfactory because of drought, excessive moisture, or other causes, the work shall be stopped until such condition shave been corrected to the satisfaction of the Engineer.
3. All operations shall be done in a direction parallel to proposed contour lines, and not uphill nor downhill.

E. Fertilizing
1. Fertilizer shall be applied within 24 hours prior to the tilling operation. The material shall be distributed uniformly over the entire area. Fertilizer shall be applied at a rate to give one and one-half pounds (0.68 kg) of each pure chemical per 1000 square feet (92.9 square meters) such as 12 pounds (5.5 kg) of 12-12-12, or 15 pounds (6.8 kg) of 10-10-10 per 1000 square feet (92.9 square meters). Alternatively, follow recommendations for fertilizer and lime application rates based upon topsoil testing.

F. Seeding
1. Seeding equipment calibration tests shall be made to determine the equipment setting required to apply the seed at the specified rates. In unplanted skips and areas noted after germination and growth of the grass, the unplanted areas shall be seeded at no additional cost. The seed box shall be kept at least half full during seeding operations to ensure even distribution of seed over all the areas seeded.

2. Leguminous seeds shall be inoculated with a standard pure culture of nitrogen fixing bacteria. The culture shall be mixed with sufficient water to distribute it thoroughly. The seed shall be wetted thoroughly with the solution and allowed to dry sufficiently to be in condition for sowing. Inoculated seed shall be sown within 30 hours after the treatment.
3. All areas shall be seeded with five pounds of seed per 1000 square feet (92.9 square meters).
4. Seeding and fertilizing shall not be done during periods of severe drought, high winds, excessive moisture, muddy or frozen ground, as determined by the Engineer, because satisfactory results are not likely to be obtained.
5. Do not seed areas in excess of that which can be mulched on same day.
6. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of topsoil testing.
7. Refer to additional requirements of the current edition of Section 50.05 of the City of New Haven Technical and Material Specifications.

G. Covering and Firming
1. Unless a cultipacker type seeder is used, the seed shall be covered with a shallow-set spike tooth harrow or a chain, plank, or brush drag. The depth of cover shall not exceed ¼ inch. In small areas, covering may need to be performed by light hand raking. After covering, the areas shall be firmed by rolling or with the use of a cultipacker.

H. Mulching
1. Straw mulch shall be spread uniformly in a continuous blanket at 1-1/2 inch depth loose measurement. Mulch shall be spread by hand or by a blower type mulch spreader. All wire from baled mulch shall be collected as it is removed from the bale.
2. Wood cellulose fiber mulch as specified shall be applied at a rate of one ton (900 kg) per acre (0.4 ha) in areas designated by the Engineer. A 4 foot by eight foot (1.2 x 2.4 m) plywood sheet shall be used along all walks and structures to prevent overspray.
3. Immediately following spreading, the straw mulch shall be anchored in the soil to a depth of 2 to 3 inches (5.08 to 7.6 cm) by a coulter disc mulch anchor machine designed to force the mulch into the soil surface. The machine shall be weighted and operated in such a manner to secure the mulch firmly in the ground to form a soil-binding mulch and prevent loss or bunching of the hay by wind. The coulter shall be at least 10 inches (25.4 cm) in diameter. Mulch shall be secured within 24 hours after seeding. Two or more passes may be required to anchor the mulch to the satisfaction of the Engineer.

I. Protection
1. After completion of construction operations, seeded areas shall be protected where necessary against traffic by erecting barricades or placing warning signs in appropriate areas. Such protective devices shall be maintained until final acceptance of the project.

## 3.02 CLEAN-UP

A. After completion of the planting operations, the entire site shall be cleared of excess soil and waste material resulting from the Contractor's work including, but not limited to, stones, stumps, roots, brush, wire, grade stakes, and all objects that might be a hindrance to maintenance operations or affect the visual appearance of the site. Soil clods and debris left on the surface shall be removed.

## 3.03 MAINTENANCE

A. The Contractor shall maintain all material beginning immediately after the work is started and continuing until final acceptance. The Owner will assume all maintenance work upon final acceptance, including the removal of stakes and guy wires at the proper time.

B. Watering

1. Maintenance shall include a thorough initial watering with programmed or hand watering of seeded areas thereafter when soil moisture is below optimum level for establishment and growth. Watering in seeded areas shall be by fine mist.

C. Maintenance of Grades and Repair of Erosion Damage

1. Original grades of the grass areas shall be maintained after commencement of planting operations and during the maintenance period. Any damage to the finished surface from construction operations shall be promptly repaired. In the event erosion occurs from either watering operations or rainfall, such damage shall be promptly repaired. Ruts, ridges, tracks, washouts or gullies, and other surface irregularities shall be corrected and areas replanted where required.

D. Maintenance of Lawn Areas

1. Shall consist of watering, mowing, fertilizing, weed control, re-seeding bare areas if necessary, repair of erosion damage, maintenance of mulch, trimming, and any other operation necessary to produce a first quality lawn. The lawn shall be mowed as necessary, keeping the lawn height to a maximum of 3-1/2 inches (8.9 cm) until acceptance. Do not cut more than 1/3 of grass blade at any one mowing. The first mowing shall take place when seedlings are 40 percent higher than desired height. Neatly trim edges and hand clip where necessary and immediately remove clippings after mowing and trimming. Do not let clippings lay in clumps. The Contractor shall provide all maintenance of the lawn areas as described until it has been thoroughly established.

E. Maintenance of Mulched Areas

1. Mulch in seeded areas shall be maintained until covered with growing grass seedlings. Mulch material that has been removed from the site by wind or other causes shall be replaced and secured. Repair work that is required because of faulty operations or negligence on the part of the Contractor shall be performed at no additional cost.

F. Weeding and/or Weed Killer Application

1. Shall be scheduled as necessary to keep the seeded areas as free of weeds as possible. All mulched areas shall be weed free at final acceptance. Remedy damage resulting from improper use of herbicides.

## 3.04 FINAL ACCEPTANCE

A. When the work has been completed, the Contractor shall notify the Engineer in writing requesting a final acceptance. At a time mutually agreeable, the Contractor and Engineer will inspect the work and report findings as to acceptability and completeness. Any work remaining to be done shall be subject to another review. The Contractor will be notified in writing by the Engineer of the provisional acceptance of completed portion of the work.

B. This final acceptance shall serve as the start of the guarantee period.

**END OF SECTION**

# DIVISION 40
# PROCESS INTEGRATION

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SECTION 40 05 01

PIPING SYSTEMS

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section specifies the general requirements for design, selection, and supply of pipe materials, fittings, appurtenances, expansion control, supports, and seismic restraints for process, mechanical, plumbing, utility, odor control ducts, and HVAC piping systems. Installation, inspection, and testing are also specified in this Section.

B. Use the general requirements specified in this section with the more specific requirements listed in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and other referenced sections. Except where referenced specification sections specify alternate provisions, the requirements of this Section apply to all piping systems listed in Section 40 05 02.

C. Provide professional engineering services for a piping system design engineer (hereinafter and in all related and referenced sections the "Design Professional") for the design and inspection of piping systems work. For the scope of the work, defined herein as the "Design Professional's Scope of Responsibility," the Design Professional provides the design, final inspection, and certification for the piping supports, seismic restraints, and expansion control as specified in this Section and referenced sections.



### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 01 33 00 – Submittal Procedures
2. Section 01 61 45 – Area Exposure Designations
3. Section 01 66 00 – Product Storage and Handling Requirements
4. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
5. Section 03 30 00 – Cast-in-Place Concrete
6. Section 31 23 00 – Excavation and Fill
7. Section 40 05 02 – Piping System Schedules
8. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
9. Section 40 05 07 – Hangers and Supports for Process Piping
10. Section 40 05 07.13 – Seismic Restraints for Piping
11. Section 40 05 07.16 – Expansion Control for Piping
12. Section 40 05 45 – Piping System Identification
13. Section 40 42 00 – Insulation for Exposed Piping and Equipment

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to

other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

| Reference | Title |
|---|---|
| ANSI B16.21 | Nonmetallic Flat Gaskets for Pipe Flanges |
| ANSI B31.1 | Power Piping |
| ANSI B31.3 | Process Piping |
| ANSI B31.9 | Building Services Piping |
| ANSI Z223.1 | National Fuel Gas Code |
| ANSI/ISA-S70.01 | Quality Standard for Instrument Air |
| ASME B1.1 | Unified Inch Screw Threads |
| ASME Section IX | Boiler and Pressure Vessel Code; Welding and Brazing Requirements |
| ASTM F37 | Sealability of Gasket Materials |
| ASTM F104 | Nonmetallic Gasket Materials |
| ASTM F152 | Tension Testing of Nonmetallic Gasket Materials |
| AWWA C651 | Disinfecting Water Mains |
| CAN/CGA B149.6 | Code for Digester Gas and Landfill Gas Installations |
| EJMA | Expansion Joint Manufacturer's Association |
| UPC | Uniform Plumbing Code |



## 1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Maximum pressure: The greatest continual pressure at which the piping system is designed to operate.
   2. Test pressure: The hydrostatic, air or gas pressure used to determine system compliance.
   3. Take down coupling: Pipe couplings that facilitate disassembly of piping systems without damage or demolition of piping system components.
   4. Embedded/Encased Piping: Piping enveloped in reinforced concrete, typically under structures and under roadways, where specified on the drawings.
   5. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.

B. Piping System Identification
   1. Process, mechanical, plumbing, utility, odor control, and HVAC piping system piping is identified by a two component alpha-numeric code, (Line Label) as follows:
      a. The first component of the code indicates the nominal line size.
      b. The second component of the code identifies the process Service or fluid being conveyed in the Piping System.
   2. Process Service identifiers for pipelines are specified on the drawings. The Process Service is defined for each Process Service Identifier in Section 40 05 02.
   3. Detailed specifications for each Process Service are scheduled in Section 40 05 02.00 through 40 05 02.99.
   4. Mark and label Piping Systems as specified in Section 40 05 45.

## 1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Refer to Section 40 05 45 for process piping identification requirements.
   2. Pipe Sleeves: Coordinate placement of sleeves and penetrations in cast-in-place concrete with raceway, duct, and pipe penetrations prior to concrete placement. Coordinate placement of sleeves and wall penetration prior to construction of masonry building elements.
   3. Coordination required with the design of piping supports (hangers, guides, anchors, structural attachments, etc.), expansion joints, and expansion control and seismic restraints. Refer to sections 40 05 06, 40 05 07, 40 05 07.13, and 40 05 07.16.
   4. Refer to paragraph 1.09 Piping System Design for additional coordination requirements.

## 1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Qualifications of the Design Professional charged with inspection and certification of pipe hangers and supports and related scope of work; provide educational background, proof of registration, and proof of insurance and previous experience in performing this type of work. No further submittals under this or any related section will be considered until the Design Professional's qualifications have been reviewed and accepted by the Engineer.
   3. A copy of this specification section, along with Sections 01 73 24, 40 05 06, 40 05 07, 40 05 07.13 and 40 05 07.16, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   4. For each piping system (refer to Piping System Schedules in Section 40 05 02.00 through 40 05 02.99), submit document listing pipe, fittings, linings, coatings, valves, flexible connectors, expansion joints, couplings, bolts, gaskets, restraints, and other items provided for each applicable pipe size and category.

5. Welding: Prior to commencing any welding of steel or stainless steel pipe, supports, and/or structural attachments, provide a written description of welding techniques, including, but not limited to, materials, methods, and quality control. Identify differences in shop and field techniques. Indicate in the submittal that the welding technique has been reviewed for each piping service and certify that the technique is acceptable for the intended service condition (piping service defined in Section 40 05 02 and area exposure designation specified in Section 01 61 45). Written procedures to be stamped and sealed by a Professional Engineer registered in the State of Connecticut and qualified for welding design.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Pre-Construction Data:
      a. Design drawings and calculations for pipe supports, anchorage, seismic restraints, and expansion control systems as specified in Sections 40 05 07, 40 05 06, 40 05 07.13, and 40 05 07.16. Drawings and calculations sealed and submitted by the Design Professional specified in this Section. The Design Professional shall affirm that loads on structures are within any stipulated load limits that may be noted on the contract documents.
      b. Submit piping layout drawings for all piping systems, including raceway, duct and other specified systems support. Indicate assembly details, location and placement of field welds, unions and flanges, fittings, valves, flushing connections, drains, sample taps, cathodic protection, seismic restraint system, expansion joints, guides, anchors, hangers, supports, and the provisions for thrust restraint, as well as any other pertinent details and appurtenances for all piping, including wall and floor penetrations, where applicable, in that area. Indicate location and clearances from structures and other utilities (ductwork, conduit, electrical tray, etc.). Include details of connections to new and existing equipment, piping and structures. Submit original layouts by the Contractor; photocopies of Contract Drawings are not acceptable. Identify the invert elevation of buried pipe at changes in slope, pipe crossings, and connections to structures on piping layout drawings in addition to providing coordinates for locating changes in horizontal alignment of buried pipe.
      c. Product Samples: Where specified or when directed by the Engineer, provide mill test results of product samples.
      d. Prior to the commencement of welding, submit current and complete documentation of the welder's qualifications.
      e. Safety plans for pneumatic pressure testing.
   3. Post-Construction Data: Inspection reports, authored, sealed, and signed by the Design Professional retained under the provisions of this Section submitted to the Engineer. The Design Professional's final report shall be submitted to the Engineer before beneficial occupancy by the Owner.

## 1.07 QUALITY ASSURANCE

1. Review the drawings prior to installation of piping, conduit services, and fixtures. Identify any conflicts and cooperate with the Engineer to determine the adjustments necessary to resolve conflicts.
2. Confirm the routing of each section of pipeline with other services prior to commencement of installation. Advise the Engineer of any conflicts with existing services or services yet to be installed. Where necessary, amend the routing of pipework to avoid conflict and confirm with the Engineer.
3. Refer to paragraph 1.09 Piping System Design for additional quality assurance requirements.

## 1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Requirements:
1. Deliver pipe, fittings, and specials to site using loading methods which do not damage pipe or linings, or coatings.
2. Piping materials delivered to site will be clearly marked to indicate size, type, class/schedule and coatings.
3. Until ready for incorporation in the work, store on site as recommended by the piping materials manufacturer to prevent damage, undue stresses, or weathering.
4. Store materials at least 8 inches above ground. Provide sufficient supports to prevent undue bending.
5. Protect non-UV light inhibited plastic from sunlight.
6. Maintain refrigerant piping factory seals until ready for incorporation into the Work.
7. Cover openings in piping, and temporarily seal to protect from contamination.
8. Protect materials and equipment from damage due to environmental conditions. Use protective cover, and protect from surface water by elevating above floor or surrounding grade.
9. Protect unfinished work at end of each workday from damage, contamination and moisture by use of plugs, caps or covers.
10. Protect piping and valves from damage pending performance of system tests.
11. Use proper implements, tools, and facilities for the proper protection of the pipe. Exercise care in the installation so as to avoid damage to pipe, linings, and coatings.
12. Inspect each pipe and fitting prior to installation. Do not install damaged pipe or pipe with damaged protective coatings or linings.
13. Prevent entry of foreign matter during handling, assembling, and installation. Use compressed air, wire brush, solvent and other acceptable means to remove all foreign matter from inside of pipe prior to installation. Remove residual scale, dirt and other foreign matter from interior of piping before final connections are made.

## 1.09 PIPING SYSTEM DESIGN

A. Design Professional:
   1. Provide professional engineering services ("Design Professional") for the design and inspection of piping systems work. The Design Professional must have not less than ten years' experience in the type of piping support, seismic restraint, and expansion control design work required for this project.
   2. The Design Profession shall be a professional engineer currently licensed to practice in the State of Connecticut.
   3. The Design Professional must obtain and maintain professional liability insurance in the amount of $1,000,000 aggregate, to be in effect for the duration of this project plus one year.
   4. The requirements for the Design Professional shall not be construed as relieving the Contractor of overall responsibility for this portion of the work.

B. Piping System Design and Inspection:
   1. The Design Professional shall provide the design, inspection, and certification for piping supports (hangers, guides, anchors, structural attachments, etc.), expansion control and seismic restraints as specified in this Section and referenced Sections.
   2. The work of the Design Professional is complementary to the design elements specified in the Contract Documents and intended to provide complete piping system designs. The Design Professional's inspection responsibilities also complement inspections by the Engineer. The division of responsibility for work is shown in the following table:



| Piping System Element (Specification) | Design Professional's Responsibility | Engineer's Responsibility |
|---|---|---|
| Pipe material and thickness, test pressures and other properties (Section 40 05 02.00 through 40 05 02.99) | (NA) | All piping |
| Contractor layout drawings (Section 40 05 01) | All piping | (NA) |
| Support design (Section 40 05 07 and Section 01 73 23, and related sections) | All piping, except as indicated for Engineer's Responsibility | Pipe supports specified on the drawings |
| Seismic bracing (Sections 40 05 07.13 and Section 01 73 23, and related sections) | All piping, except as indicated for Engineer's Responsibility | Seismic bracing specified on the drawings |
| Expansion and Control Design (Section 40 05 07.16 and related sections) | All piping, except as indicated for Engineer's Responsibility | Expansion Control provisions specified on the drawings |
| Inspection – General. For design and specification conformance (Section 40 05 01 and related sections) | All piping | (NA) |

   3. Acceptable types of supports, guides, saddles, expansion joints, flexible couplings, hangers and structure attachments for general piping support are specified in Section 40 05 07. Seismic restraints are specified in Section 40 05 07.13. Pipe expansion control systems are specified in Section 40 05 07.16. Incorporate these specific elements into the design prepared by the Design Professional.
   4. Pipe support and seismic restraint placement is subordinate to the function of anchorage, flexibility, and expansion control provisions. Do not interfere with the

function of anchorage, flexibility, and expansion control provisions specified on the drawings.

5. Where pipe anchors are specified, they have been designed for longitudinal (axial) seismic loading, in addition to other longitudinal forces associated with expansion control, and pipe thrust for the associated piping. Rely on the specified anchors for longitudinal seismic bracing of the pipe in these instances.
6. There may be situations where the Engineer wants to control where certain anchors are located, the level of forces that can be transmitted to structures, the direction that expansion growth is allowed, or requires use of particular piping elements. In such cases these elements will be specified on the drawings and incorporated into the Design Professional's design. Mandatory anchorage locations identified on the drawings and maximum limitations, if any, for structure loads from the anchor will be as indicated on the drawings, identifying location and the maximum force that can be imposed on the structure. Where structural load would be exceeded, provide piping flexibility or expansion joints to reduce the maximum loading imposed on the structure.
7. For general understanding of intent and bidding purposes, general support locations, arrangements, types and means of attachment may be shown on the drawings. Some of the elements may be specifically designed and detailed. If a particular type of support, anchor, seismic restraint or expansion element is detailed on the drawings, then incorporate those elements into the Contractor's design. Include all elements of the piping system in Piping submittals by the Contractor, including those portions directed by the Engineer and complete piping runs.
8. Calculate the structural reaction loads for all fixed supports and indicate the calculated reaction loads on the submitted layout drawings. Notify the Engineer if any elements specified on the Drawings are incompatible with the overall piping system and its function.
9. Include consideration of and provisions for:
    a. Support and restrain pipe independent of support or restraint provided by equipment or without equipment supported loads exceeding equipment manufacturer's nozzle loading recommendations. Obtain maximum nozzle loads from the equipment manufacturer.
    b. Routing of pipe to provide access aisles free of obstruction and worker hazards. Unless otherwise specified or approved by the Engineer, the minimum clear space between equipment is 36 inches horizontally. Minimum vertical clearance is 7 ft above the floor or local grade at pedestrian access aisles and egress paths. Minimum clearance for equipment access aisles in galleries, tunnels and utilidors is 10 ft by 10 ft.
    c. Electrical bonding for all gas, fuel, and pneumatic conveyance systems.
    d. Dielectric separation, as specified.
10. Include all elements of piping systems required for fabrication and construction in the piping layout submittals. Depict couplings, support, restraint, anchorage, expansion control measures and other elements of the piping system.
11. Depict fitting angles and vertical and horizontal pipe locations, as determined by the Contractor, on piping layout drawings.
12. Do not interfere with maintenance functions and access around equipment, including monorails and hoists.

## PART 2 PRODUCTS

### 2.01 PIPE MATERIALS - GENERAL

A. All pipe materials to be new, free from defects and conforming to the requirements and standards identified in the Piping System Schedules (Section 40 05 02.00 through 40 05 02.99) and related sections.

B. New and existing piping is designated by process service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Investigate connections to existing piping and provide suitable connections, including electrical isolation, as necessary.

C. Fittings and Coupling Compatibility: To assure uniformity and compatibility of piping components, furnish fittings and couplings for grooved-end or shouldered-end piping systems from the same manufacturer.

D. Buried Piping: Size temporary and/or permanent thrust restraints. Design restraint systems to allow complete piping system disassembly without destruction of any portion of the piping system.

### 2.02 MATERIAL FOR PIPING SUPPORT, SEISMIC RESTRAINTS AND PIPE ANCHORS

A. This paragraph specifies materials for pipe supports specified in Section 40 05 07, seismic restraints specified in Section 40 05 07.13, pipe anchors, certain expansion control elements specified in Section 40 05 07.16, and all associated appurtenances. Section 01 61 45 defines environmental exposures by physical location. Pipe Support, Seismic Bracing, and Pipe Anchor materials are specified based on the environmental exposure specified in Section 01 61 45. Provide Pipe Support, Seismic Bracing and Pipe Anchor components fabricated from materials as specified in the following table:

| Environmental Exposure or Pipe Material | Materials [1] | Nuts, bolts, washers, and fasteners |
|---|---|---|
| Outdoor | Steel, hot dip galvanized after fabrication | Type 304/316 stainless steel |
| Indoor, Dry | Steel, hot dip galvanized after fabrication | Steel, Zinc plated or hot-dip galvanized after fabrication |
| Indoor, Wet | Type 316 stainless steel or FRP | Type 316 stainless steel |
| Chemical Corrosive | Fiberglass (FRP) | Type 316 stainless steel |
| Head Space | Type 316 stainless steel or FRP | Type 316 stainless steel |
| Submerged | Type 316 stainless steel or FRP | Type 316 stainless steel |
| Undefined | Type 316 stainless steel or FRP | Type 316 stainless steel |
| Stainless steel piping | Same type of stainless steel as the pipe or FRP | (per area as defined in this table) |

*Notes:*

1. *Where materials as designated in drawing details or indicated in other specification sections, those requirements govern over the provisions of this table.*

## 2.03 PIPE AND VALVE COMPATIBILITY

A. Coordinate the selection of pipe materials, linings, and end connections so that valves operate properly over their entire range (e.g., sufficient disk clearance for butterfly valves). Support wafer style valves or spectacle flanges between flanges of equal inside diameter.

## 2.04 BONDING JUMPERS

A. Provide plated, flexible copper braid jumpers with unplated copper ferrules for attachment to pipe flanges, rated for a 100 amp minimum. Provide Burndy Electrical, Type B series, or Approved Equal, and sufficient conductive, anti-oxidant compound (Burndy Electrical Penetrox series or Approved Equal) to protect ferrules.

## 2.05 JOINTS – GENERAL

A. Provide joints for disassembly within 3.0 ft of any connection to equipment, on both sides of structural penetrations, and within 2.0 ft of all threaded end valves.

B. Unless otherwise specified on the drawings or in equipment specifications, adapt all equipment connections to a flanged connection compatible with the connected piping system.

C. Flexible Joints at Structural Joint Crossings: Provide a flexible joint (or joints) on all piping crossing structural joints.



## 2.06 FLANGES AND OTHER COUPLINGS

A. Pipe connections are specified in the Piping System Schedules in Sections 40 05 02.00 through 40 05 02.99

B. General requirements for flanges are as follows:
   1. Where raised-face and flat flanges are provided for connection, reface the raised-face flanges. Flange face to be flush with flat-faced companion flanges on flat-faced valve or equipment flanges.
   2. Provide flat-faced flanges on each side of butterfly valves.
   3. For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.

C. Slip-on flanges that are attached to a pipe by means of set screws and gaskets (uni-flange, etc.) are not acceptable.

## 2.07 FITTINGS – GENERAL

A. Fittings are specified in the Piping System Schedules.

B. Provide eccentric reducers in horizontal lines with the flat side on top, unless specified otherwise on the drawings (e.g., flow meters in horizontal runs requiring submergence).

C. Provide concentric reducers in vertical lines, unless otherwise specified on the drawings.

D. Provide reducers upstream and downstream of flow measurement devices to adapt line size to the specified flow measurement device dimension. Coordinate with the specific instrument requirements.

E. Provide long radius (greater than or equal to 1.5 x nominal diameter) elbows unless otherwise specified on the drawings.

## 2.08 GASKET MATERIALS

A. For flat faced flanges, use full-face gaskets. For raised-face flanges, use ring type gaskets. Conform to ANSI B16.21.

B. Refer to the Piping System Schedule for the specified gasket material. Material designations used in the detailed pipe specification sheets are as follows:
   1. EPDM: ethylene-propylene-diene-terpolymer 70 durometer
   2. Neoprene: neoprene (black) 70 durometer
   3. Nitrile: nitrile (Buna N)
   4. SBR: Styrene-butadiene (red)
   5. Natural rubber: natural rubber
   6. Compressed synthetic fibers (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37)
   7. Compressed synthetic fibers (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F152), 0.1 mL/h Leakage Fuel A (ASTM F37)
   8. Gylon - Type 1: Garlock Style 3500: 1.35 MPa (ASTM F152), 0.22 mL/h Leakage Fuel A (ASTM F37)
   9. Gylon - Type 2: Garlock Style 3510: 1.35 MPa (ASTM F152), 0.04 mL/h Leakage Fuel A (ASTM F37)
   10. CPE - Chlorinated Polyethylene
   11. Spiral-wound: per ASME B16.20, rated to 1200 degree Fahrenheit Flexitallic SS316L or approved equal
   12. PTFE bonded EPDM, full-face gaskets
   13. Viton/FKM – Fluoroelastomer, 75 Durometer



## 2.09 DISSIMILAR METAL CONNECTIONS

A. Where dissimilar metals are to be connected, provide dielectric fittings and/or isolating flanges, including bolt sleeves and washers, according to Section 40 05 06.

## 2.10 CATHODIC PROTECTION

A. Provide cathodic protection of piping, pipe fittings, and appurtenances where specified on the drawings.

## 2.11 STRUCTURAL ELEMENT PENETRATIONS

A. Penetrations through structural elements are referenced to a custom detail or Standard Detail. Where a penetration detail is not specified, conform to the Standard Detail relevant to the type of structure, exposure, and type of pipe.

B. Provide pipe sleeves capable of supporting the loads applied during placement of concrete or during block work erection.

## 2.12 PIPE MARKERS, DETECABLE WARNING TAPE, AND TRACER WIRE

A. Pipe marker, detectable warning tape, and tracer wire materials per Section 40 05 45.

# PART 3 EXECUTION

## 3.01 PREPARATION

A. Prior to installation, inspect, and field measure to ensure that previous work is not prejudicial to the proper installation of piping.

B. Pothole existing pipe at connections to new pipe to confirm material and joints prior to submittal of pipe layout drawings.

C. The Drawings are, in part, diagrammatic, make all minor modifications to suit installed equipment and structural element locations and elevations and coordinate with electrical construction.

D. Provide details of connections to new and existing equipment, piping, and structures in piping layout drawing submittals. Unless otherwise specified on Drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

E. Piping arrangements indicated on the drawings have been estimated from the approximate configuration of the type of equipment listed in the equipment specifications. If the equipment to be provided does not have the same configuration, modify the piping arrangement as necessary. Include any piping modifications in shop drawings submitted prior to fabrication or installation.



## 3.02 PIPE SUPPORT, ANCHORAGE, AND SEISMIC BRACING

A. Support piping with anchor brackets, guides, saddles, or hangers. Pipe movement due to thermal expansion and internal pressure and dynamic forces shall be accommodated by pipe springing, anchors, expansion joints, and guides selected for the specific purpose by the Design Professional retained under the provisions of this Section. Provide supports on each run at each change of direction.

B. Provide seismic bracing as required to resist seismic loads.

C. Do not use existing pipes and supports to support new piping. Existing tunnel pipe support racks can be used for new pipe if the Design Professional determines that the existing rack components are adequate to support the additional load.

D. Install expansion loops, anchors, expansion joints, and guides where specified on the drawings.

## 3.03 PIPING CONNECTIONS TO MACHINES

A. Align piping at machine connections in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come-a-longs or other mechanical means to align field piping with the connections at the machines.

B. Do not force bolts into mating flange bolt holes. Align flange bolt holes to permit insertion of bolts by hand (without tools, hammering, or prying).

C. Use of 'dutchmen' mitered sections or similar specials to achieve the required alignment with machine connections are strictly prohibited.

D. Provide equipment connection fittings per Section 40 05 06 as specified on the drawings.

## 3.04 JOINT AND COUPLING OPTIONS

A. Provide pipe connection (joint and coupling) options as specified in the Piping System Schedule.

B. If a Piping System Schedule lists several connection options, then any of the listed options may be used for a particular pipe material, but the selected option shall be used consistently. For example, if flanged or grooved connections are specified and grooved are represented on the Drawings, then flanged may be installed in lieu of the grooved couplings specified on the drawings.

C. Connecting straight runs of pipe by welding is acceptable only where the individual Piping System Schedule allows welding as a connection option.

D. Where connections other than those indicated on the Piping System Schedule are specified on the Drawings, locate the connection specified on the drawing at the specific location indicated on the drawing.

E. Provide rigid, non-rotating connections at all valves and equipment.



## 3.05 SMALL BORE UTILITY PIPING

A. Field route small bore (generally less than 3-inch) diameter branch piping for utility services.

B. In general, small bore utility branch piping is not specified on the Drawings unless a specific pipe routing or configuration is to be provided or where necessary to show valves or instrumentation requiring electrical connections.

C. Distribution lines for small bore utility piping are specified on the Drawings along with service connection routes to locations that require utility service piping.

D. Install small bore utility piping that must be drained to provide freeze protection with a continuous slope down to the drain.

## 3.06 BONDING

A. Bonding jumpers shall be as specified in this Section.

B. Bonding shall be provided for all gas, fuel, and pneumatic conveyance systems to control static electricity.

C. Construct electrically continuous piping for the process services listed above and connect directly or indirectly to earth ground.

D. Provide bonding jumpers where sections of pipe are interrupted with non-conducting sections, fully lined valves that are not through-bolted or other interruption in continuity.

E. Remove any coatings, dirt, grease or other contaminants from flanges where jumpers are to be installed. Apply sufficient conductive, anti-oxidant compound to protect the entire ferrule from galvanic action and hydrogen sulfide attack.

## 3.07 SEWER AND DRAIN PIPING

A. Run horizontal drainage piping as straight as practicable and at uniform pitch.

B. Install pipe 3-inch or less in diameter with slope of not less than two percent, unless otherwise specified on the Drawings.

C. Install pipe larger than 3-inch diameter with slope of not less than one percent, unless otherwise specified on the Drawings or required by the Plumbing Code.

## 3.08 SLEEVES

A. Unless otherwise noted in the specified pipe penetration details or otherwise approved by the Engineer, provide sleeves where piping passes through a wall, floor, or ceiling.

B. Locate and place sleeves prior to construction of cast-in-place elements and prior to the construction of concrete and masonry building elements.

## 3.09 PIPE JOINTS AND CONNECTIONS

A. Field cuts for glass-lined pipe are not permitted.

B. Cut pipe with appropriate tool and deburr.

C. Make joints tight. Test and remake leaking joints with new materials. Do not use thread cement or caulking to remake joints.

D. Do not use sharp toothed wrench in making up brass pipe, or chrome plated items.

E. Provide thread forms and length in accordance with ASME standards. Use lubricant or sealant on male threads suitable for proposed pipe service.

F. Clean joints before soldering. Use flux and alloy appropriate for specified operating temperature and pressure.

G. Welding procedures, welder certification/qualification, and weld testing per ASME Section IX, Boiler and Pressure Vessel Code. Make welds per the specified standard when ASME B31.1 or ASME B31.3 are specified for a Piping System in the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99).

H. Coat gasket with gasket manufacturer's recommended lubricant between flange faces.

## 3.10 TAKEDOWN COUPLINGS

A. Takedown Couplings: Provide takedown couplings at the locations specified on the Drawings in accordance with this Section.

B. Provide takedown couplings at changes in piping direction and where specified in the Drawings on straight runs of pipe.

C. Provide screw unions, flanged or grooved end coupling type joints as takedown couplings.

D. Use flanged or grooved end joints on pipelines 1.5-inch diameter and larger.

E. Where piping passes through walls provide takedown couplings within 40 inches of the wall.

F. Provide a union or flanged connection within 24 inches of each threaded end valve.

## 3.11 INSTALLATION OF BURIED PIPE AND PIPE BELOW STRUCTURES

A. Trenching and backfill for buried pipe: conform to Section 31 23 00.

B. Pipe laying and bedding: conform to Section 31 23 00.

C. Restrain all plugs, caps, tees and bends in buried pressure piping systems by means of restrained joints as specified in the respective Piping System Schedule.

D. In accordance with Section 40 05 06, and where specified on the Drawings, provide flexibility per specified details where buried pipe passes under, through, or is connected to structures. Provide restrained joint connections or provide restraints across each un-restrained joints.

E. Install pipe in straight alignment. Do not exceed 3/8-inch variance over 30 ft from the true alignment in any direction.

F. Slope gravity lines uniformly from point of origin to discharge.

G. Ensure the pipe alignment stays true during and after placement of concrete encasement.

H. Ensure that the method used to prevent pipe uplift during placement of concrete encasement results in an invert and crown true to intended grade.

I. Maintain circular cross section of pipe.

J. Provide lean concrete below the underside of the slab or footing for backfill over pipe laid below structures when pipe is less than 6 inches below the underside of the slab or footing, unless specified otherwise. Place concrete in accordance with Section 03 30 00.

K. Provide Heat-Shrinkable Cross-Linked Polyolefin Coating or Tape Wrap coating on all flanged, grooved, and welded joints that are buried or below structures.

L. Provide Petrolatum Tape wrap on all valves and mechanical pipe couplings that are buried or below structures. Install per manufacturer's recommendations. Candidate Manufacturers:
   1. Denso Densyl Tape
   2. #1 Wax Tape
   3. Approved Equal

M. Use anti-seize compound with all stainless steel nuts and bolts.

N. Provide detectable warning tape for all buried pipe. Provide tracer (locate) wire as specified in Section 40 05 45.

## 3.12 EXPOSED INSTALLATION

A. Fabricate and install domestic hot and cold water piping, sanitary piping and storm drainage piping in accordance with the Plumbing Code.

B. Provide pipe system layout in accordance with the following criteria:
   1. Drawings show general layout of piping. Exact dimensions determined by Contractor.
   2. Maintain minimum clear areas through tunnels and principal access aisles as specified in this Section.
   3. Expanding or swaging of tubing to fit IPS (Iron Pipe Size) fitting sockets is not permitted.
   4. Use reducing fittings where change in pipe size occurs.
   5. Use couplings only where pipe runs are longer than standard supplied pipe lengths.
   6. Make exposed polished or enameled connections to fixtures or equipment with special care to avoid damage to finished surfaces.
   7. Make changes in direction only with fittings.
   8. Install piping with not less than minimum slope to ensure adequate drainage and venting.
   9. Maintain clear areas around equipment to allow adequate access for maintenance as specified in this Section.
   10. Ensure valve operators are accessible from floor level. Provide chain wheel operators for valves with centerline elevations of 7 feet or above.
   11. Ensure piping ancillaries and in-pipe instrumentation is installed in accessible locations which do not create problems for traffic in the clear areas.

C. Make adequate provision in piping and pipe support systems for expansion, contraction, slope, and anchorage.

D. Install pipe support system to adequately secure the pipe and to prevent undue vibration, sag or stress.

E. Install expansion joints where specified on the Drawings or where required by the Design Professional, to allow for piping expansion and contraction.

F. Install expansion loops or bends where specified, or required by the Design Professional, to allow for proper pipe expansion. Construct expansion loops with long radius welded bends.

G. Provide temporary supports as necessary during construction to prevent overstressing of equipment, valves or pipe.

H. Accurately cut all piping for fabrication to field measurements.

I. Install pipes in straight alignment and parallel to wall. Do not exceed 3/8-in variance over 30 ft from the true alignment, in any direction.

J. Fabricate and assemble pipe runs so that the pipework is not stressed to achieve the desired alignment and that no stresses are transferred to equipment or equipment flanges. Unless stipulated by the Design Professional to address significant thermal strain, and accepted by the Engineer, the "springing" of pipe and fittings to ensure alignment is not permitted. Undo and subsequently remake all pipework connections where so instructed by the Engineer to ensure that unintended springing does not occur. Take care not to damage equipment, valves, or flanges.

K. Slope instrument air piping to condensate traps.

L. Do not cut or weaken the building structure to facilitate installation of piping.

M. In parallel pipe runs, offset flanges and/or grooved joint fittings by a minimum of 8 inches longitudinally to allow for proper access.

N. In vertical pipe runs of pipe diameter greater than 10 inches, provide 8-inch long spool piece on lower side of each valve.

O. Do not install water piping over electric switchboards, transformers, cable tray or electric motor starters.

P. Provide pipe markers for all exposed pipe.

## 3.13 THREADED JOINTS

A. Conform to the requirement of ANSI B31.1.

B. Ream the end of all pipes to remove all burrs and cuttings when fabricating threaded joints.

C. Clean out pipe and repair linings and coatings prior to joining.

D. Apply Teflon tape to male threads and join pipe. Use both Teflon tape and Teflon sealing compound on stainless steel pipe threads. Do not apply extra tape to make up for slack in the joint.

## 3.14 FLANGED JOINTS

A. Maintain consistent flange bolt hole positions along the entire length or run of the pipe.

B. For pipe installed with a horizontal axis, position flange bolt holes so that the vertical centerline of the flange face bisects the arc between flange bolt holes ("Two-Holed").

C. For pipe installed with a vertical axis, position flange bolt holes so that the horizontal centerline of the flange face bisects the arc between flange bolt holes and is perpendicular to the closest structural wall ("Two-Holed").

D. Clean flanges and gaskets prior to connection.

E. Lubricate gaskets with gasket manufacturer's recommended lubricant and apply anti-seize compound to all bolts.

F. Bring flanges into close parallel and lateral alignment.

G. Tighten bolts progressively. Proceed from side to side of the flange.

H. Use proper length bolts for each size flange on flanged connections. Washers may not be used to take up excess bolt length. Provide approximately two full threads bolt projection beyond nuts. Bolts with excessive length of exposed threads will not be permitted. All-thread rod is not acceptable for bolting flanges.

I. When joining steel to cast iron flanges, take care to avoid damage to the cast iron flange. Ensure both flanges are flat-faced and use full face gaskets.

J. Align flanges which connect piping to mechanical equipment to close parallel and lateral alignment prior to tightening bolts. Do not place strain on the equipment.

K. Allow a minimum of 6 inches' clearance to face or 8 inches to edge of flange to wall, floor, or ceiling unless otherwise specified.



## 3.15 INSULATION

A. Insulate piping systems in accordance with the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99) and Section 40 42 00.

## 3.16 FLEXIBLE HOSE CONNECTORS

A. Accurately align pipelines to receive flexible connectors before installing the connectors. Do not stretch, compress, misalign or offset the connectors.

B. Align and install each flexible connector in accordance with the manufacturer's instructions.

C. Support, anchor and guide the piping so that the flexible hose connectors are not required to absorb any axial compression or elongation.

D. Do not torque or twist the flexible connectors.

E. Check bolt tightness and tighten where necessary, a maximum of one week after commissioning and periodically thereafter.

## 3.17 EXPANSION JOINTS

A. Accurately align pipelines to receive expansion joints before installing the joint. Do not stretch, compress or offset the joint to fit the piping. Install expansion joints in accordance with manufacturer's instructions prior to releasing preload.

B. Align and install each expansion joint in accordance with EJMA standards and with the manufacturer's written instruction; properly guide and anchor all expansion joints. No lateral movement is permitted on compensator type expansion joints.

C. On rubber expansion joints, check bolt tightness, and tighten where necessary one week after Commissioning is completed.

## 3.18 REPAIR/RESTORATION

A. Repair pipe with damaged shop-applied protective linings in accordance in accordance with specified standard (e.g. AWWA C210) or accordance with the lining manufacturer's directions, if no standard is cited.

B. Damaged glass lining cannot be repaired. Replace piping with damaged glass lining.

C. Patching inserts, overlays, or pounding out of dents is not be permitted.

D. Repair pipe with damaged protective coatings and holdback areas for welding and other field fabrication, as follows:

1. For shop-applied coatings, not subject to Section 09 90 00 requirements, in accordance with specified standard (e.g. AWWA C210) or in accordance with the coating manufacturer's directions, if no standard is cited.
2. For coatings applied pursuant to Section 09 90 00 requirements, apply repair coatings in conformance with the applicable Section 09 90 00 coating system, including thickness and stipulated preparation of the lowest full thickness coating layer (i.e. exposed metal would require full profile preparation and specified multi-layer coating restoration).
3. Prepare areas to be repaired not less than 2-inches beyond damaged areas and feather repair coating into adjacent areas.
4. Repair to provide equivalent protection to undamaged coatings and a uniform appearance when judged from 4 feet away.

E. Other requirements may be stipulated in related piping sections.

## 3.19 FIELD QUALITY CONTROL

A. Inspections:
   1. Inspect and provide reports as specified in Section 40 05 07, Section 40 05 07.13, and Section 40 05 07.16.
   2. Submit the Design Professional's final report before beneficial occupancy by the Owner.

## 3.20 TESTING

A. Provide 24 hours notice prior to testing.

B. Do not insulate or conceal work until piping systems are tested and have met all required criteria.

C. Complete any required weld tests.

D. Supply all water, air, and inert gases required for pressure testing.

E. Supply all pumps, compressors, gauges, etc. required for testing.

F. Install air threadolets, air relief valves, and line fitting valves as necessary to complete testing. Remove after testing and plug threadolets.

G. Cap or plug all lines which are normally open ended. Remove on completion of testing.

H. Provide all temporary thrust restraints necessary for testing. Remove upon completion of testing.

I. Test all underground lines prior to backfilling. Do not place concrete encasement until lines are tested and have met all required criteria.

J. Test all existing piping where it connects to new piping to the first valve in the existing piping. Repair any failures in existing piping which occur as a result of the test after informing the Engineer of such failure.

K. Isolate all pumps and low pressure equipment and appurtenances during testing so as not to place any excess pressure or thrust forces on the equipment.

L. Where defective material or equipment is identified, repair or replace using new material.

M. Flush and drain liquid pipes after pressure tests. Purge all gas pipes after pressure tests using inert gas.

N. Dispose of flushing water in manner approved by the Engineer, which causes no damage to buildings or siteworks.

## 3.21 HYDROSTATIC PRESSURE TESTING OF LIQUID LINES

A. Hydrostatically test all lines normally used for the conveyance of liquids using water as the test medium, unless otherwise specified in this Section.

B. Test pressures and durations as specified in the Piping System Schedules.

C. Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.

D. Lined pipelines: Allow filled pipeline or section thereof to stand under a slight pressure for at least 8 hours (24 hours for cement mortar lining) to allow the lining to absorb water and to allow the escape of air from air pockets.

E. Zero leakage is permitted throughout the specified test period for all exposed piping, buried insulated piping, and any liquid chemical lines.

F. Show evidence of leakage rates below 0.02 gal per hour per inch pipe diameter per 100 ft of pipe length for buried piping, unless otherwise specified.

G. Test drains in accordance with the Plumbing Code.

H. For hydraulic and lube oil systems, test using the medium of service. Provide zero loss of pressure throughout the specified test period.

## 3.22 PNEUMATIC PRESSURE TESTING

A. Use nitrogen gas or oil free dry air to test piping systems where nitrogen or air is the specified testing medium in the Piping System Schedule.

B. Submit a testing plan and a safety plan for each piping system that will be pressure tested with nitrogen gas or oil free dry air. Do not perform pressure testing with air or nitrogen until a favorable review of the safety plan and testing plan for the piping system has been returned from the Engineer. Comply with all workplace safety and pressure vessel safety codes and guidelines.

C. Provide a separate pressure relief valve for pneumatic pressure testing.

D. Locate pressure relief valve within visual range of the test gauge and with exhaust to a safe location.

E. Set relief valve at not more than full test pressure plus 10 percent.

F. Continuously monitor and control testing to assure personnel safety and piping integrity.

G. Remove all personnel from areas where piping will be subjected to pressure tests and prevent entry into testing areas until test pressure has been relieved.

H. Protect installed work from potential damage from pressure testing failures. The Contractor is responsible for any damage or injury resulting from failed pressure testing with air or nitrogen.

I. When using nitrogen or air to test steel or stainless steel pipelines, gradually introduce the test gas up to a pressure of 45 psig or 1/3 of specified test pressure, whichever is less.

J. While maintaining this pressure, test lines for leaks using soapy water.

K. When the line is free from leaks at this pressure, increase by increments of 50 psig or 1/3 of specified test pressure (whichever is less) to the specified test pressure.

L. After each increment, retest using soapy water; take corrective action as necessary.

M. When the system is free from leaks at the test pressure, depressurize the system slowly.

N. To prevent the entrance of water or moisture into the medium source, disconnect the test source from the system and cap.

O. Where specified, maintain nitrogen pad after testing until the line is put into service. Label any piping for which a pad is provided and maintained.

P. Provide high purity nitrogen gas used for testing, in cylinders fitted with pressure regulators for 0 to 300 psig and all necessary fittings and adaptors necessary to complete the connection between the source and the system header. Provide self-relieving type pressure regulator that vents to the atmosphere and include a throttling valve.

Q. Provide oil free air with a relative humidity of zero for testing. Provide all fittings, adaptors, accessories, and the pressure regulator and throttling valve that are suitable for pressure testing with air and rated for 300 psig service.



## 3.23 PRESSURE TESTING OF GAS, AIR, AND VAPOR LINES

A. Hydrostatically or pneumatically pressure test, as specified in the Piping System Schedules, all lines normally used for the conveyance of gas, air, and/or vapor in accordance with ASME procedures for testing pressure piping and CAN/CGA B149.6 for buried digester gas piping. Pneumatically test all instrument air lines in accordance with ISA-S7.0.01 and digester gas piping in accordance with CAN/CGA B149.6.

B. For gas and air lines to be hydrostatically tested, check support system to ensure it is capable of withstanding loads imparted by test method. Provide any additional supports necessary in a manner acceptable to the Engineer. At the Engineer's request, provide calculations indicating design of temporary support system.

C. Test pressures are identified in the Piping System Schedule.

D. Zero leakage rate is required at the specified test pressure through the test period. Prior to commencing test using air, ensure air will be at ambient temperature and specified test pressure.

E. Do not exceed the maximum specified leakage rate during the test period for all other systems tested with air.

F. Remake all joints which display leakage and retest.

## 3.24 TESTING OF HAZARDOUS GAS AND LIQUID LINES

A. All process pipes shall be tested as Hazardous Gas or Liquid lines, unless the Engineer chooses to waive this requirement.

B. Remove components which may be damaged by test pressures and plug openings. Provide tee in any existing lines to be tested adjacent to the terminal valve.

C. Pressure test after cleaning.

D. Zero leakage at specified test conditions is required. Repair and retest lines until successful test is achieved. Test all digester gas lines in accordance with CAN/CGA B149.6.

E. Plug and/or disconnect all vents to the atmosphere, close all valves to the atmosphere, and open all in-line valves. Return the system to its appropriate operating condition after testing, including resetting of vents and valves.

F. Hydrostatically test PVC and CPVC pipelines using water as the test medium, as specified in the Piping System Schedules. Where support systems are not designed for hydrostatic testing or drying of steel pipelines is impractical, with the Engineer's approval, the Contractor may use nitrogen gas or dry air as the test medium, providing the specified safety plan is submitted and necessary safety precautions are implemented to minimize the risk incurred when performing such a test.

G. Replace all moisture absorbing gaskets and valve packing after hydrostatic testing.

H. After testing, dry all lines.
   1. Steel or stainless steel Lines: Pass steam through the lines from the high end until all lines are thoroughly heated. Allow condensate and foreign material to drain during steaming. Disconnect and drain lines from all low points. While lines are warm, blow dry, oil-free air with a dew point below -40 degrees F through the system until the existing dew point is the same as the supply air. Fix valves in the half open position during drying. Ensure that valves temporarily removed from the system during drying operations are completely free of moisture prior to reinstallation.
   2. PVC Lines: Drying applies solely to vacuum lines. Drain and remove all free water and moisture from the system. Swab the pipe to remove any excess water. Air dry the pipe in the same manner as steel lines, additionally ensuring that the entering air temperature is not greater than 120 degrees F.

I. Fill the line with inert gas if service gas is reactive with air.

J. Introduce service gas immediately after testing and drying and inert gas filling. Test the system for leaks. Allow time for the complete replacement of air or inert gas from the piping with the service gas.

K. Use an appropriate sensing device when testing for leaks.

L. If leaks are detected when the system is tested with service gas, do not implement repairs until all gas has been purged from the system. Repeat the hydrostatic testing and drying sequence prior to retesting the line with service gas.

## 3.25 CLEANING AND FLUSHING

A. After installation and prior to testing, perform initial cleaning of process and utility lines. Clean piping greater than 6 inches and less than 24 inches by passing a tightly fitting cleaning ball or swab through the pipeline, unless specified otherwise. Lines greater

than 24 inches may be cleaned manually or with a cleaning ball or swab. Give lines smaller or equal to 6 inches an initial flush or purge.

B. After initial cleaning, connect the piping systems to related process and mechanical equipment. Insert temporary screens, provided with visible locator tabs, in the suction of pumps and compressors in accordance with the following table:

| Suction size, in. | Maximum screen opening, in. |
|---|---|
| 0 – 1 | 1/16 |
| 1-1/4 – 3 | 1/4 |
| 3-1/2 – 6 | 1/2 |
| Over 6 | 1 |

C. Maintain the screens during testing, flushing/purging, initial startup, and the initial operating phases of the commissioning process. In special cases and with the Engineer's acceptance, screens may be removed for performance tests. Install screens for clear water testing and initial operation on liquid systems handling solids. Initial operation on solids systems following clear water testing may be without screens.

D. Unless specified otherwise, flush liquid systems after testing, with clean water and screens in place. Maintain flushing for a minimum period of 15 minutes and until no debris is collected in the screens.

E. Remove the screens and make the final connections after the screens have remained clean for a minimum of 24 consecutive hours of operation. Keep screens in place for 24 hours of clean water operation on solids handling systems; remove prior to placing the system into solids handling service.

F. In air or gas systems with pipe sizes less than or equal to 6 inches, purge with air and/or inert gases before testing. Upon completion of testing and cleaning, drain and dry the piping with a dry air stream. Satisfy ANSI/ISA-S7.0.01 standards for instrument air systems.

G. Purge digester gas, natural gas, and propane systems with nitrogen gas and provide a nitrogen pad maintained at 10 psig until put in service. Purge and dry digester gas systems in accordance with CGA B149.6.

H. For hazardous gas and liquid systems, clean interior of the pipelines by drawing a cloth or swab impregnated with an appropriate solvent (carbon tetrachloride or trichloroethylene) through the pipe. Do not clean interior of refrigerant lines. Dismantle valves and hand clean. Plug lines at the end of each day. Properly dispose of all waste solvents.

I. Clean and flush piping connecting to HVAC equipment in accordance with Division 23.

## 3.26 DISINFECTION

A. Flush and disinfect lines intended for potable water service after testing in accordance with AWWA C651.

**END OF SECTION**

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SECTION 40 05 02

PIPING SYSTEM SCHEDULES

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section specifies a Piping System Schedule for each Process Service. Each Piping System Schedule specifies piping system materials for groups of similar process piping services.

B. The table in paragraph 1.01C lists process services and the corresponding Piping System Schedule that specifies piping system material requirements for the associated process piping service. See Part 4 for Piping System Schedules that define materials for piping services.

C. Piping System Schedule assignments are listed in the following table:

| Process Service Identifier | Process Service | Piping System Schedule | Fluid Category | Pipe Marker Background Color |
|---|---|---|---|---|
| D | Drain | 40 05 02.87 | Drain/Vent | Green |
| FOG | Fats, Oils, Grease | 40 05 02.56 | Wastewater | Red |
| FOR | Fuel Oil Return | 26 32 13.15 | Fuel Oil | Orange |
| FOS | Fuel Oil Supply | 26 32 13.15 | Fuel Oil | Orange |
| HWR | Hot Water Return | 40 05 02.27 | Water | Gray |
| HWS | Hot Water Supply | 40 05 02.27 | Water | Gray |
| OC | Odor Control | 23 31 16 | Air | |
| STD | Storm Drain | 40 05 02.87 | Drain/Vent | Green |
| V | Vent | 40 05 02.89 | Drain/Vent | Green |
| 2W | Nonpotable City Water | 40 05 02.27 | Water | Green |



### 1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

| Reference | Title |
|---|---|
| ASME B1.20.1 | Pipe Threads, General Purpose |
| ASME B16.1 | Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250 |
| ASME B16.3 | Malleable Iron Threaded Fittings Class 150 and 300 |

| Reference | Title |
|---|---|
| ASME B16.5 | Pipe Flanges and Flanged Fittings |
| ASME B16.9 | Factory-Made Wrought Steel Butt Welding Fittings |
| ASME B16.11 | Forged Steel Fittings, Socket Welding and Threaded |
| ASME B16.12 | Cast Iron Threaded Drainage Fittings |
| ASME B16.18 | Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.22 | Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B31.1 | Power Piping |
| ASME B31.3 | Process Piping |
| ASME B31.9 | Building Services Piping |
| ASME B32 | Solder Metal |
| ASME B36.10 | Welded and Seamless Wrought Steel Pipe |
| ASME B36.19 | Stainless Steel Pipe |
| ASME B1.1 | Unified Inch Screw Threads |
| ASME Section IX | Boiler and Pressure Vessel Code; Welding and Brazing Requirements |
| ASTM A47 | Malleable Iron Castings |
| ASTM A53 | Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless |
| ASTM A74 | Cast Iron Soil Pipe and Fittings |
| ASTM A105/A105M | Forgings, Carbon Steel, for Piping Components |
| ASTM A106 | Seamless Carbon Steel Pipe for High Temperature Service |
| ASTM A126 | Grey-Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM A135 | Electric-Resistance-Welded Steel Pipe |
| ASTM A139 | Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over) |
| ASTM A167 | Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate |
| ASTM A181/181M | Forgings, Carbon Steel, for General Purpose Piping |
| ASTM A182/182M | Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A193/193M | Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service High Pressure Service and Other Special Purpose Applications |
| ASTM A194/194M | Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service or High Temperature Service, or Both |
| ASTM A197 | Cupola Malleable Iron |
| ASTM A234/A234M | Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures |
| ASTM A240 | Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels |
| ASTM A269 | Seamless and Welded Austenitic Stainless Steel Tubing for General Service |
| ASTM A276 | Stainless and Heat-Resisting Steel Bars and Shapes |
| ASTM A307 | Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength |
| ASTM A312/312M | Seamless and Welded Austenitic Stainless Steel Pipe |
| ASTM A320/320M | Alloy Steel Bolting Materials for Low-Temperature Service |
| ASTM A403/A403M | Wrought Austenitic Stainless Steel Piping Fittings |
| ASTM A409/A409M | Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service |
| ASTM A480/A480M | General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip |

| Reference | Title |
|---|---|
| ASTM A480/A480M | General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip |
| ASTM A536 | Ductile Iron Castings |
| ASTM A563 | Carbon and Alloy Steel Nuts |
| ASTM A774/A774M | As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures |
| ASTM A778 | Welded, Unannealed Austenitic Stainless Steel Tubular Products |
| ASTM A1011/A1011M | Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| ASTM B75 | Seamless Copper Tube |
| ASTM B88 | Seamless Copper Water Tube |
| ASTM B584 | Copper Alloy Sand Castings for General Applications |
| ASTM C76 | Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |
| ASTM C564 | Rubber Gaskets for Cast Iron Soil Pipe and Fittings |
| ASTM C361 | Reinforced Concrete Low-Head Pressure Pipe |
| ASTM C443 | Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C478 | Circular Precast Reinforced Concrete Manhole Sections |
| ASTM D638 | Test Method for Tensile Properties of Plastics |
| ASTM D792 | Test Method for Specific Gravity and Density of Plastics by Displacement |
| ASTM D1248 | Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable |
| ASTM D1784 | Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds |
| ASTM D1785 | Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2241 | Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR) |
| ASTM D2466 | Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 |
| ASTM D2467 | Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2513 | Thermoplastic Gas Pressure Pipe, Tubing, and Fittings |
| ASTM D2564 | Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings |
| ASTM D2665 | Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings |
| ASTM D2996 | Filament-Wound Reinforced Thermosetting Resin Pipe |
| ASTM D3034 | Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings |
| ASTM D3212 | Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals |
| ASTM D3261 | Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings |
| ASTM D3350 | Polyethylene Plastics Pipe and Fittings Materials |
| ASTM D4101 | Propylene Plastic Injection and Extrusion Materials |
| ASTM D4174 | Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems |
| ASTM D4894 | Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials |
| ASTM D4895 | Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion |
| ASTM F441 | Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 |
| ASTM F894 | Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe |

| Reference | Title |
|---|---|
| AWWA C104 | Cement–Mortar Lining for Ductile-Iron Pipe and Fittings |
| AWWA C105 | Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids |
| AWWA C110 | Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids |
| AWWA C111 | Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings |
| AWWA C115 | Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges |
| AWWA C150 | Thickness Design of Ductile-Iron Pipe |
| AWWA C151 | Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids |
| AWWA C153 | Ductile-Iron Compact Fittings |
| AWWA C200 | Steel Water Pipe, 6 Inches and Larger |
| AWWA C203 | Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied |
| AWWA C205 | Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches through 144 Inches |
| AWWA C206 | Field Welding of Steel Water Pipe |
| AWWA C207 | Steel Pipe Flanges for Waterworks Services - Sizes 4 Inch Through 144 Inch |
| AWWA C208 | Dimensions for Fabricated Steel Water Pipe Fittings |
| AWWA C209 | Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines |
| AWWA C210 | Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe |
| AWWA C214 | Tape Coating Systems for the Exterior of Steel Water Pipelines |
| AWWA C222 | Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings |
| AWWA C301 | Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |
| AWWA C303 | Reinforced Concrete Pressure Pipe - Steel Cylinder Type, Pretensioned, for Water and Other Liquids |
| AWWA C600 | Installation of Ductile-Iron Water Mains and their Appurtenances |
| AWWA C606 | Grooved and Shouldered Joints |
| AWWA C651 | Disinfecting Water Mains |
| AWWA C900 | Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water |
| AWWA M11 | Steel Pipe - A Guide for Design and Installation |
| CISPI 301 | Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings |
| EJMA STDS | Standards of Expansion Joint Manufacturers' Association, Edition No. 6 |
| FSA | Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division |
| FEDSPEC, L-C-530B(1) | Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy |
| MIL-H-13528B | Hydrochloric Acid, Inhibited, Rust Removing |
| MIL-S-8660C | Silicone Compound |
| MIL-STD-810C | Environmental Test Methods |
| MSS SP-25 | Standard Marking System for Valves, Fittings, Flanges and Unions |
| MSS SP-43 | Wrought Stainless Steel Butt Welding Fittings |

| Reference | Title |
|---|---|
| MSS SP-97 | Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends |
| MSS SP-114 | Corrosion Resistant Pipe Fittings Threaded and Socket Welding Class 150 and 1000 |
| NSF/ANSI 61: | Drinking Water System Components – Health Effects |
| SSPC | Society for Protective Coatings |
| SAE J1227 | Assessing Cleanliness of Hydraulic Fluid Power Components and Systems |

## 1.03 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Pipe Connections and Joints:
   1. BABS – Bell and Ball Spigot
   2. BAS – Bell and Spigot
   3. BFW – Butt Fusion Weld
   4. BSS – Bolted Split Sleeve Coupling
   5. BW – Butt Weld
   6. BSW – Butt-Strap Weld
   7. CGRV – Cut (or Cast) Grooved End Coupling
   8. CPLG – Coupling
   9. CPO – Compression Type Push-On
   10. CPRSN – Compression
   11. DLW – Double Lap Weld (Bell and Spigot)
   12. EFSW - Electro-Fusion Socket Weld
   13. FLG – Flanged
   14. FLRD – Flared
   15. FP – Full Penetration
   16. FSW - Fusion Socket Weld
   17. HAS - Hub and Spigot, Compression (Cast Iron Soil Pipe)
   18. HBLS - Shielded Hubless (Cast Iron Soil Pipe)
   19. HGRV – HDPE Groove Coupling
   20. HLF CPLG – Half Coupling
   21. HPEG – HDPE Plain End with Gripping Teeth
   22. HXGT - HDPE by Grooved End Transition
   23. LR ELL – Long Radius Elbow
   24. MJ – Mechanical Joint
   25. PGRV - Proprietary Groove Coupling
   26. PO – Push-on
   27. RBAS – Restrained (Lap Welded) Bell and Spigot with O-ring rubber gasket
   28. RGRV – Rolled Grooved End Coupling
   29. RJC – Ring Joint Coupling

30. RMJ – Restrained Mechanical Joint
31. RPO – Restrained Push-On joint
32. SLV – Solvent Weld
33. SLDR – Solder or Brazing
34. SLW – Single Lap Weld (Bell and Spigot)
35. SR ELL – Short Radius Elbow
36. SW – Socket Weld
37. THD – Threaded
38. UN – Union

C. Flanges:
1. FF – Full Face
2. LF – Loose Flange
3. LJ – Lap Joint
4. LWN – Long Weld Neck
5. RF – Raised Face
6. SO – Slip-On
7. THD – Threaded
8. WN – Weld Neck

D. Materials:
1. DI – Ductile Iron
2. RCP – Reinforced Concrete Pipe
3. RCP-LHP – Reinforced Concrete Low Head Pressure Pipe
4. SS – Stainless Steel
5. SV – Service (Cast Iron Soil Pipe available with SV rating or XH, extra heavy, rating)

E. Welding:
1. FP – Full Penetration
2. SML – Seamless
3. WLD – Welded

F. Other:
1. CFT - Cured Film Thickness
2. DFT – Dry Film Thickness
3. Dim – Dimensions
4. M or E Pipe – Matches or exceeds rating of connecting pipe
5. Thk – Thickness
6. Sch – Schedule
7. Std – Standard
8. STD – Standard Weight or Standard

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Pipe size (nominal diameter) and the Process Service Identifier for the contents of the pipeline are specified in pipe line labels on the drawings.

B. Provide piping system materials and components per the Piping System Schedule assigned for the specified process service and pipe size.

C. The Rating column in the Piping System Schedule specifies the minimum acceptable pressure rating or wall thickness for the component of the piping system.

## PART 3 NOT USED

## PART 4 SCHEDULES

### 4.01 PIPESPEC SYSTEM SHEETS/DETAILED PIPING SPECIFICATION SHEETS.

A. Piping System Schedules follow this Section. Piping System Schedules are assigned a Section number in the range from 40 05 02.00 through 40 05 02.99.

**END OF SECTION**

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## Schedule 40 05 02.27 - Plant Utility Water, Low Pressure

| Process Service | Hot Water Supply | Hot Water Return | Nonpotable City Water | | |
|---|---|---|---|---|---|
| Process Service Identifier | HWS | HWR | 2W | | |

### Test Conditions

| Pressure (psig) | Duration (min.) | Medium |
|---|---|---|
| 200 | 120 | Water |

### General Requirements

1. Full-Faced flanges mated with raised face flanges are not permitted.
2. Mating flanges for pipe shall be of the same Standard, Class and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.
3. Threads per ASME B1.20.1.
4. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel; weld Type 316L to Type 316L pipe material.)
5. Solvent welding of PVC piping performed with Weld-On 724 (ASTM F 493, NSF/ANSI 14, NSF/ANSI 61) or Approved Equal. Universal plastic pipe solvent is not acceptable. Prior to solvent welding, clean pipe joints to remove all loose debris and prime with a compatible primer. Primer shall stain piping.

### Notes:

1. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Provide Long Radius Elbows. Provide full flow fittings. Segmentally welded fittings are not acceptable.
3. Provide long radius five cut mitered elbows for segmentally welded fittings.
4. Install lining and coating prior to welding Threadolet or Half Coupling.
5. Provide Concrete Surround for pipe buried below structures.
6. Except at flanged connections at valves, flanged connections/joints not permitted on buried Ductile Iron Pipe.
7. FNPT tap at factory installed tapping boss. Taps at other locations on pipe and fittings are not permitted.
8. No lining or coating for Concrete Cylinder Pipe.
9. Bolts and nuts with metallurgy specified in AWWA C111.
10. BW (butt weld) connections/joints not permitted for 14-inch through 24 inch pipe.
11. Provide square nut operator, extension stem, and valve box for buried valves.
12. 3/8 inch thick wall required for installation of CGRV on 24-inch pipe.

## Schedule 40 05 02.27 - Plant Utility Water, Low Pressure

| Process Service | Hot Water Supply | Hot Water Return | Nonpotable City Water | | |
|---|---|---|---|---|---|
| Process Service Identifier | HWS | HWR | 2W | | |

**Indoor Dry, Indoor Wet, Outdoor, Process Corrosive**

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| Pipe | 1/8 thru 2-1/2 | Sch. 40 | THD | Steel: ASTM A53, Gr B, Type E or Type S, galvanized, Dim. Per ASME B36.10 | 40 05 24 | |
| | 3 thru 12 | Sch. 40 | CGRV, RGRV, FLG | Steel: ASTM A53, Gr B, Type E or Type S, Dim. Per ASME B36.10 | 40 05 24 | |
| Lining for Pipe & Fittings | All | — | — | None | — | |
| External Coating | All | Thk per Std | | Epoxy primer: Factory Applied, AWWA C151; compatible with finish coating system specified in Section 09 90 00 | | |
| | Valves | 16 mils DFT | — | Liquid Epoxy: Factory Applied, AWWA C210 | 40 05 24 | |
| Fittings | 1/8 thru 2-1/2 | Class 150 | THD | Malleable Iron: ASTM A47 or A197, galvanized, Dim. per ASME B16.3 | 40 05 24 | |
| | | Class 150 | THD | Ductile Iron: ASTM A536-Gr 65/45/12, galvanized, Dim. per ASME B16.3 | | |
| | | Class 3000 | THD | Forged Steel: ASTM A105, galvanized, Dim. per ASME B16.11 | | |
| | 3 thru 24 | Class 150 | CGRV, RGRV | Malleable Iron Grooved End: ASTM A47, Dim. per manufacturer's standard | 40 05 24 | 2 |
| | | M or E Pipe | CGRV, RGRV | Ductile Iron Grooved End: ASTM A536-Gr 65/45/12, Dim. per manufacturer's standard | | |
| | | Sch. 40 or Std. Wt. | CGRV, RGRV | Wrought Steel Grooved End: ASTM A234-WPB, r/D dim. per ASME B16.9, ASTM A53 grooved tangents per manufacturer's standard dim. | | |
| | | Sch. 40 or Std. Wt. | CGRV, RGRV | Fabricated Steel Grooved End: ASTM A53, Gr B, Type E or Type S, Dim. per manufacturer's standard | | |
| | | Sch. 40 or Std. Wt. | FLG | Wrought Steel: ASTM A234-WPB, Dim. per ASME B16.9 | | |
| Taps | 1/2 thru 2-1/2 | Class 3000 | THD | Forged Steel Tee: ASTM A105, galvanized, Dim. per ASME B16.11 | 40 05 24 | |
| | | Class 150 | THD | Ductile Iron Tee: ASTM A536-Gr 65/45/12, galvanized, Dim. per ASME B16.3 | | |
| | | Class 150 | THD | Malleable Iron Tee: ASTM A47 or ASTM A197, galvanized, Dim. per ASME B16.3 | | |
| | 3 thru 48 | Class 3000 | FP Beveled Fillet Weld | Forged Steel Threadolet or Half Coupling: ASTM A105, Dim. per ASME B16.11 | 40 05 24 | 4 |
| Grooved Coupling | 3 thru 24 | M or E Pipe | CGRV, RGRV | Rigid Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606<br>Flexible Coupling: ASTM A536-Gr 65/45/12, Groove Dim. per AWWA C606 | 40 05 24 | |
| Flanges | 4 thru 24 | Class 150 | LWN, WN, SO | Forged Steel: ASTM A105, FF, Dim. per ASME B16.5 | 40 05 24 | |
| | | Class D | SO | Plate Steel: FF, Material and Dim. per AWWA C207 | | |

## Schedule 40 05 02.27 - Plant Utility Water, Low Pressure

| Process Service | Hot Water Supply | Hot Water Return | Nonpotable City Water | | |
|---|---|---|---|---|---|
| Process Service Identifier | HWS | HWR | 2W | | |

**Indoor Dry, Indoor Wet, Outdoor, Process Corrosive**

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| FLG Bolts, nuts and hardware | All | All | — | Alloy Steel Bolts: ASTM A193-Gr B7 with<br>Carbon Steel Nuts: ASTM A194-Gr 2H heavy hex | — | 1 |
| Flange gaskets | 1/8 thru 10 | 1/16 in Thk. | FLG | Nitrile or Neoprene | 40 05 01 | |
| | 12 thru 48 | 1/8 in Thk. | FLG | Nitrile or Neoprene | 40 05 01 | |
| Mechanical Coupling Gaskets | 3 thru 48 | — | CGRV, RGRV | EPDM | 40 05 01 | |
| Compression and Push-On Gaskets | All | — | — | None | — | |
| Valves | 1/4 thru 2-1/2 | | THD | Ball: Bronze Body/Ball, 40 05 63.02 | 40 05 63.03 | |
| Insulation | 1/4 thru 8 | 1 in. Thk | | Cellular Elastomeric: ASTM C534-Type I Grade 1, Low Temperature Range, Freeze Protection, PVC Jacket/Covers | 40 42 00 | |

## Schedule 40 05 02.27 - Plant Utility Water, Low Pressure

| Process Service | Hot Water Supply | Hot Water Return | Nonpotable City Water | | |
|---|---|---|---|---|---|
| Process Service Identifier | HWS | HWR | 2W | | |

### Headspace, Submerged - Exposed

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| Pipe | All | Sch. 40S | THD, BW, SW, FLG | Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19 | 40 05 23 | |
| Lining for Pipe & Fittings | All | — | — | None | — | |
| External Coating | All | — | — | None | | |
| Fittings and Taps | 1/2 thru 3 | Class 3000<br>Class 40S<br>Class 150 | SW, THD<br>BW, THD<br>THD | Forged Stainless Steel: ASTM A182-F316L, Dim. per ASME B16.11.<br>Wrought Stainless Steel: ASTM A403-WP316L, Dim. per ASME B16.9.<br>Cast Stainless Steel: ASTM A351-CF8M, Dim. per ASME B16.3 | 40 05 23 | |
| Flanges | 1/2 thru 3 | Class 150 | WN, SO, THD | Forged Stainless Steel: ASTM A182-F316L, FF, Dim. per ASME B16.5. | 40 05 23 | |
| FLG Bolts, nuts and hardware | All | All | — | Stainless Steel Bolts: ASTM A193 Gr B8M<br>Stainless Steel Nuts: ASTM A194 Gr 8M | — | 1 |
| Flange gaskets | ALl | 3/16 in Thk. | FLG | Spiral wound, AISI Type 316L stainless steel, non-asbestos filler with compression ring per ASME B16.20 or approved equal | 40 05 01 | |

## Schedule 40 05 02.27 - Plant Utility Water, Low Pressure

| Process Service | Hot Water Supply | Hot Water Return | Nonpotable City Water | | |
|---|---|---|---|---|---|
| Process Service Identifier | HWS | HWR | 2W | | |

**Buried (Includes Embedded and Encased)**

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| Pipe | 1/2 thru 3 | Sch. 40 | THD | Steel: ASTM A53, Gr B, Type E or Type S, galvanized, Dim. Per ASME B36.10 | 40 05 24 | |
| Lining for Pipe & Fittings | 1/2 thru 3 | — | — | None | — | |
| External Coating | All | 50 mils | | Polyethylene Encasement: AWWA C105, Field Installed | | |
| Fittings | 1/2 thru 3 | Class 150 | THD | Malleable Iron: ASTM A47 or A197, galvanized, Dim. per ASME B16.3 | 40 05 24 | |
| | | Class 150 | THD | Ductile Iron: ASTM A536-Gr 65/45/12, galvanized, Dim. per ASME B16.3 | | |
| | | Class 3000 | THD | Forged Steel: ASTM A105, galvanized, Dim. per ASME B16.11 | | |
| Valves | All | — | — | None | — | |
| Insulation | 1/4 thru 8 | 1 in. Thk | | Cellular Elastomeric: ASTM C534-Type I Grade 1, Low Temperature Range, Freeze Protection, PVC Jacket/Covers | 40 42 00 | |

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## Schedule 40 05 02.56 – FOG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Process Service | Fats, Oils, Grease | | | | | | |
| Process Service Identifier | FOG | | | | | | |

### Test Conditions

| Pressure (psig) | Duration (min.) | Medium |
|---|---|---|
| 200 | 120 | Water |

### General Requirements

1. Full-Faced flanges mated with raised face flanges are not permitted.
2. Mating flanges for pipe shall be of the same Standard, Class, and Series. Mating flanges at valves and equipment shall have specified rating and matching drilling pattern.
3. Pipe Threads per ASME B1.20.1.
4. Match metal alloy/grade/type for any metal welded to pipe or fittings. (e.g. Do not weld carbon steel to stainless steel; weld Type 316L to Type 316L pipe material.)
5. All welding and cutting must be performed before glass lining is applied. Field welding or field cutting glass lined pipe is not permitted without approval from the Engineer.

### Notes:

1. Bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
2. Rolled or cut grooves installed prior to application of glass lining. Field installation of grooves is not permitted without approval from the Engineer.
3. Provide Long Radius Elbows. Provide full flow fittings. Segmentally welded elbows are not acceptable.
4. FNPT tap at factory installed tapping boss prior to lining. Taps at other locations on pipe and fittings are not permitted.
5. CGRV connections where shown on drawings to aid in removal of equipment, valves, instruments and appurtenances
6. CPVC only to be used inside Admin building. Ductile iron shall be used in other instances.
7. CPVC shall be unlined.

## Schedule 40 05 02.56 – FOG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Process Service | Fats, Oils, Grease | | | | | | |
| Process Service Identifier | FOG | | | | | | |

**Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, Submerged, Headspace - Exposed**

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| Pipe | 3/4 thru 3 | Sch. 40 | BW, SW, THD, FLG | Stainless Steel: ASTM A312-TP316L, SML, Dim. Per ASME B36.19. | 40 05 23 | |
| | 4 thru 8 | Cl 53 | FLG, CGRV | Ductile Iron: AWWA C151<br>Sch 80 CPVC | 40 05 19<br>40 05 31.13 | 2, 5<br>6 |
| Lining for Pipe & Fittings | Ductile Iron<br>PVC | 10 mil. | — | Glass: Ferrock MEH-32, Vitco SG-14 or equal<br>None | 40 05 19 | 7 |
| External Coating | All<br><br><br><br>Valves | Thk. per Std.<br><br><br><br>— | —<br><br><br><br>— | Epoxy primer: Factory Applied, AWWA C151; compatible with finish coating system specified in Section 09 90 00<br><br><br><br>Manufacturer's Standard Shop Coating: | 40 05 24<br>40 05 19<br>40 05 31.13<br><br>— | |
| Fittings | 3/4 thru 3<br><br>4 thru 8<br>4 thru 8 | Sch. 40S<br>Class 150<br>350 psi<br>Sch. 80 | BW, THD<br>THD<br>FLG, CGRV<br>SLV, THD, FLG | Wrought Stainless Steel: ASTM A403-WP316L, Dim. per ASME B16.9.<br>Cast Stainless Steel: ASTM A351-CF8M, Dim. per ASME B16.3<br>Ductile Iron: AWWA C110 or AWWA C153<br>CPVC: ASTM D1784 Class 23447-B, Dim. Per ASTM F439 | 40 05 23<br><br>40 05 19<br>40 05 31.13 | <br><br>2, 3, 5<br> |
| Taps | All | Sch. 40<br>Class 150 | BW, THD<br>THD | Wrought Stainless Steel Tee: ASTM A403-WP316L, Dim. per ASME B16.9.<br>Cast Stainless Steel Tee: ASTM A351-CF8M, Dim. per ASME B16.3 | 40 05 23 | 4 |
| Grooved Coupling | 4 thru 8 | 150 psi | CGRV<br>CGRV | Rigid Coupling: ASTM A536-Gr 65/45/12, per AWWA C606<br>Flexible Coupling: ASTM A536-Gr 65/45/12, per AWWA C606 | 40 05 19 | 5 |
| Flanges | 4 thru 8 | 250 psi | FLG | Ductile iron: AWWA C115 for pipe, AWWA C110 for fittings, Dim. per ASME B16.1-Class 125 | 40 05 19 | |
| | 4 thru 8 | Class 150 | FLG | CPVC: ASTM A1784-Class 23447-B, FF, Dim. per ASME B16.5 | 40 05 31.13 | |
| FLG Bolts, nuts and hardware | All | All | | Stainless Steel 316 | | |
| Flange gaskets | 4 thru 8 | 1/16 in Thk. | FLG | Neoprene or Nitrile | 40 05 01 | |
| Mechanical Coupling Gaskets | 4 thru 8 | — | CGRV | Nitrile: ASTM D2000 Type 5BG615A14B24 and AWWA C606<br>Neoprene | 40 05 01 | |
| Compression and Push-On Gasket | None | — | — | None | — | |

## Schedule 40 05 02.56 – FOG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Process Service | Fats, Oils, Grease | | | | | | |
| Process Service Identifier | FOG | | | | | | |

**Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, Submerged, Headspace - Exposed**

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| Valves | All | — | Per Spec | Ball Valves – per Spec<br>Knife Gate Valves – per Spec<br>Ball Check Valves – per Spec<br>Plug Valves – per Spec | 40 05 63.03<br>40 05 61.91<br>40 05 65.30<br>40 05 62.12 | |
| Insulation | 3/8 thru 8 | 1 in. Thk | — | Cellular Elastomeric: ASTM C534 Type I Grade 1, Low Temperature Range, Freeze Protection, Aluminum or PVC (with UV inhibitor if outdoors) Jacket/Covers | 40 42 00 | |

## Schedule 40 05 02.56 – FOG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Process Service | Fats, Oils, Grease | | | | | | |
| Process Service Identifier | FOG | | | | | | |

**Buried (Includes Embedded and Encased)**

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| Pipe | All | Class 56 | RMJ, RPO, FLG | Ductile Iron: AWWA C151 | 40 05 19 | 2, 3 |
| Lining for Pipe & Fittings | Ductile Iron, All | 10 mils | — | Glass Lining: Factory Applied, ASTM B 1000-15 | 40 05 19 | |
| External Coating | Ductile Iron, All | Thk. per Std. | — | Asphaltic: Manufacturer's Standard, AWWA C151, Factory Applied | 40 05 19 | |
| | | — | — | Polyethylene Encasement: AWWA C105, Field Installed | | |
| | Valves | — | — | Coating System : Per specification, Field Applied | 09 90 00 | |
| Fittings | 4 thru 12 | 350 psi | RMJ, FLG, RPO | Ductile Iron: AWWA C110 or AWWA C153 | 40 05 19 | 2, 3 |
| Taps | Ductile Iron, All | Sch. 40 | THD | Steel Short Nipple: ASTM A53, Seamless-Gr B, Type E or Type S, galvanized, Dim. per ASME B36.10 | 40 05 19 | 4 |
| Grooved Coupling | 4 thru 12 | M or E Pipe | CGRV | Flexible Coupling: ASTM A536 Gr 65/45/12, Groove Dim. per AWWA C606 | 40 05 19 | |
| Flanges | Ductile Iron, All | 250 psig | FLG | Ductile Iron: AWWA C115 for pipe, AWWA C110 for fittings, Dim. per ASME B16.1-Class 125 | 40 05 19 | 3 |
| FLG Bolts, nuts and hardware | All | | | Carbon Steel Nuts: ASTM A563-A with Xlyan fluoropolymer coating, Tripac 2000 Blue or approved equal | | 1 |
| Flange gaskets | 1/2 thru 10 | 1/16 in Thk. | FLG | Nitrile or Neoprene | 40 05 01 | |
| | 12 | 1/8 in Thk. | FLG | Nitrile or Neoprene | 40 05 01 | |
| Mechanical Coupling Gaskets | 4 thru 12 | — | CGRV | Nitrile or Neoprene | 40 05 01 | |
| Compression and Push-On Gasket | 4 thru 12 | — | RMJ, RPO, RBCS | Neoprene or Nitrile | 40 05 01 | |
| Valves | All | — | — | None | — | |
| Insulation | All | 1 ½" Thk | — | Urethane foam type with a polyvinyl chloride (PVC) jacket | 40 42 13.33 | |

## Schedule 40 05 02.89 – Building Mechanical Drainage

| | | | | | |
|---|---|---|---|---|---|
| Piping Service | Drain | Storm Drain | | | |
| Piping Service Abbreviation | D | STD | | | |

### Test Conditions

| Pressure (psig) | Duration (min.) | Medium |
|---|---|---|
| 5.0 | 15 | Water |

### General Requirements

1. Minimum test conditions specified above. Comply with applicable local plumbing code.
2. Sleeve drain, waste and vent piping through structural concrete and masonry.
3. Piping under structures, concrete encased pipe from the structure, and piping extended from the structure through the interface between piped commodities common to process/mechanical and yard piping, shall be either CISP or DIP, as specified.
4. Refer to Section 22 40 00 for plumbing fixtures and trim.
5. Provide copper tube for Outdoor HVAC equipment condensate drains.
6. Pipe Threads per ASME B1.20.1.

### Notes:

1. Provide cast iron soil pipe for buried pipe within 5 feet of building perimeter. Pipe materials transition to be at least 6 in above slab or 6 inches inside building perimeter wall.
2. Provide long radius elbows.
3. Provide magnetic tracer tape,
4. Provide BAS joints with embedded steel joint rings for 30-inch and larger RCP.
5. Pipe Tape Wrap is not required for pipe installed in Indoor Dry, Indoor Wet, and Outdoor Area Exposures.
6. Flange bolt length per ASME B16.5 plus three additional threads. Hex head bolt dimensions per ASME B18.2.1. Class 2A standard coarse series threads per ASME B1.1, standard coarse thread series. Hex nut dimensions per ASME B18.2.2 (Heavy Hex). Class 2B standard coarse series threads per ASME B1.1.
7. Provide Non Corrosive, High-Strength, Low-Alloy Steel Bolts or fluoropolymer coated Carbon Steel Bolts for flanges installed in Buried Area Exposure.
8. PVC lining is not required for D, RWP, and STD service.
9. Fabricated (miter cut pipe) PVC fittings are not acceptable.
10. Unreinforced Precast Concrete Manholes: 6 inch minimum wall thickness. Reinforced Precast Concrete Manholes: 4 inch minimum wall thickness. Provide Rubber gasket joints or mastic sealant joints between Precast Concrete Manhole Sections.
11. Bolts and nuts with metallurgy specified in AWWA C111.
12. Install per Cast Iron Soil Pipe Institute recommended practice specified in Cast Iron Soil Pipe and Fittings Handbook.
13. Provide Polyethylene Encasement: per AWWA C105, Field Applied, for Buried pipe under buildings and within 5 feet of building perimeter.

## Schedule 40 05 02.89 – Building Mechanical Drainage

| | | | | | |
|---|---|---|---|---|---|
| Piping Service | Drain | Storm Drain | | | |
| Piping Service Abbreviation | D | STD | | | |

**Indoor Dry, Indoor Wet, Outdoor, Process Corrosive, and Headspace – Exposed and Buried (Includes Embedded and Encased) Under Buildings and Within 5 feet of Building Perimeter**

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| Pipe | 1/4 thru 1-1/2 | Sch. 40 | THD | Steel: ASTM A53, galvanized, Gr B, Type E or Type S, Dim. Per ASME B36.10 | 40 05 24 | 1 |
| | 1-1/4 thru 12 | Sch. 40 | SLV | PVC: ASTM D1784-Class 12454-B or ASTM D2665-Class 12454-B, NSF 61 certified, Dim. Per ASTM D1785 | 40 05 31.13 | 3 |
| Lining for Pipe & Fittings | 1/4 thru 1-1/2 | — | — | None: | — | |
| | PVC, All | — | — | None: | — | |
| External Coating | 1/4 thru 1-1/2 | 2 wraps / layers | — | Pipe Wrap Tape: Polyethylene or PVC tape, Field Applied on Installed Pipe | — | 5 |
| | PVC, All | — | — | None: | — | |
| Fittings | 1/4 thru 1-1/2 | Class 150 | THD | Malleable Iron: ASTM A47 or A197, galvanized, Dim. per ASME B16.3 | 40 05 24 | 2 |
| Fittings | 1/4 thru 1-1/2 | Class 150 | THD | Ductile Iron: ASTM A536-Gr 65/45/12, galvanized, Dim. per ASME B16.3 | 40 05 19 | |
| | | — | SLDR | Wrought Copper and Copper Alloy (Brass or Bronze): Materials and Dim. per ASME B16.22 | | |
| | | — | SLDR | Cast Copper Alloy (Brass or Bronze): Materials and Dim. per ASME B16.18 | | |
| | PVC, All | Sch. 40 | SLV | PVC: ASTM D2665-Class 12454-B, NSF 61 certified, Dim. Per ASTM D3311 | 40 05 31.13 | 2 |
| Taps | All | — | — | None: | | |
| Flanges | PVC, All | Sch. 80 | FLG | PVC: ASTM A1784-Class 12454-B FF, Dim. Per ASME 16.5. | 40 05 31.13 | |
| FLG Bolts, nuts, and hardware | All | — | — | Alloy Steel Bolts: ASTM A307-Gr B with Carbon Steel Nuts: ASTM A563-Gr A heavy hex | — | 6, 7 |
| Flange gaskets | 14 thru 48 | 1/8 in Thk | FLG | Neoprene | 40 05 01 | |
| Valves | All | — | — | None | — | |
| Insulation | ½ thru 36 | 1 in. Thk. | — | Fiberglass or Mineral Wool: ASTM C547-Type I Grade A, Medium-Temperature Range, Condensation Control, Aluminum Jacket/Covers | | |

## Schedule 40 05 02.89 – Building Mechanical Drainage

| | | | | | |
|---|---|---|---|---|---|
| Piping Service | Drain | Storm Drain | | | |
| Piping Service Abbreviation | D | STD | | | |

**Buried (Includes Encased and Embedded) 5 feet Beyond Building Perimeter - Yard Piping**

| Component | Line Size, in | Rating | Conn./Joints | Material | Spec Section | Notes |
|---|---|---|---|---|---|---|
| Pipe | 1-1/4 thru 12 | Sch. 40 | SLV | PVC: ASTM D1784-Class 12454-B or ASTM D2665-Class 12454-B, NSF 61 certified, Dim. Per ASTM D1785 | 40 05 31.13 | 3 |
| | 3 thru 15 | DR 35 | PO | PVC: ASTM D1784-Class 12454-B, Dim. Per ASTM D3034 | 40 05 31.13 | 3 |
| Lining for Pipe & Fittings | PVC, All | — | — | None | — | |
| External Coating | PVC, All | — | — | None | — | |
| Fittings | 1-1/4 thru 12 | Sch. 40 | SLV | PVC: ASTM D2665-Class 12454-B, NSF 61 certified, Dim. Per ASTM D3311 | 40 05 31.13 | 2 |
| | PVC, 3 thru 15 | SDR 35 | PO | Molded PVC: ASTM D1784-Class 12454-B, Dim. Per ASTM D3034 | 40 05 31.13 | 2, 9 |
| Compression and Push-On Gasket | PVC, All | — | PO | Oil Resistant gasket: ASTM F477 | — | |

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SECTION 40 05 06

SPECIALTY COUPLINGS AND ADAPTERS FOR PROCESS PIPING

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes specialty couplings and adapters to provide electrical isolation, connect misaligned pipe, provide pipeline flexibility, provide disconnection/dismantling capabilities, and other specialty functions in pipelines.

B. Connections, couplings, and joints used to connect pipe segments and fittings that are not specifically designed to provide the capabilities of a specialty coupling are specified with the pipe materials.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 61 45 – Area Exposure Designations
   2. Section 09 90 00 – Painting and Coating
   3. Section 40 05 01 – Piping Systems
   4. Section 40 05 02 – Piping System Schedules



### 1.03 REFERENCE STANDARDS

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document

| Reference | Title |
|---|---|
| ASME B31.1 | Power Piping |
| ASME B31.9 | Building Service Piping |
| ASME Section IX | Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications |
| ASTM A36 | Standard Specification for Carbon Structural Steel |
| ASTM A53 | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |

| Reference | Title |
|---|---|
| ASTM A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications |
| ASTM A194 | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both |
| ASTM A536 | Standard Specification for Ductile Iron Castings |
| ASTM F593 | Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F594 | Standard Specification for Stainless Steel Nuts |
| AWWA C105 | Polyethylene Encasement for Ductile-Iron Pipe Systems |
| AWWA C111 | Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |
| AWWA C116 | Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings |
| AWWA C153 | Ductile-Iron Compact Fittings |
| AWWA C206 | Field Welding of Steel Water Pipe |
| AWWA C213 | Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines |
| AWWA C219 | Bolted, Sleeve-Type Couplings for Plain-End Pipe |
| AWWA C550 | Protective Epoxy Coatings for Valves and Hydrants |
| AWWA C606 | Grooved and Shouldered Joints |
| AWWA M11 | AWWA M11 – Steel Pipe: A Guide for Design and Installation |
| NSF 61 | Drinking Water System Components - Health Effects |



## 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
      a. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
      b. Manufacturers' product data, catalog cuts, typical installation details, and dimensions for each size and type of specialty coupling or adapter furnished for the project.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Provide new specialty pipe couplings and adapters, free from defects and conforming to the requirements and standards specified in this Section.

B. Provide specialty couplings and adapters at locations indicated on drawings.

## 2.02 MECHANICAL COUPLINGS

A. Fasteners and Gaskets
   1. Except as otherwise specified in this Section, fasteners specified by Area Exposure Type. See Section 01 61 45 – Area Exposure Designations.
      a. Indoor Dry, Indoor Wet, and Outdoor: Manufacturer's Standard
      b. Process Corrosive, Headspace, Chemical Corrosive and Submerged: ASTM F593, Type 316 stainless steel, marking F593F.

c. Non-corrosive high-strength, Low-alloy steel, ASTM A449 Gr 3, Class C or Class D, with metallurgy specified in AWWA C111, regardless of any other protective coating.

2. Gasket material requirements for mechanical couplings are specified in the Piping System Schedules (Section 40 05 02.00 to Section 40 05 02.99).

B. Equipment Connection Fittings:

1. Equipment connection fittings join flanged pipe ends with both lateral and angular misalignment adjustment between the axes of the pipes. In addition, equipment connection fittings provide full pressure thrust restraint between the field piping connection and equipment connection flanges.

a. Equipment connection fittings consist of two flanged coupling adapters, a plain end section of pipe and thrust restraint tie rods and associated fittings designed to transmit thrust without transmitting shear to the thrust restraint rods and without compromising provisions for accommodating angular and parallel misalignment.

b. Materials and features are to conform to the requirements established in this Section. Standard "dismantling joints" incorporate only one flanged coupling adapter and are not acceptable substitutes.

c. Candidate manufacturers:

1) Romac ECF Series

2) Baker Coupling Company, Los Angeles

3) Approved equal

2. Single sleeve of plain end piping conforming to the Piping System Schedule for the specified Process Service and of sufficient length to span the gap between the connection at the equipment and the connection at the field piping with Sleeve Flange Coupling Adapters at each end.

3. Provide thrust restraint by means of all-thread rod spanning between flanges. Rod nuts and spherical washer sets provide a ball-joint type self-aligning feature for all-thread thrust restraint rods. All-thread thrust restraint rods project through the flange and mating flange coupling adapter bolt holes or through holes in the restraint lug plates that extend beyond the flange diameter. Secure all-thread thrust restraint rod to the flanges with flange nuts or lug plates.

4. Provide lock washers between spherical washer sets and fastening nuts at both ends of all-thread thrust restraint rods. Double nutting with non-locking nuts is not an acceptable method of providing a self-locking feature.

5. All-thread thrust restraint rod diameter provides freedom of movement through all bolt holes to allow unrestricted maximum adjustment of equipment connection fittings to accommodate piping misalignment without transmitting any shear to the thrust rods and also to permit full development of thrust restraint at all thrust restraint rod tension take-ups.

6. Design equipment connection fittings per the requirements of AWWA C219.

7. Provide ASTM A193 grade B7, B8, or B8M thrust rods, ASTM A194 grade 2H, 8, or 8M nuts, with matching washers and lock washers to develop full rated piping system pressure thrust forces. For pump applications, select thrust rod quantities and diameters such that the thrust rod stretch under the piping system's operating pressure does not exceed 2.0 mils.

8. Factory apply dry film molybdenum disulfide anti-galling compound to ends of thrust rods, covering all threads subject to nut travel and tightening.

9. Gaskets:
    a. Flange gaskets: Match gasket material specified for Flange Gaskets in the Piping System Schedule for the associated Process Service.
    b. Follower gaskets: Compression Wedge. Match gasket material specified for Mechanical Coupling Gaskets in the Piping System Schedule for the associated Process Service.
10. Provide schedule 40, ASTM A53, Grade B pipe sleeves with ASTM A536, Grade 65-45-12 or ASTM A36 flange bodies and end rings. Pressure rating of flange adapters meet or exceed the pressure rating of the mating flanges. Coat and line all metal portions of equipment connection fittings, with the exception of 316 stainless steel components, with fusion bonded epoxy conforming to AWWA C550 and NSF 61.

## 2.03 UNIONS

A. 2-inch and Smaller: Ground joint screwed pattern unions.

B. 2 1/2-inch and Larger: Ground joint flange unions.

C. Dielectric Unions: Match the pipe material except bronze may be used with copper piping. Dielectric unions shall be EPCO, Capitol Manufacturing, or approved equal.

## 2.04 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Flange Insulating Kits: 2-1/2 inches and larger:
    1. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
    2. In accordance with applicable piping material specified in Piping System Schedules (Section 40 05 02.00 through 40 05 02.99). Provide insulating flange assemblies per ASME B31.9 or B31.1. Flange assembly pressure/temperature rating equal to or greater than pipeline rating.
    3. Galvanically compatible with piping.
    4. Gaskets: Full face, Type E, with elastomeric sealing element. Sealing element retained in a groove within retainer portion of gasket.
    5. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA G-10 grade).
    6. Insulating Washers: Fiberglass reinforced epoxy (NEMA G-10 grade).
    7. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
    8. Manufacturers:
        a. Pipeline Seal and Insulator, Houston, TX
        b. Advance Products and Systems, Lafayette, LA
        c. Approved equal

B. Insulating Sleeve Couplings:
    1. Rockwell Type 416.
    2. Dresser Style 39.
    3. Approved equal.

C. Flexible Insulated Couplings:
    1. Dresser; STAB-39.

2. Baker Coupling Company, Inc.; Series 216.
3. Approved equal

D. Insulating Unions: Union Type, 2 inches and Smaller:
1. Screwed or solder-joint.
2. O-ring sealed with molded and bonded insulation to body.
3. O-ring sealed with molded and bonded insulating bushing to union body, as manufactured by Central Plastics Co., Shawnee, OK.
4. Approved equal

## 2.05 COATINGS

A. Field coat mechanical couplings in Buried exposure areas with System M-1 as specified in Section 09 90 00 – Painting and Coating.

B. Field coat mechanical couplings in Indoor Dry, Indoor Wet, Outdoor, Submerged, Chemical Corrosive, Headspace, and Process Corrosive exposure areas as scheduled in Section 09 90 05.



# PART 3 EXECUTION

## 3.01 FLEXIBILITY

A. Unless otherwise specified, pipe passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a double ball expansion joint) as specified on the Drawings. Locate pipe couplings within 24 inches of the structure for 2-inch through 6-inch diameter pipe; within 40 inches of the structure for 8-inch through 24-inch pipe; and within one and one-half pipe diameters of the structure for pipe larger than 24-inch. Where required for resistance to pressure, restrain mechanical couplings in accordance with Chapter 13 of AWWA M11 including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

B. Install Double Ball Expansion Joints with ¼ inch elongation/extension of the minimum axial elongation capability specified in this Section.

## 3.02 DIELECTRIC CONNECTIONS

A. Provide an insulating section of rubber or plastic pipe where a copper pipe is connected to steel or cast iron pipe. The insulating section shall have a minimum length of 12 pipe diameters.

B. Dielectric unions as specified in this Section may be used instead of the specified insulating sections.

**END OF SECTION**

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SECTION 40 05 07

HANGERS AND SUPPORTS FOR PROCESS PIPING

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section specifies hangers and supports for all exposed piping systems specified in Section 40 05 01. This section does not include pipe supports for fire sprinkler systems or seismic restraints.

B. Scope Of Contractor Design: The Contractor shall provide the services of a "Design Professional" as specified in Section 40 05 01 to conduct all necessary piping and support design for exposed piping.

   a. Whether a design or general arrangement is shown or not, Contractor's Design Professional shall design all pipe supports, anchorage, restraints and expansion control, as specified. Where a conflict arises, Contractor's Design Professional shall present any conflict to Engineer for resolution.

   b. The Design Professional's work shall incorporate design criteria and other conditions as specified herein, in related sections and as shown on the drawings.

   c. Additional requirements are specified in related sections.



### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 01 33 00 – Submittal Procedures
2. Section 01 61 45 – Area Exposure Designations
3. Section 01 66 00 – Product Storage and Handling Requirements
4. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
5. Section 03 30 00 – Cast-in-Place Concrete
6. Section 05 05 20 – Anchor Bolts
7. Section 40 05 01 – Piping Systems
8. Section 40 05 02 – Piping System Schedules
9. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
10. Section 40 05 07.13 – Seismic Restraints for Piping
11. Section 40 05 07.16 – Expansion Control for Piping
12. Section 40 05 45 – Piping System Identification
13. Section 40 42 00 – Insulation for Exposed Piping and Equipment

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if

referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| AISC Manual of Steel Construction | American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Ed. |
| FEDSPEC WW-H-171e-78 | Hangers and Supports, Pipe |
| MFMA-2-91 | Metal Framing Standards Publication |
| MSS SP-69-91 | Pipe Hangers and Supports - Selection and Application |
| MSS SP-58-93 | Pipe Hangers and Supports - Materials, Design and Manufacture |

## 1.04 DEFINITIONS

Not Used.

## 1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination required with the design of piping systems, expansion joints, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.09 Hanger and Supports Selection and Design for additional coordation requirements.



## 1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.
   3. Hanger and support locations and components shall be indicated on the piping layout drawings required by Section 40 05 01.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Design Professional's reports as specified in paragraph 3.05.

## 1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

B. Refer to paragraph 1.09 Pipe Hanger and Support Selection and Design for additional quality assurance requirements.

## 1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

## 1.09 PIPE HANGER AND SUPPORT SELECTION AND DESIGN

A. Hanger And Support Selection:

1. The Contractor shall cause the pipe hangers and supports to be designed and selected by the Design Professional retained under the provisions of Section 40 05 01. This provision, however, shall not relieve the Contractor of overall responsibility for this portion of the work. Hanger and support selection shall be based on the following:
   a. The Contractor shall select pipe hangers and supports as specified in the project manual. Selections shall be based upon the pipe support classifications specified in MSS-SP 69, the piping insulation thickness specified in Section 40 42 00, and any special requirements which may be specified in the project manual.
   b. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.
   c. Where a particular pipe support arrangement is shown, a design incorporating that arrangement shall be used.
   d. Where a particular pipe support design is shown, that design shall be used.
   e. Pipe supports shall be spaced such that pipe span deflections do not exceed 0.1-inch.
   f. Pipe support design shall incorporate applicable criteria of ASME or other recognized standard.
   g. The pipe hanger and support system shall be coordinated with the seismic restraint system specified under Section 40 05 07.13.
   h. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:
      1) Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.
      2) Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.
      3) Reaction forces due to test and operational conditions.
      4) Reaction forces due to the operation of safety, relief, or other valves.
      5) Wind, snow or ice loadings on outdoor piping.
      6) Supports shall be designed to prevent transfer of the weight of piping, valves and piping appurtenances to equipment piping connections. All supports adjacent at equipment connections to piping systems shall have provisions for vertical and horizontal adjustment. Two flexible piping connections not less than one pipe diameter apart shall be provided between piping supports and any equipment piping connection.
   i. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.
   j. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.

k. Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.

l. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.

m. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

n. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper-plated, rubber, plastic or vinyl coated, or stainless steel hanger and support components.

o. Stock hanger and support components shall be used wherever practical.

p. Fiberglass framing channel shall be provided where specified.

B. The following structural criteria shall also be applied:

1. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.
2. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.
3. Where critical support load requirements have been identified, limiting structural load requirements are shown.
4. Pipe support hangers, brackets etc. shall be of suitable capacity and shall be appropriate to the individual structural member that is used to support the pipe.
5. The structural integrity of existing and new members shall in no way be impacted by the placement of connections for pipe supports. For example, the tension reinforcement in reinforced concrete members shall not be impacted in any way by the placement of fasteners for pipe supports.
6. Spacing and arrangement of hangers supporting pipe shall be provided in such a manner that the loads from the pipes on existing and new structural members shall be quasi-uniform. These quasi-uniform loads shall not exceed the allowable design loads for mechanical equipment as shown on existing (not necessarily contract) drawings and as listed under Design Live Loads in the General Notes.
7. For new construction, unless otherwise shown, pipe may be supported from nearest structural element (floor, ceiling, or wall). The Design Loads for mechanical equipment, as listed in the General Notes sheet of the Structural drawings shall not be exceeded.
8. The loads and specific attachment requirements for pipe supports on new concrete Tees shall be coordinated with the Tee manufacturer and incorporated into the design of the Tees.
9. Unless otherwise specified, pipe supports from existing Tees or other roof types shall not be constructed without an evaluation of capacity and appropriate design from Contractor's Design Professional.

C. The following, project-specific criterion shall also be applied:

1. The spacing for pipe hangers shall not be less than 5 feet and shall not exceed 375 lbs of load for all existing pre-cast, Double Tee roof elements. For hangers off flanges of existing Tees, a washer shall be provided having minimum dimensions of 1/4 inch

thick by 4 inch long and 4 inch wide. The design and projection of those hangers above the roof shall be coordinated with the architectural roofing system.

2. For sodium hydroxide systems, pipe supports shall be 60 percent closer than the maximum spacing indicated for plastic piping for water service.

## PART 2 PRODUCTS

### 2.01 PERFORMANCE/ DESIGN CRITERIA

A. Service Conditions:

1. The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:
   a. Hot Systems
      1) A - 1. 120 degrees F to 450 degrees F
      2) A - 2. 451 degrees F to 750 degrees F
      3) A - 3. Over 750 degrees F
   b. Ambient Systems
      1) B. 60 degrees F to 119 degrees F
   c. Cold Systems
      1) C - 1. 33 degrees F to 59 degrees F
      2) C - 2. -20 degrees F to 32 degrees F

B. Design:

1. The Contractor shall cause the design of pipe hanger and support systems to be developed in conjunction with preparation of the design seismic restraints and expansion control system by the Design Professional selected in accordance with Section 40 05 07-1.01 and 1.09. The pipe system drawings specified in Section 40 05 07-1.06 shall show the hanger and support locations as well as the details of the seismic restraints and expansion control systems. The pipe hanger and support design drawings and calculations shall be prepared and signed by the design professional and shall bear the Design Professional's registration seal.



### 2.02 MATERIALS

A. Standard pipe supports and components shall be manufactured by B-Line, Carpenter & Patterson, Kin-Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP-69 and FEDSPEC WW-H-171e.

B. Pipe support materials shall conform to the requirements of MSS SP-58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA-2.

## 2.03 CONFIGURATION, COMPONENTS, FEATURES

A. General:

1. Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be hot-dip or mechanically galvanized after fabrication. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in Section 26 05 00-1.05 Corrosive Areas as shown on the drawings, which shall be type FRP or 304 stainless steel.

B. Pipe Hangers And Supports:

1. Pipe hangers and supports of dissimilar metals than pipe shall be insulated. Pipe hangers and supports shall support pipe in the manner recommended by the pipe manufacturer and/or applicable building or piping codes.

C. Rack And Trapeze Supports:

1. Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection of 1/240 of the span.

D. Structural Attachments:

1. Type A - Malleable Iron Concrete Insert: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.
2. Type B - Side Beam Bracket: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B-Line B3062, or equal.
3. Type C - Malleable Beam Clamp With Extension Piece: Clamp and extension piece shall be malleable iron, tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B-Line B3054, or equal.
4. Type D - Steel Beam Clamp With Eye Nut: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.
5. Type E - Framing Channel Post Base: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B-Line B280, or equal. Double channel: Unistrut P2073A, B-Line B281, or equal.
6. Type F - Welded Beam Attachment: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B-Line B3083, Grinnell Fig. 66, or equal.
7. Type G - Welded Steel Bracket: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.
8. Type H - Cast Iron Bracket: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.
9. Type J - Adjustable Beam Attachment: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B-Line B3082, or equal.
10. Type K - Double Channel Bracket: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel. Cantilever bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B-Line B297-12 through B297-36, or equal.

11. Type L - Single Channel Bracket: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B-Line B198-6, B198-12, B196-18 and B196-24, or equal.
12. Type M - Wall Mounted Channel: Wall channel shall be single channel framing channel as specified in paragraph 2.03 Framing Channel.
13. Type N - Pipe Stanchion Floor Attachment: Baseplate shall be carbon steel with 1/2 inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.
14. Type Q - Continuous Concrete Inserts: shall be 1 5/8 by 1 3/8 Channel, cold formed 12 Ga. steel conforming to ASTM A 1001, stainless steel GR 33 or ASTM GR 33 A., hot dip galvanized conforming to ASTM A123 or A153, UNISTRUT P3200 Series, or approved equal.

E. Accessories:
1. Hanger Rods: Rods shall be carbon steel, threaded on both ends or continuous threaded and sized as specified.
2. Weldless Eye Nut: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B-Line B3200, or equal.
3. Welded Eye Rod: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B-Line B3211, or equal.
4. Turnbuckle: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B-Line B3202, or equal.
5. Framing Channel: Framing channel shall be 1 5/8 inches square, roll formed, 12-gage carbon steel. Channel shall have a continuous slot along one side with in-turned clamping ridges. Single channel: Unistrut P1000, B-Line B22, or equal. Double channel: Unistrut P1001, B-Line B22A, or equal. Triple channel: Unistrut P1004A, B-Line B22X, or equal.



## 2.04 THERMAL PIPE HANGER SHIELD:

A. Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation specified in Section 40 42 00. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

B. Standard Shield:
1. Insulation:
a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.
3. Connection: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

C. Vapor Barrier Shield:
1. Insulation:
a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F
2. Steel Jacket: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.
3. Connection: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vapor tight connection to pipe insulation vapor barrier.



## PART 3 EXECUTION

### 3.01 HANGER AND SUPPORT LOCATIONS

A. Locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.

B. Locate at least one hanger or support within 2 feet from a pipe change in direction.

C. Locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

D. Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, support the piping in such a manner that temporary supports shall not be necessary for this procedure.

E. Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

### 3.02 INSTALLATION

A. Weld and bolt attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.

B. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

C. Install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

D. Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

E. Install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

I. Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

J. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.



## 3.03 ADJUSTMENTS

A. Adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

## 3.04 ANCHOR BOLTS

A. Anchor bolts in new concrete shall be cast in place. Refer to Section 05 05 20.

## 3.05 INSPECTION AND CERTIFICATION

A. The Design Professional retained by the Contractor under the provisions of Section 40 05 01 shall inspect the pipe hangers, support and restraint systems at not less than bi-weekly intervals during construction and furnish the Engineer with monthly reports. The Design Professional shall inspect the completed pipe hanger, support and restraint system before the Owner assumes beneficial occupancy and provide written certification, without any qualification statements, that the installation conforms to the design professional’s design and the Contract Document requirements as may be described in other Sections or on the drawings. All reports shall bear the Design Professional's seal and signature in accordance with the laws, rules and regulations of the state.

## APPENDIX A: PIPE HANGERS AND SUPPORTS TABLES

TABLE A - SUPPORT SPACING AND ALLOWABLE ROD LOADS

| NOMINAL PIPE SIZE (INCHES) | SUPPORT ROD SIZE AND MAXIMUM LOAD PER ROD - SEE NOTES 1 AND 2 | | MAXIMUM SUPPORT SPACING (FEET) | | | |
|---|---|---|---|---|---|---|
| | ROD SIZE (INCHES) | MAX LOAD (POUNDS) | STEEL | COPPER | PLASTIC SEE NOTE 4 | CAST IRON SEE NOTE 5 |
| 3/8 TO 3/4 | 3/8 | 610 | 5 | 5 | CONTINUOUS | --- |
| 1 | 3/8 | 610 | 5 | 5 | 5 | --- |
| 1-1/4 | 3/8 | 610 | 5 | 5 | 5 | --- |
| 1-1/2 | 3/8 | 610 | 5 | 5 | 5 | --- |
| 2 | 3/8 | 610 | 10 | 10 | 5 | |
| 2-1/2 | 3/8 | 610 | 10 | 20 | 5 | |
| 3 | 1/2 | 1130 | 10 | 20 | 5 | |
| 4 | 5/8 | 1810 | 15 | 20 | 5 | |
| 6 | 3/4 | 2710 | 15 | 20 | 5 | |
| 8 | 3/4 | 2710 | 20 | --- | 5 | |
| 10 | 3/4 | 2960 | 20 | --- | 10 | |
| 12 | 7/8 | 3960 | 20 | --- | --- | |
| 14 | 1 | 4960 | 20 | --- | --- | |
| 16 | 1 | 4960 | 20 | --- | --- | |
| 18 | 1 | 4960 | 20 | --- | --- | |
| 20 | 1-1/4 | 8000 | 20 | --- | --- | |
| 24 | 1-1/4 | 8000 | 20 | --- | --- | |
| 30 | 1-1/2 | 11630 | 20 | --- | --- | |

12 FEET FOR PRESSURE PIPE
10 FEET FOR SOIL PIPE

TABLE A NOTES:

1. DESIGN WEIGHT SHALL BE TWICE THE WEIGHT OF THE PIPE FULL OF WATER PLUS THE WEIGHTS OF VALVES, FITTINGS, INSULATING MATERIALS AND SUSPENDED HANGER COMPONENTS ON THE RUN OF PIPE BEING SUPPORTED.
2. ROD SIZES SHOWN ARE FOR THE SUPPORT OF A SINGLE PIPE. WHEN SUPPORTING MORE THAN ONE PIPE, ROD SHALL BE SIZED USING DESIGN WEIGHTS (SEE NOTE 1) TO DETERMINE THE TOTAL DESIGN LOAD. THE TOTAL DESIGN LOAD SHALL NOT EXCEED THE MAXIMUM LOADS IN THE TABLE ABOVE.
3. PIPE SHALL NOT HAVE POCKETS FORMED IN THE SPAN DUE TO SAGGING OF THE PIPE BETWEEN SUPPORTS CAUSED BY THE WEIGHT OF THE PIPE, MEDIUM IN THE PIPE, INSULATION, VALVES AND FITTINGS.
4. SPAN SHOWN IS FOR SCHEDULE 80 PVC PIPE AT 100°F. SPANS FOR OTHER PLASTICS, OTHER PVC PIPE SCHEDULES AND PIPES AT HIGHER TEMPERATURES SHALL BE SHORT- ENED IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS. "CONTINUOUS" MEANS PIPE SHALL BE IN CONTINUOUS OR SIMILAR CHANNEL.
5. PROVIDE A MINIMUM OF ONE HANGER PER PIPE LENGTH, WITHIN 4-INCHES OF THE BELL.
6. PIPE HANGER AND SUPPORT SELECTION SHALL BE IN ACCORDANCE WITH TABLE B (M2302) AND SPECIFICATION 15096.

## TABLE B HANGER AND SUPPORT SELECTIONS

| SYSTEM TEMP RANGE DEG F | INSULATION NOTE 1 | PIPE ATTACHMENTS | | | | | | | | BUILDING STRUCTURAL ATTACHMENTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HORIZONTAL | | | | | | | VERTICAL | STEEL AND/OR MALL. IRON | | | |
| | | STEEL STRAPS | STEEL BANDS | STEEL CLAMPS | CAST IRON HANGING ROLLS | CAST IRON SUPPORTING ROLLS | STEEL TRAPEZES AND RACKS | THERMAL HANGER SHIELDS | STEEL OR CAST IRON STANCHIONS | STEEL RISER CLAMPS | INSERTS | BEAM CLAMPS | WELDED AND BOLTED ATTACHMENTS | BRACKETS |
| HOT A-1 120 TO 450 | COVERED | 13 | 1, 2 | 3 | 4, 5 | 8 | 20, 21 | SEE SPEC | 10 | 11, 12 | A | C, D | F, J, M | B, G, H, K, L |
| | BARE | 6, 7 13 | 1, 2 | 3 | 4, 5 | 8 | 20, 21 | NONE | 10 | | | | | |
| HOT A-2 451 TO 750 | COVERED | 13 | 1 | 3 | 4, 5 | 8 | 20, 21 | SEE SPEC | 10 | 11, 12 | A | C, D | F, J, M | B, G, H, K, L |
| | BARE | NONE | NONE | 3 | NONE | NONE | 20, 21 | NONE | NONE | | | | | |
| HOT A-3 OVER 750 | COVERED | 13 | 1 | 3 (ALLOY) | 4, 5 | 8 | 20, 21 | SEE SPEC | 10 | 11, 12 | NONE | C, D | F, J, M | B, G, H, K, L |
| | BARE | 13 | NONE | 3 (ALLOY) | NONE | NONE | 20, 21 | NONE | NONE | | | | | |
| AMBIENT B 60 TO 119 | COVERED | 13 | 1, 2 | 3 | 4, 5 | 8 | 20, 21 | SEE SPEC | 9,10 | 11, 12 | A | C, D | F, J, M | B, G, H, K, L |
| | BARE | 6, 7 13 | 1, 2 | 3 | 4, 5 | 8 | 20, 21 | NONE | 9,10 | | | | | |
| COLD C-1 33 TO 59 | COVERED | 13 | 1, 2, 3 | 3 | 4, 5 | 8 | 20, 21 | SEE SPEC | 10 | 11, 12 | A | C, D | F, J, M | B, G, H, K, L |
| | BARE | 6, 7 13 | 1, 2, 3 | 3 | 4, 5 | 8 | 20, 21 | NONE | 10 | | | | | |
| COLD C-2 -2 TO 32 | COVERED | 13 | 1, 2, 3 | 3 | 4, 5 | 8 | 20, 21 | SEE SPEC | 10 | 11, 12 | A | C, D | F, J, M | B, G, H, K, L |
| | BARE | NONE | 1, 2, 3 | 3 | 4, 5 | 8 | 20, 21 | NONE | 10 | | | | | |



TABLE B NOTES:

1. HANGERS ON INSULATED SYSTEMS SHALL INCORPORATE THERMAL HANGER SHIELDS.
2. HANGER AND SUPPORT SPACING SHALL BE IN ACCORDANCE WITH TABLE A (M2301).

TABLE C
SEISMIC RESTRAINT SPACING

| NOM. PIPE SIZE | MAXIMUM SPAN BETWEEN BRACES | | BRACE TYPE | MAXIMUM BRACE LENGTH |
|---|---|---|---|---|
| | LATERAL BRACE (FEET) | LONGITUDINAL BRACE (FEET) | | |
| 2 | 40 | 80 | A1 | 9'-4" |
| 2-1/2 | 40 | 80 | A1 | 9'-4" |
| 3 | 40 | 80 | A1 | 9'-4" |
| 4 | 40 | 80 | A1 | 9'-4" |
| 6 | 40 | 80 | A1 | 9'-4" |
| 8 | 40 | 40 | A1 | 9'-4" |
| 10 | 40 | 40 | A1 | 9'-4" |
| 12 | 40 | 40 | A2 | 10'-0" |
| 14 | 30 | 30 | A2 | 10'-0" |
| 16 | 25 | 25 | A2 | 10'-0" |
| 18 | 20 | 20 | A2 | 10'-0" |
| 20 | 16 | 16 | A2 | 10'-0" |
| 24 | 10 | 10 | A2 | 10'-0" |

(S) - STANDARD WALL

END OF SECTION

SECTION 40 05 07.13

SEISMIC RESTRAINTS FOR PIPING

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section specifies seismic restraints for bracing all piping systems specified in Section 40 05 01. This section does not include seismic restraints for fire sprinkler systems.

B. Provide professional engineering services for a piping system dsign engineer (hereinafter the "Design Professional") as specified in Section 40 05 01, this Section, and related sections.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 61 45 – Area Exposure Designations
   3. Section 01 66 00 – Product Storage and Handling Requirements
   4. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
   5. Section 03 30 00 – Cast-in-Place Concrete
   6. Section 05 05 20 – Anchor Bolts
   7. Section 40 05 01 – Piping Systems
   8. Section 40 05 02 – Piping System Schedules
   9. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
   10. Section 40 05 07 – Hangers and Supports for Process Piping
   11. Section 40 05 07.16 – Expansion Control for Piping
   12. Section 40 05 15 – Piping System Identification
   13. Section 40 42 00 – Insulation for Exposed Piping and Equipment



### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

| Reference | Title |
|---|---|
| AISC Manual of Steel Construction | American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, 9th Edition |
| MFMA-2 | Metal Framing Standards Publication |
| MFMA-101 | Guidelines for the Use of Metal Framing |
| MSS SP-58 | Pipe Hangers and Supports - Materials, Design and Manufacture |

| Reference | Title |
|---|---|
| MSS SP-69 | Pipe Hangers and Supports - Selection and Application |
| MSS-SP-89 | Pipe Hangers and Supports – Fabrication and Installation Practices |
| SMACNA | Seismic Restraint Manual—Guidelines for Mechanical Systems |

## 1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Longitudinal direction: direction parallel to the pipe axis.
   2. Lateral direction: direction perpendicular to the pipe axis.

## 1.05 ADMISTRATIVE REQUIREMENTS

A. Cordination:
   1. Coordination required with the design of piping systems, expansion joints, pipe supports, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.09 Seismic Restraint Design for additional coordation requirements.

## 1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Seismic restraint system drawings and calculations as specified in paragraph 1.09 Seismic Restraint Design.
   3. Seismic restraint locations and legend as specified in paragraph 3.01.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. The Design Professional's reports and certification of final installation as specified in Section 40 05 01 and paragraph 3.03.



## 1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

B. Refer to paragraph 1.09 Seismic Restraint Design for additional quality assurance requirements.

## 1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01

## 1.09 SEISMIC RESTRAINT DESIGN

A. Design Professional:
   1. The seismic restraint system shall be designed by the Design Professional retained under Section 40 05 01. Seismic restraint details shall be designed in conjunction with preparation of pipe system hangers and drawings specified in Section 40 05 01.
   2. All drawings and work product for the seismic restraint system shall bear the design professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

B. Restraint Selection:
   1. The Contractor shall select, locate and provide seismic restraints for piping in accordance with this section. As set forth in Section 40 05 01, this work shall be the product of a Design Professional retained by the Contractor.
   2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.
   3. Seismic restraints may be omitted from the following installations:
      a. Gas piping less than 1-inch inside diameter.
      b. All other piping less than 2 1/2-inch inside diameter.
   4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
   5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.
   6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.
   7. Branch lines shall not be used to brace main lines.
   8. Seismic bracing shall not limit the expansion and contraction of the piping system.



# PART 2 PRODUCTS

## 2.01 PERFORMANCE/ DESIGN REQUIREMENTS

A. Service Conditions:
   1. Provide seismic bracing to resist seismic loading caused by forces applied at the individual pipe's center of gravity. Designed seismic bracing for seismic loading as specified in Section 01 73 24. Seismic loading shall be assumed to be acting in the lateral, longitudinal, and vertical directions simultaneously.
   2. Provide all piping systems with seismic restraints conforming to governing state and local codes.
   3. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

## 2.02 MANUFACTURERS

A. Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B-Line, Kin-Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or approved equal.

B. Pipe restraint materials, design, manufacture, installation, and application shall conform to the requirements of MSS SP-58, MSS-SP-69, MSS-SP-89, MFMA-1, and MFMA-101.

## 2.03 MATERIALS

A. General:
   1. Unless otherwise specified, restraints manufactured of iron or steel, including braces, pipe and structural attachments, shall be hot-dip galvanized after fabrication.
   2. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc-coated except for those subject to moisture or corrosive atmosphere, which are listed in Section 26 05 00-1.05 Corrosive Areas; those compounds shall be type 304 stainless steel.
   3. Also listed in Section 26 05 00-1.05 Corrosive Areas are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe supports, anchor and seismic brace components (not just fittings and accessories) shall be made of fiberglass.

## 2.04 CONFIGURATION, COMPONENTS, AND FEATURES

A. Thermal Pipe Hanger Shield:
   1. Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in Section 40 05 07-2.04. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.



# PART 3 EXECUTION

## 3.01 PIPE RESTRAINT LOCATIONS

A. Locate the first seismic restraint on a piping system not more than 10 feet from the main riser, entrance to a building or piece of equipment.

B. Brace ductile and cast iron pipe on each side of a change in direction of 90 degrees or more. Brace or stabilize joints in risers between floors.

C. At a minimum, brace no-hub and bell and spigot cast iron soil pipe longitudinally every 20 feet and laterally every 10 feet.

D. Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

E. Indicate seismic restraint locations and components on the piping layout drawings required by Section 40 05 01. The drawings shall bear a legend giving load information and restraint component selection at each restraint location and shall be sealed and

signed by the Design Professional retained by the Contractor for design of the pipe hanger and support system under the provisions of Section 40 05 01.

## 3.02 INSTALLATION

A. Use rod stiffener assemblies at seismic restraints for hanger rods over 6 inches in length. Use a minimum of two rod stiffener clamps on any rod stiffener assembly.

B. Install lateral and longitudinal bracing between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

C. Weld and bolt attachments to the building structural steel in accordance with the requirements of AISC M011. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

D. Use embedded anchor bolts instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging. Otherwise, design and provide anchor bolts in accordance with Section 05 05 20.

E. Install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Make butt joint connections to pipe insulation at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7 feet above the floor.

## 3.03 INSPECTION AND CERTIFICATION

A. The Design Professional retained by the Contractor under the provisions of Section 40 05 01 shall inspect the seismic restraint system at not less than bi-weekly intervals during construction and furnish the Engineer with monthly reports.

B. The Design Professional shall inspect the completed seismic control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 07 requirements.



**END OF SECTION**

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SECTION 40 05 07.16

EXPANSION CONTROL FOR PIPING

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section specifies expansion control for the piping systems specified in paragraph 2.01 Service Requirements. This section addresses pipe anchorage, pipe guides, and expansion control by either expansion joints or pipe deflection.

B. Provide professional engineering services for a piping system dsign engineer (hereinafter the “Design Professional”) as specified in Section 40 05 01, this Section, and related sections.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 01 33 00 – Submittal Procedures
2. Section 01 61 45 – Area Exposure Designations
3. Section 01 66 00 – Product Storage and Handling Requirements
4. Section 01 73 24 – Design Requirements for Non-Structural Components and Non-Building Structures
5. Section 03 30 00 – Cast-in-Place Concrete
6. Section 05 05 20 – Anchor Bolts
7. Section 09 90 00 – Coating Systems
8. Section 40 05 01 – Piping Systems
9. Section 40 05 02 – Piping System Schedules
10. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping
11. Section 40 05 07 – Hangers and Supports for Process Piping
12. Section 40 05 07.13 – Seismic Restraints for Piping
13. Section 40 05 45 – Piping System Identification
14. Section 40 42 00 – Insulation for Exposed Piping and Equipment



### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

| Reference | Title |
|---|---|
| AISC Manual of Steel Construction | American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition |
| ASTM A276 | Stainless and Heat-Resisting Steel Bars and Shapes |
| EJMA STDS | Standards of Expansion Joint Manufacturers' Association, Edition No. 5 |

## 1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

| Term | Definition |
|---|---|
| Expansion joint | Any device containing one or more bellows used to absorb dimensional changes. |
| Main anchor | An attachment between a structure and a pipe which must withstand the full pipeline thrust due to pressure, pipe bending, pipe compression, flow, spring forces, pipe and contents weight and other pipe forces. |
| Intermediate anchor | An attachment between a structure and a pipe which withstands the same forces as a main anchor except the pressure forces. |
| Sliding anchor | An attachment between a structure and a pipe which absorbs forces in one direction while permitting motion in another. |
| Pipe guide | A device fastened to a structure, which permits the pipeline to move freely in only one direction, along the axis of the pipe. |
| Pipe section | That portion of pipe between two anchors. |
| Planar pipe guide | A device fastened to a structure, which permits transverse movement or bending of the pipeline in one plane. |
| Lateral direction | Direction perpendicular to the pipe axis. |
| Longitudinal direction | Direction parallel to the pipe axis. |



## 1.05 ADMISTRATIVE REQUIREMENTS

A. Cordination:
   1. Coordination required with the design of piping systems, expansion joints, pipe supports, and expansion control and seismic restraints.
   2. Refer to Section 40 05 01 for additional coordination requirements.
   3. Refer to paragraph 1.09 Expansion Control Design for additional coordation requirements.

## 1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   3. Identify expansion control locations and components indicated on piping layout drawings as specified in Section 40 05 01.
   4. Expansion control schedules as specified in paragraph 4.01.

B. Information Submittals:
   1. Procedures: Section 01 33 00.
   2. Anchor bolt calculations in accordance with Section 05 05 20 requirements.
   3. The Design Professional's reports and final certification, as specified under paragraph 3.02

## 1.07 QUALITY ASSURANCE

A. Refer to Section 40 05 01 for additional quality assurance requirements.

B. Refer to paragraph 1.09 Expansion Control Design for additional quality assurance requirements.

## 1.08 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Additional requirements: 40 05 01.

## 1.09 EXPANSION CONTROL DESIGN

A. Design:
   1. The expansion control system shall be designed by the Contractor's Design Professional selected under Section 40 05 01.
   2. Expansion control details shall be designed in conjunction with preparation of pipe system hangers and seismic restraint systems drawings specified in Section 40 05 01.
   3. The resulting drawings, calculations, and work product for the expansion control system shall bear the Design Professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

B. Design Guidelines:
   1. The Design Professional shall use the following guidelines in preparation of the designs and calculations specified in paragraph 1.09 Expansion Control Design.
      a. The difference between the minimum and maximum temperatures listed in the table in paragraph 2.01 Service Requirements shall be used for calculating pipe expansion.
      b. Published coefficients of thermal expansion for pipe materials shall be used for the listed temperature range. The source of the coefficients of expansion used in the calculations shall be included with the information provided as Product Data.
      c. Expansion control systems shall be designed for maximum reliability. Unless otherwise indicated on the Drawings, "L", "U", or "Z" bends shall be employed to control expansion in preference over expansion joints.
      d. Expansion control systems using pipe bends shall be designed to limit bending stress in the pipe associated with deflection at the worst case temperature difference. The maximum allowable bending stress shall be 1/3 of the yield stress for the pipe material. If loading conditions or uncertainties warrant, a lower allowable stress value shall be used. A recognized pipe bending stress calculation method and documentation supporting its use shall be provided as Product Data.
      e. The requirements set forth in Section 40 05 06.23 shall prevail if expansion joints are used. Expansion control design for expansion joints shall conform to the guidelines given in the Standards of The Expansion Joint Manufacturers Association, Inc. (EJMA).

f. If the Design Professional chooses to use expansion control or pipe support methods that involve higher loadings on the structure than are specified and/or shown on the drawings, the Engineer shall be notified in the submittal required in Section 40 05 01. The requested loads shall be listed and the Engineer will redesign the structure as necessary at the Contractor's expense.

g. The test pressures listed in the Piping Systems Schedules sheets shall be used when calculating pressure forces.

h. Pipe guides or planar pipe guides shall be provided to control the movement of pipes when "L", "U", or "Z" bends are used for expansion control. The guides shall be located as indicated in EJMA standards. An alternative recognized standard may be used for this purpose only upon approval by the Engineer.

i. For piping systems with potentially large loads, recommended main anchor locations are shown on the drawings. Intermediate anchors shall be provided as needed. Maximum forces that the structure can withstand at the main anchor points are noted on the drawings. Anchors shall be designed to attach to the structure and solidly to the pipe. Pipe clamps or U-bolts are not allowed unless they are designed to withstand the forces imposed upon the anchor and have stops welded to the pipe so that the pipe cannot slip in the anchor.

j. Anchors and guides shall be coordinated with the pipe support systems specified in Section 40 05 07 and seismic restraints specified in Section 40 05 07.13.

k. The design of the expansion control, pipe support and seismic restraints for the listed piping systems shall be integrated to provide maximum flexibility for maintenance access to equipment, appurtenances such as valves etc., and to the pipe itself.

l. The piping layout indicated shall be reviewed in relation to, surrounding structures, adjacent piping and equipment before selecting the anchors, guides, and expansion control method to be used at each point.

m. There shall be no metal-to-metal contact between a pipe and restraint component of dissimilar metals.

n. Branch lines shall not be used to anchor main lines.

o. For elevated pipe sections, fabricated support frames or other appropriate structures shall be designed to withstand the specified loads plus gravity and seismic loads. The supports shall be designed to provide access to equipment, walkways, gates, and other piping.



## PART 2 PRODUCTS

### 2.01 PERFORMANCE/ DESIGN REQUIREMENTS

A. Service Conditions:

1. Expansion control as specified in this section shall be provided to control pipe movements and loads occurring as a result of pipeline temperature changes.
2. Those piping systems listed in the following table shall be provided with expansion control conforming to good engineering practice.

| Piping system | Minimum temperature, degrees F | Maximum temperature, degrees F |
|---|---|---|
| FOG | 30 | 140 |
| HWS | 70 | 230 |
| HWR | 70 | 230 |

## 2.02 MATERIALS

A. Unless otherwise specified, anchors, and guides shall be manufactured of iron or steel, including braces, pipe and structural attachments, and shall be hot-dip galvanized after fabrication. Supports cast integrally with cast iron fittings are specifically prohibited for use in any application where shear forces may be imposed on the support.

B. Structural anchors may be fabricated from structural steel and coated as specified in Section 09 90 00.

C. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in Sections 26 05 00-1.05 Corrosive Areas and 1.05 Hazardous (Classified) Areas, which shall be Type 304 stainless steel.

D. Also listed in Section 26 05 00-1.05 Hazardous (Classified) Areas are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe support, anchor and brace components (not just fittings and accessories) shall be made of fiberglass.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install the expansion control system in accordance with the drawings required in paragraph 1.09 Expansion Control Design.

B. Metal-to-metal contact between a pipe and pipe anchor of dissimilar metals is not permitted.

C. Weld and bolt attachments to the building structural steel in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

D. Provide embedded anchor bolts instead of concrete inserts, wedge anchors, expansion anchors, adhesive, or other non-embedded type of anchor for expansion control installations in areas below water surface or normally subject to submergence. Anchor bolt installation as specified in Section 05 50 20.

E. Install thermal pipe hanger shields on insulated piping at required locations during guide installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Roller assemblies are specified in the Drawings. Roller shall roll freely without binding.

H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7 feet above the floor.

## 3.02 INSPECTION AND CERTIFICATION

A. The Design Professional retained by the Contractor under the provisions of Section 40 05 01 and this Section shall inspect the completed expansion control system at not less

than bi-weekly intervals during construction and furnish the Engineer with monthly reports.

B. The Design Professional shall inspect the completed expansion control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 07 requirements.

## PART 4 SCHEDULES

### 4.01 EXPANSION CONTROL SCHEDULES

A. General: Anchor, guide, and expansion joint locations shall be indicated on the piping layout drawings required by Section 40 05 01 and paragraph 1.09 Expansion Control Design. In addition, schedules shall be prepared as specified below.

B. Anchors:
   1. The anchor schedule shall list as a minimum:
      a. Anchor Point Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Forces
      f. Load, pounds
      g. Direction
      h. Anchor Description
      i. Remarks

C. Guides:
   1. The guide schedule shall list as a minimum:
      a. Guide Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Guide Description
      f. Remarks

D. Expansion Joints:
   1. The expansion joint schedule shall list as a minimum:
      a. Expansion Joint Label
      b. Pipe Size and Service
      c. Contract Drawing No.
      d. Layout Drawing No.
      e. Movement, inches
         1) Lateral movement
         2) Compression movement

3) Extension movement
4) Angular movement

f. Maximum Spring Force, pounds
g. Test Pressure, PSIG
h. Pressure Force, pounds
i. Total Forces
j. Load, pounds
k. Direction
l. Expansion Joint Description
m. Special Features
n. Remarks

**END OF SECTION**

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SECTION 40 05 19

DUCTILE IRON PIPE

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section specifies ductile iron pipe and fittings.

### 1.02 RELATED SECTIONS

A. Section 01 33 00 – Submittal Procedures

B. Section 01 66 00 – Product Storage and Handling Requirements

C. Section 40 05 01 – Piping Systems

D. Section 40 05 02 – Piping System Schedules

E. Section 40 05 06 – Specialty Coupling and Adapters for Process Piping

### 1.03 REFERENCES

A. This section and the corresponding Piping System Schedules (Section 40 05 02) contain references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ASME B16.1 | Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250 |
| ASME B16.5 | Pipe Flanges and Flanged Fittings |
| ASTM B1000 | Casting Preparation and Test Procedure of Porcelain Enamel-lined Pipe, Fittings, and Valves for Use in the Municipal Wastewater, Sewage, and Water Treatment Industry |
| ASTM C150 | Portland Cement |
| ASTM A716 | Standard Specification for Ductile Iron Culvert Pipe |
| AWWA C104 | Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe |
| AWWA C105 | Polyethylene Encasement for Ductile-Iron Pipe Systems |
| AWWA C110 | Ductile-Iron and Gray-Iron Fittings |
| AWWA C111 | Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings |
| AWWA C115 | Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges |
| AWWA C116 | Protective Fusion-Bonded-Epoxy Coating for the Interior and Exterior Surfaces for Ductile-Iron and Gray-Iron Fittings. |
| AWWA C150 | Thickness Design of Ductile-Iron Pipe |
| AWWA C151 | Ductile-Iron Pipe, Centrifugally Cast |
| AWWA C153 | Ductile-Iron Compact Fittings |
| AWWA C600 | Installation of Ductile-Iron Water Mains and Their Appurtenances. |

| Reference | Title |
|---|---|
| AWWA C606 | Grooved and Shouldered Type Joints |
| ISO 8179-1 | Ductile Iron Pipes – Externa Zinc-based Coating - Part 1: Metallic Zinc with Finishing Layer |

## 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer is the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance with the specifications. Failure to include a copy of the marked-up specification sections along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Manufacturer's product data, catalog cuts, dimensions and materials. Indicate each Piping System Schedule where the product will be used.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Certifications indicated in the following documents:
      a. ASTM A716, sworn statement of inspection and certification
      b. AWWA C110, certification of inspection and testing
      c. AWWA C111, record of specified tests
      d. AWWA C115, affidavit of compliance
      e. AWWA C151, manufacturer's statement and affidavit of compliance
      f. AWWA C606, affidavit of compliance



## 1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.

B. Lift and handle glass lined pipe from the exterior of the pipe. Lifting or handling glass lined pipe using hooks, forks, or chains in contact with the interior of the pipe is not permitted.

# PART 2 PRODUCTS

## 2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards identified in Section 40 05 02 and related sections.

B. Pipe.
   1. Provide increased wall thickness where specified on the Drawings.

## 2.02 PIPE AND FITTING LINING

A. Provide pipe and fittings with lining as specified in Piping System Schedules in Section 40 05 02.00 through 40 05 02.99. Requirements for each lining type are specified in this Section.
   1. Cement-mortar Lining
      a. Factory applied
      b. Line pipe and fittings with cement mortar as specified in AWWA C104.
      c. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalis.
      d. Patch field welds, cuts, connections, and damaged lining in accordance with AWWA C104.
   2. Glass Lining
      a. Factory or Shop applied per ASTM B1000 and lining manufacturer's recommended installation procedures.
      b. Prepare pipe and fittings per ASTM B1000. Bore, machine, or grit blast pipe to remove any voids, protrusions or surface irregularities and to obtain a smooth continuous surface for glass lining. Grind or grit blast fittings to remove any voids, protrusions or surface irregularities. Boring, machining, or grit blasting shall not reduce the minimum pipe wall thickness below the minimum wall thickenss required for standard Thickness Class 53 Ductile Iron Pipe (for pipes 6-inch nominal diameter and greater) and standard Thickness Class 56 Ductile Iron Pipe (for pipes smaller than 6-inch nominal diameter).
      c. Line pipe and fittings with glass lining, 10 mils minimum thickness, using a dual layer coating system of vitreous material conforming to ASTM B1000.
      d. Provide continuous coverage glass lining as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection. Maximum holiday indications limiter per ASTM B1000.
      e. Damaged glass lining cannot be repaired. Cut or damaged glass lined pipe must be replaced.
      f. Candidate manufacturers:
         1) Ferrock, MEH 32
         2) Vitco SG 14
         3) CBGL911
         4) Approved equal
   3. Ceramic Epoxy
      a. Factory applied per manufacturer's recommendations.
      b. Line pipe and fittings with amine cured novolac epoxy containing at least 20 percent ceramic quartz pigment.
      c. 40 mils minimum thickness
      d. Candidate Manufacturers:
         1) Protecto 401

2) Approved equal

4. Unlined
   a. Provide pipe and fittings with a bare metal (no coating) interior.

## 2.03 PIPE AND FITTING COATING

A. Provide pipe with coating as specified in Piping System Specification Sheets in Section 40 05 02. Requirements for each coating type are specified in this Section.
   1. Asphaltic Coating
      a. Factory applied
      b. Coat pipe and fittings with 1 mil, minimum, of asphaltic material as specified in AWWA C151.
   2. Zinc Coating with Asphaltic Top Coat
      a. Factory applied
      b. Coat pipe and fittings with a layer of arc-sprayed zinc per ISO 8179-1. Zinc applied at not less than 200 g/m$^2$ of pipe surface area. Apply a finishing layer asphaltic topcoat per AWWA C151.
   3. Polyethylene Encasement
      a. Field installed
      b. Encase pipe and fittings in polyethylene wrap as specified in AWWA C105.
      c. Polyethylene tubing shall be Anti-Microbial, Low Density Polyethylene (LDPE) or High Density Polyethylene (HDPE):
         1) LDPE: 8-mil linear low density polyethylene film meeting the requirements of AWWA C105, impregnated with ½ percent NM-100 anti-microbial compound. Fulton Enterprises Biofilm, or Approved Equal.
         2) HDPE: 4-mil high density, cross-laminated polyethylene film meeting the requirements of AWWA C105.
      d. Seam/Joint Tape – Acceptable manufacturer:
         1) Polyken No. 900 (polyethylene)
         2) Scotchwrap No. 50 (polyvinyl)
         3) Approved equal
   4. V-Bio Enhanced Polyethylene Encasement
      a. Field installed
      b. Encase pipe and fittings in polyethylene tubing as specified in AWWA C105.
      c. Three layer, co-extruded, linear low density polyethylene wrap.
      d. 8 mils minimum wrap thickness
      e. Inner surface of polyethylene wrap infused with anti-microbial biocide and corrosion inhibitor.
      f. Candidate Manufacturers:
         1) Daubert Cromwell
         2) Approved Equal
   5. Polyamidoamine Epoxy Primer
      a. Factory or shop applied
      b. Coat pipe and fittings with Amide or Polyamide cured epoxy, 4 to 8 mils DFT

6. Uncoated
    a. Provide pipe and fittings with a bare metal (no coating) exterior.

## 2.04 FUSION-BONDED EPOXY LINING AND COATING FOR PIPE AND FITTINGS

A. Factory or shop applied

B. Fusion Bonded Epoxy lining and coating per AWWA C116.

## 2.05 JOINTS AND COUPLINGS

A. Push-On (PO) Joint (Unrestrained)
    1. Rubber ring compression gasket, push-on type joints conforming to AWWA C111.
    2. 5 degree deflection at rated operating pressure for joints on 4-inch through 30-inch pipe.
    3. Candidate manufacturers:
        a. American Cast Iron Pipe Company Fastite
        b. U.S. Pipe Tyton Joint
        c. Approved equal

B. Restrained Push-On (RPO) Joint
    1. Restrained, rubber ring compression gasket, push-on joints conforming to AWWA C111
    2. Restrained by the interference of metallic rings, bolts, locking segments or other interlocking components with flanges, lugs, beads, grooves or retainer rings that are integrally cast into or welded onto both ends of the joint. Restrained joints with gripping wedges, or gripping gaskets, radial pads, or other devices that penetrate, grip, or embed in the pipe material to resist axial thrust loads are not acceptable.
    3. Candidate manufacturers:
        a. American Cast Iron Pipe Company, Flex-Ring or Lok-Ring
        b. U.S. Pipe, TR Flex or HP LOK
        c. Approved equal

C. Mechanical Joint (MJ)
    1. Mechanical Joints per AWWA C110 and AWWA C111

D. Restrained Mechanical Joint (RMJ)
    1. Restrained by tie-rods/bolts tying the gasket gland to a second retainer/follower gland behind a welded ring on the spigot end of the joint. Restrained joints with gripping wedges, or gripping gaskets, radial pads, or other devices that penetrate, grip, or embed in the pipe material to resist axial thrust loads are not acceptable.
    2. Fully restrained mechanical joints for above or below ground service conforming to AWWA C110 and AWWA C111.
    3. Candidate manufacturers:
        a. American Cast Iron Pipe Company, Mechanical Joint Coupled Joint
        b. U.S. Pipe, BOLT-LOK or MECH-LOK
        c. Approved equal

E. Grooved couplings (CGRV) and fittings
   1. Cast or cut groove dimensions per AWWA C606
   2. Flexible or Rigid Couplings as specified in the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99).
   3. When pipe wall thickness does not meet the minimum requirements of AWWA C606 for rolled or cut groove joints, provide shouldered ends per the requirements of AWWA C606.
   4. Candidate manufacturers:
      1) Victaulic
      2) Gruvlok
      3) Approved equal
   5. Grooved end flanged coupling adapters candidate manufacturers:
      a. Victaulic Style 341
      b. Approved equal
   6. Grooved end transition couplings to steel pipe candidate manufacturers:
      a. Victaulic Style 307
      b. Approved equal

F. Ring Joint Coupling (RJC):
   1. Circumferential coupling segments bolted together to engage shouldered end or ring adpapters. Groove dimensions per coupling manufacturer's requirements.
   2. Flexible or Rigid Couplings as specified in the Piping System Schedules (Sections 40 05 02.00 through 40 05 02.99).
   3. When pipe wall thickness does not meet the minimum requirements for the specified groove joint(s), provide shoulder ends or ring adapters welded to pipe ends.
   4. Candidate manufacturers:
      a. Victaulic Vic-Ring
      b. Approved equal

G. Bell and Ball Spigot Flexible (BABS) Joint
   1. Boltless type with retainer lock to prevent rotation after assembly
   2. Up to 15 degrees of deflection at operating pressure
   3. Candidate manufacturers:
      a. Flex-Lok Joint by American Cast Iron Pipe
      b. USIFlex by US Pipe
      c. Approved equal

H. Sleeve/Transition Coupling
   1. When connecting new ductile iron piping to existing piping, field verify outside diameters of existing pipe prior to connection. See drawings for location and installation requirements.
   2. Candidate Manufacturers:
      a. Romac, "501"
      b. JCM, "212"

c. Smith-Blair, "461"
d. Approved equal

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. General:
1. Follow piping routes specified on the drawings as closely as possible. Submit proposed deviations in accordance with Section 01 33 00.
2. Install pipe in accordance with AWWA C600.
3. Make connections to existing structures and manholes so that the finished work will conform as nearly as practicable to the requirements specified for new manholes, including necessary concrete work, cutting and shaping. Shape concrete mortar within any structure and manhole as specified.

B. Insulating Sections: Where a metallic nonferrous pipe/appurtenance connects to ferrous pipe/appurtenance, provide an insulating section per Section 40 05 06.

C. Anchorage: Provide as specified on the Drawings.

### 3.02 REPAIR/RESTORATION

A. Per Section 40 05 01

### 3.03 COMPONENT TEST PHASE

A. Buried Piping: Test hydrostatic pressure in accordance with Section 5 of AWWA C600, using the test pressures and allowable leakage specified in Section 40 05 01.

B. Exposed and Concrete Encased Piping: Conduct hydrostatic pressure tests in accordance with Section 40 05 01.

### 3.04 POLYETHYLENE ENCASEMENT

A. Install polyethylene as specified in AWWA C105 and within this Section.

B. Wrapping:
1. Wrap buried pipe, fittings, valves, and couplings.
2. Prior to the placing of concrete, wrap fittings that require concrete backing.
3. Wrap the polyethylene tube seams and overlaps and hold in place by means of a 2-inch-wide plastic backed adhesive tape.
4. The tape shall be such that the adhesive shall bond securely to both metal surfaces and polyethylene film.
5. Bedding and initial backfill for polyethylene wrapped pipe shall be a well-graded granular material to avoid cutting or damaging the polyethylene tube during placement and backfilling.

**END OF SECTION**

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SECTION 40 05 23

STAINLESS STEEL PROCESS PIPE AND TUBING

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section specifies stainless steel pipe and fittings.

### 1.02 RELATED SECTIONS

A. Section 40 05 01 – Piping Systems

B. Section 40 05 02 –Piping System Schedules

### 1.03 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.



| Reference | Title |
|---|---|
| ANSI B31.3 | Process Piping |
| ASME Section IX | Boiler and Pressure Vessel Code; Welding and Brazing Requirements |
| ASTM A480 | General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip |
| AWWA M11 | Steel Pipe-A Guide for Design and Installation |
| AWWA C227 | Bolted, Split-Sleeve Restrained and Non-Restrained Couplings for Plain-End Pipe |
| AWWA C606 | Grooved and Shouldered Joints |
| CSA W48.3 | Low Alloy Steel Covered Electrodes for Shielded Metal Arc Welding |

### 1.04 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.

2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the CONTRACTOR, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The CITY shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the CONTRACTOR with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
3. Piping layout drawings as specified in Section 40 05 01.
4. Manufacturers' product data, catalog cuts, typical installation details, and dimensions. Indicate on the submittal each piping system where the product will be used.
5. Pipe wall thickness calculations for pipe fabricated per AWWA C220. Demonstrate the maximum permissible internal design pressure in the pipe based on the wall/shell thickness specified in the Piping System Schedule for the associated Process Service and pipe size and the support and/or bedding conditions specified on the Drawings. Steel pipe design calculations conform to AWWA M11.
6. Pipe wall thickness and reinforcement calculations for fittings fabricated per AWWA C226. Demonstrate that the maximum permissible internal design pressure for fabricated fittings matches or exceeds the maximum permissible internal design pressure in the connecting pipe for the support and/or bedding conditions specified on the Drawings. Fabricated steel pipe fitting design calculations conform to AWWA M11.
7. Calculations for any pipe and fittings that are not fabricated per one of the components standards listed in the specified ASME B31 code.
8. Submit calculations for engineered flange face rings in accordance with Appendix D of ASME Section VIII Division 1.

B. Informational Submittals:
1. Procedures: Section 01 33 00.
2. Manufacturers' certificates of compliance with specified industry standards.

## 1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 6600 for Shipment and Storage.

B. Deliver pipe and fittings with end protectors in place. Do not remove protectors until materials are about to be installed.

C. Prevent carbon steel contamination of stainless steel pipe and fittings during storage, handling, fabrication, and installation.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. All pipe system materials to be new, free from defects and conforming to the requirements and standards specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) and this Section.

B. Pipe.
   1. Use pickled and annealed sheet or plate for manufacture of fabricated stainless steel pipe.
   2. Finish.
      a. 8-gage through 16-gage material: No. 1 or 2B per ASTM A480.
      b. 3/16-inch and heavier plate material: No. 1 mill finish per ASTM A480, "Hot-Rolled or Cold-Rolled, and Annealed or Heat Treated, and Blast Cleaned or Pickled."

C. Shop-fabricated stainless steel pipe and fittings.
   1. Furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be provided.
   2. Manufacture using Weld Procedure Specifications (WPS) that have been qualified under ASME Section IX. Document qualifications in Procedure Qualification Reports (PQR). Use only certified welders who have successfully completed performance qualification tests per ASME Section IX for manufacture of stainless steel pipe.

D. Flanges.
   1. Plate steel backing ring flanges, AWWA C207 Class D minimum thickness.
   2. Ductile iron backing ring flanges with the following flange thicknesses.

| Flange Size, in | Flange Thickness, minimum, in. |
|---|---|
| 3 | 1/2 |
| 4 | 9/16 |
| 6 thru 10 | 5/8 |
| 12 thru 16 | 3/4 |
| 18 thru 22 | 7/8 |
| 24 thru 30 | 1 |
| 36 | 1-1/8 |
| 42 | 1-1/4 |
| 46 to 54 | 1-3/8 |
| 60 | 1-1/2 |

   3. Stub ends.
      a. Wall thickness equal to or greater than pipe or fitting to which it is welded.
      b. Lap face/gasket mating surfaces clean, free of debris, with welds ground flush and surface roughness between 3.18 and 12.7 microns RMS.

E. Fittings.
   1. Double ferrule compression fittings capable of holding the full bursting pressure of connected tubing.
   2. Candidate manufacturers for double ferrule compression fittings.
      a. Swagelok.
      b. Gyrolok.
      c. Approved Equal.
   3. Provide straight tapered reducers. Flanged & flued reducers and bushing type adapters are not permitted.
   4. Pressure rating and thickness of elbows, tees, crosses, and wyes equal to or greater than connecting pipe.

F. Grooved couplings and fittings.
   1. Flexible and rigid coupling with pipe grooves compliant with AWWA C606.
   2. When pipe wall thickness does not meet the minimum requirements of AWWA C606 for rolled or cut groove joints, provide shoulder ends per the requirements of AWWA C606.
   3. Candidate manufacturers.
      a. Victaulic
      b. Gruvlok
      c. Approved equal.

G. Bolted split sleeve couplings.
   1. AWWA C227 compliant sleeve with single or double arch cross section of the same material as pipe. Body thickness equal to or greater than that of connecting pipe wall thickness.
   2. Candidate manufacturers.
      a. Victaulic, Style 231S through 234S.
      b. Approved equal.



## 2.02 SHOP FABRICATION

A. Metal forming processes.
   1. Use pinch rolls with a hard chrome finish to form cylinders. Thoroughly clean the rolls using Avesta BlueOneTM 130 Pickling Paste or approved equal, prior to roll forming the pipe. Alternatively, provide a protective barrier between the stainless steel plate/sheet and the plate rolls during the forming process.
   2. Provide a protective barrier between pipe welding rollers and the stainless steel pipe cylinder. Alternately, new rollers or rollers that have been turned down on a lathe to provide a new and clean working face may be used.

B. All saws, drills, files, wire brushes, grinding wheels, etc. will be free of carbon contamination and designated for stainless steel use only.

C. Provide nonferrous, stainless steel, or rubber-lined pipe storage and fabrication racks.

D. Use nylon slings or straps for handling stainless steel piping.

E. Preparation of surfaces to be welded.
   1. Surfaces of joints to be welded are to be free from mill scale, slag, grease, oil, paint, rust, and other foreign material.
   2. Use only stainless wire wheels and grinding wheels that have not come into contact with carbon steel.
   3. Flame cutting or any use of oxy-acetylene gas cutting tools is prohibited. Use plasma arc torch with a nitrogen or argon-hydrogen carrier gas, laser or waterjet processes for cutting and plate beveling.
   4. Air arc and gas backgouging are prohibited. Use grinding and plasma gouging methods to achieve full penetration welds.

F. Welding.
   1. Welding and production processes are to conform to ASME B31.3.
   2. Use of Solar Flux is prohibited.
   3. Use of FCAW welding is prohibited.
   4. Pipe and fittings with wall thickness up to 11-gage (1/8-inch): weld using the GTAW process.
   5. Pipe and fittings with wall thicknesses greater than 1/4 inch may be welded using an automated SAW process.
   6. Pipe and fittings with wall thickness greater than 11-gage (1/8-inch): Bevel and complete root pass using the GTAW process, followed by subsequent passes with the GTAW, GMAW, or Metallic Arc SMAW process.
   7. Filler material:
      a. Add only ELC wire grades to provide a cross section at the weld equal to or greater than the parent metal.
      b. SMAW electrodes to conform to CSA W48.3.
   8. Make weld deposit smooth and evenly distributed and with a crown of no more than 1/16-inch on the I.D. and 3/32-inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices are not permitted.
   9. Full penetration butt welds: provide inert gas shielding to the interior and exterior of the joint.
   10. Lap joints: provide full thickness seal welds on both joints.

G. Remove excessive weld deposits, slag, spatter, and projections by grinding. Grind welds smooth on gasket surfaces. Tack welds, clips, and other attachments.
   1. Repair nicks, gouges, notches, and depressions in the base metal in the area before the joint weld is made.
   2. Remove tack welds, clips, and other attachments and repair defects, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Remove cracked tack welds.
   3. Grind those areas to be repaired down to clean metal and then repair by building up with weld metal. Grind the repaired areas smooth to form a plane surface with the base metal.

H. Defects and repairs.
   1. Remove welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications, by chipping or grinding throughout their depth to clean base metal.
   2. Do not perform calking or peening of welds to correct defects.
   3. Enlarge welds found deficient in dimension but not in quality by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate.
   4. Remove weld deposits, slag, weld spatter, and projections into the interior of the pipe by grinding.

I. Finish.
   1. Treat all welded joints with Avesta BlueOne™ 130 Pickling Paste or approved equal and rinse with clean water.
   2. If rusting of embedded iron occurs, pickle the affected surface with Avesta BlueOne™ 130 Pickling Paste or approved equal.
   3. Rinse clean using Avesta FinishOne Passivator 630 or approved equal.



## PART 3 EXECUTION

### 3.01 GENERAL

A. Field Installation Weather conditions.
   1. Perform welding only when the surfaces are clean and completely free of any moisture or mineral deposits. Protect pipe and fittings from salt water spray or deposition or clean and protect pipe and fitting joints prior to welding.
   2. Do not weld the pipe during periods of high winds or rain unless the areas being welded are properly shielded.

B. Field welding.
   1. Use couplings and prefabrication of pipe systems at the factory to minimize field welding to the greatest extent possible. Pipe butt welds may be performed at the job site, providing the butt welds are performed only with an inert gas shielded process and that the welding requirements of this Section are rigidly adhered to.
   2. On the interior and exterior of the pipe, remove all residue, oxide, and heat stain from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Avesta BlueOne™ 130 or approved equal, followed by complete removal of the agent.

C. Use wooden scaffolding and/or ladders if possible to gain access to work areas. If metal scaffolding and/or ladders must be used, tape or otherwise shield the contact points between scaffolding/ladders and the stainless steel.

D. After installation, wash and rinse all foreign matter from the piping surface. Adhere to the passivation manufacturer's recommendations and local regulations for safety and disposal of any waste chemicals.

## 3.02 REPAIR/RESTORATION

A. Per Section 40 05 01 and as specified herein.

B. Paint all steel or iron flanges, couplings, and appurtenances in accordance with Section 09 90 00. Painting of the stainless steel pipe is not required.

C. Restore areas damaged or discolored by field welding or handling, iron contamination or soiled to a uniform surface finish and consistently clean surface with methods specified for shop fabrication.

D. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

## 3.03 COMPONENT TEST PHASE

A. Per Section 40 05 01.

**END OF SECTION**

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SECTION 40 05 24

STEEL PROCESS PIPE

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section specifies steel pipe and fittings.

### 1.02 RELATED SECTIONS

A. This Section contains specific references to the following related sections. Additional related Sections may apply that are not specifically listed below.
   1. Section 40 05 01 – Piping Systems
   2. Section 40 05 06 – Specialty Couplings and Adapters for Process Piping

### 1.03 REFERENCE STANDARDS

A. This Section contains references to the following documents. Those documents are a part of this Section as specified and modified. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there was no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced. In all cases, the effective version of the local building code at the time of Advertisement for Bids or Invitation to Bid shall be considered the building code in effect.



| Reference | Title |
|---|---|
| ANSI B16.3 | Malleable Iron Threaded Fittings, Class 150 and 300 |
| ANSI B16.9 | Factory-Made Wrought Steel Buttwelding Fittings |
| ANSI B16.11 | Forged Steel Fittings, Socket-Welding and Threaded |
| ASTM A36/A36M | Structural Steel |
| ASTM A47 | Ferritic Malleable Iron Castings |
| ASTM A53 | Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless |
| ASTM A105/A105M | Forgings, Carbon Steel, for Piping Components |
| ASTM A106 REV A | Seamless Carbon Steel Pipe for High-Temperature Service |
| ASTM A197 | Cupola Malleable Iron |
| ASTM A234/A234M | Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures |
| ASTM A283/A283M REV A | Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars |
| ASTM A536 | Ductile Iron Castings |
| ASTM A570/A570M | Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality |

| Reference | Title |
|---|---|
| ASTM A572/A572M REV B | High Strength Low Alloy Columbium-Vanadium Steels of Structural Quality |
| AWWA C200 | Steel Water Pipe 6 Inches and Larger |
| AWWA C205 | Cement-Mortar Protective Lining and Coating for Steel Water Pipe--4 In. and Larger-- Shop Applied |
| AWWA C206 | Field Welding of Steel Water Pipe |
| AWWA C207 | Steel Pipe Flanges for Waterworks Services--Sizes 4 In. Through 144 In. |
| AWWA C208 | Dimensions for Fabricated Steel Water Pipe Fittings |
| AWWA C209 | Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines |
| AWWA C210 | Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe |
| AWWA C214 | Tape Coating Systems for the Exterior of Steel Water Pipelines |
| AWWA C600 | Installation of Ductile-Iron Water Mains and Their Appurtenances |
| AWWA M11 | Steel Pipe--A Guide for Design and Installation |
| SSPC-SP10 | Near-White Blast Cleaning |

## 1.04 QUALITY ASSURANCE

A. Testing:
   1. Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.



# PART 2 PRODUCTS

## 2.01 PIPE MATERIALS

A. Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 40 05 01.

B. Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

## 2.02 PIPE MANUFACTURE

A. Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 40 05 01. The minimum wall thickness for ASTM A53 or ASTM A106 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

B. AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

## 2.03 CONNECTIONS

A. Connections shall be as specified in Section 40 05 01 and shall conform to Section 40 05 06. Coating for buried connections shall be as specified in Section 40 05 06.

## 2.04 FITTINGS AND APPURTENANCES

A. Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

B. Unless otherwise specified, steel fittings and appurtenances shall conform to the requirements of ASTM A234, ASTM A105, or ANSI B16.11; and fabricated steel fittings and appurtenances shall conform to AWWA C208.

C. Fittings for grooved end piping systems shall be full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings. Cast fittings shall be cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. Standard steel fittings, including large size elbows, shall be forged steel conforming to ASTM A106. Standard segmentally welded fittings shall be fabricated of Schedule 40 carbon steel pipe.

D. Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

## 2.05 PIPE LINING

A. Epoxy:
   1. Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:
      a. No coal tar products shall be incorporated in the liquid epoxy.
      b. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.
   2. The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. Cement Mortar:
   1. Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2-inch by 4-inch by 13-gage self-furling wire mesh reinforcement for hand-applied lining.

C. High Temperature Service Epoxy:
   1. Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC-SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

## 2.06 PIPE COATING

A. Epoxy:
   1. Unless otherwise specified, pipe and fittings shall be coated with a liquid epoxy as specified in AWWA C210 with the following exceptions:
      a. No coal tar products shall be incorporated in the liquid epoxy.

b. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

2. The coating shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. Polyethylene Tape:

1. Where specified, pipe and fittings shall be coated and wrapped with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C214. The coating application shall be a continuous step operation in conformance with AWWA C214, Section 3. The total coating thickness shall be not less than 50 mils for pipe 24 inches and smaller and not less than 80 mils for pipe 26 inches and larger.

## 2.07 FUSION EPOXY COATING AND LINING

A. Where specified, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 203, or equal. Surface preparation shall be in accordance with SSPC-SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 12 mils minimum dry film thickness.

B. Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 306.

## 2.08 JOINT GASKETS

A. Joint gaskets shall be in accordance with Section 40 05 06.

## 2.09 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:

1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.
2. Contractor's layout drawings as specified in Section 40 05 01.



# PART 3 EXECUTION

## 3.01 INSTALLATION

A. General:

1. Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 40 05 06.
2. Sleeve-type mechanical pipe couplings shall be provided in accordance with AWWA M11 and Section 40 05 06.
3. Pipe lining and coatings at field joints shall be applied as specified in paragraphs 2.05 and 2.06.
4. Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in Section 40 05 06.

B. Anchorage:

1. Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01 33 00.

## 3.02 TESTING

A. Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 05 01.

**END OF SECTION**

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SECTION 40 05 31.13

SOLVENT CEMENT WELDED PVC AND CPVC PRESSURE PIPE

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section specifies Polyvinylchloride (PVC) and Chlorinated Polyvinylchloride (CPVC) pipe and fittings with solvent cement welded or threaded connections/joints.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 60 00 – Product Requirements
   3. Section 09 90 00 – Painting and Coating Systems
   4. Section 40 05 02 – Piping System Schedules



### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

| Reference | Title |
|---|---|
| ASME B31.3 | Process Piping |
| ASTM D1784 | Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds |
| ASTM D1785 | Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2464 | Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2466 | Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 |
| ASTM D2467 | Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2564 | Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings |
| ASTM D2855 | Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings |
| ASTM F402 | Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings |
| ASTM F437 | Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM F438 | Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40 |
| ASTM F439 | Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM F441 | Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 |
| ASTM F477 | Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F493 | Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings |
| ASTM F656 | Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic |
| ASTM F1970 | Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems |

## 1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. PVC: Polyvinylchloride
   2. CPVC: Chlorinated Polyvinylchloride

## 1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this specification section with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote each deviation with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification section along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Piping layout drawings as specified in Section 40 05 01.
   4. Manufacturer's product data, catalog cuts, typical installation details, and dimensions. Indicate each Piping System Schedule where the product will be used.

## 1.06 DELIVERY, STORAGE AND HANDLING

A. Procedures: Section 01 66 00 for shipment and storage.



# PART 2 PRODUCTS

## 2.01 MATERIALS

A. Provide PVC and CPVC piping system materials as specified in Piping System Schedules (Section 40 05 02.00 through Section 40 05 02.99) for the specified Process Service.

## 2.02 COMPONENTS

A. CPVC Solvent Weld Cement:
   1. Pipe and fittings 6-inch diameter and smaller: IPS 724 Weld-on Cement or Approved Equal.
   2. Pipe and fittings greater than 6-inch diameter: IPS 729 Weld-on Cement or Approved Equal.
   3. Heavy bodied, medium setting.
   4. ASTM F493, 100 percent solvent and CPVC resin. No fillers permitted.
   5. Universal plastic pipe solvent is not acceptable.
   6. Formulated for use with sodium hypochlorite solution and other caustic solutions.

B. PVC Solvent Weld Cement:
   1. Pipe and fittings 12-inch diameter and smaller: IPS 711 Weld-on Cement or Approved Equal.
   2. Pipe and fittings greater than 12-inch diameter: IPS 719 Weld-on Cement or Approved Equal.
   3. Heavy bodied, medium setting.
   4. ASTM 2564, 100 percent solvent and PVC resin. No fillers permitted.
   5. Universal plastic pipe solvent is not acceptable.

C. Primer:
   1. Staining solvent conforming to standard ASTM F656.
   2. Manufactured by solvent weld cement manufacturer.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Join by means of socket fittings and solvent cement welding in conformance with ASTM D2855 and ASTM F402.

B. Make solvent-cemented joints in strict compliance with the manufacturer's/supplier's instructions and recommended procedures.

C. Connections:
   1. Connect to different pipe materials by means of flanges, specified adapters, or transition fittings.
   2. Provide threaded by solvent-welded socket joint adapters at connections to equipment and appurtenances with threaded connections.
   3. Foreign material to be removed from the pipe interior prior to assembly.

D. Plastic pipe installation personnel trained to ASME B31.3.

E. Bedding and Backfill: As approved by Engineer. Blocking under pipe is not permitted.



### 3.02 FIELD QUALITY CONTROL

A. Conduct hydrostatic pressure tests in accordance with Section 40 05 01.

**END OF SECTION**

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SECTION 40 05 45

PIPING SYSTEM IDENTIFICATION

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section specifies the supply and installation of permanent identification labels and markers for piping systems.

B. Requirements for the supply and installation of permanent identification tags for valves are specified in Section 40 05 60.

### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 33 00 – Submittal Procedures
   2. Section 01 45 00 – Area Exposure Designations
   3. Section 40 05 02 – Piping System Schedules
   4. Section 40 05 60 – Valves



### 1.03 REFERENCES

A. References:
   1. This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

| Reference | Title |
|---|---|
| ASME A13.1 | Scheme for the Identification of Piping Systems |
| ANSI Z535.1 | Safety Colors/APWA Uniform Color Code for Marking Underground Utilities |

## 1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:
   1. Embedded/Encased piping: Piping enveloped in concrete, typically under structures or under roadways.
   2. Exposed: All area exposures specified in Section 01 45 00 other than buried, submerged, or encased/embedded.
   3. Buried: Below grade walls or roofs; locations covered and in contact with earth/soil.

## 1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Provide a full line product brochure showing available Piping System Marker and Detectable Warning Tape standard text and color options. Submit all text and colors proposed for use.
   3. Provide manufacturer's recommended installation instructions for Detectable Warning Tape.
   4. Provide product brochures and data sheets for tracer wire and splice kits. Submit all wire insulation colors proposed for use.
   5. Submit proposed tracer wire access box(es) for test leads. Submit electrical continuity test results upon completion.
   6. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.

B. Informational Submittals:
   1. Procedures: Section 01 33 00.
   2. Electrical continuity test results.
   3. Sample of each piping identification plastic marker used.
   4. Sample of each detectable warning tape used.



# PART 2 PRODUCTS

## 2.01 PIPING SYSTEM MARKERS FOR EXPOSED PIPE

A. Identify material contained in exposed piping systems using a colored plastic marker legend system conforming to ASME A13.1.

B. For exposed piping, provide pre-coiled mechanically attached type colored markers that are easily removable. Adhesive type markers are not acceptable.
   1. Resistant to petroleum based oils and grease and meet criteria for humidity, solar radiation, rain, salt, fog, leakage and fungus specified by MIL-STD-810.
   2. Withstand a continuous operating temperature range of -40 to 250 degrees.
   3. Manufactured and applied in one continuous length of plastic including directional arrows. Markers comprised of letters and directional arrows individually applied to the maker are not acceptable. Legends and arrows printed on polyester subsurface and over laminated with Tedlar.

4. Text size per ASME A13.1.
5. Marking Services Style MS-995, Brady Style B-689, or approved equal.

C. Each piping system marker to be color coded for identification and labelled with the Process Service Identifier and directional flow arrows indicating the direction of flow in the pipe. Piping System marker background colors are specified in Section 40 05 02 for each process service. Except for piping system markers with an orange, yellow or white background color, provide white text and directional arrows for all piping system markers. Provide black text and directional arrows for pipe markers with an orange, yellow or white background.

## 2.02 DETECTABLE WARNING TAPE AND TRACER WIRE FOR BURIED PIPE

A. Provide Detectable Warning Tape for all buried piping:
   1. Detectable Warning Tape shall be 6 inches wide, colored per ANSI Z535.1 (APWA Uniform Color Code for Marking Underground Utilities) and made of inert plastic material suitable for direct burial with solid aluminum foil core. Minimum 5 mil laminate thickness. Tin or nickel plated clips for joining sections of tape, as provided by the tape manufacturer.
   2. Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or approved equal.
   3. Print two messages on buried Detectable Warning Tape. The first message reads **"CAUTION CAUTION CAUTION _____ PIPE BURIED BELOW"** with bold letters approximately 2 inches high. Fill the blank with the Process Service name. The second message reads **"CALL _____"** with letters approximately 3/4 inch high. Both messages printed at maximum intervals of 2 feet. Fill the blank with phone number provided by the Engineer.

B. Install tracer (locate) wire along the buried portion of pipe alignments, as directed by Engineer.
   1. Direct burial rated, 12 gauge solid copper, 600-volt UF tracer wire with heavy-duty PVC insulation. Tracer wire insulation color-coded to match each utility service as designated in ANSI Z535.1 (APWA Uniform Color Code for Marking Underground Utilities).
   2. SPLICES: Silicone-filled UL-Listed product specifically designed for waterproof direct bury splicing of tracer wire. 3M DBR-6; or approve equal.
   3. WIRE ACCESS BOXES: Cast iron valve box top piece frame and cover set within a concrete ring cast flush with grade, as appropriate for the location in which it will be installed and for the traffic loading it may be subject to, and in accordance with the applicable elements of the Standard Detail for valve box installations. Mark lids in raised or recessed lettering with the word “Test”. Submit all wire access boxes proposed for use to the Engineer for review.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF PIPING SYSTEM MARKERS

A. Provide piping system markers and direction arrows at locations conforming to ASME A13.1 and at the following locations:
   1. Apply intermittent markings on straight pipe runs, close to all valves, fittings, and adjacent to all changes in direction.
   2. Where pipes pass through walls, partitions, and floors, apply markings on both sides of walls, partitions, and floors.
   3. At point of entry and leaving each pipe chase and/or confined space, and piping accessible at each access opening.
   4. Adjacent to valves and where valves are in series at intervals of no more than 6 feet.
   5. At least once in each room and at maximum spacing of 40 feet. Exception: gas piping to be identified at 6-ft intervals in ceiling plenums.
   6. Spacing for markings not less than 1 foot.
   7. At the beginning and end points of each run; and, at each piece of equipment in each run.

B. Visibility
   1. Place identification on the bottom of the piping system for pipe systems located near ceiling or above the normal line of sight.
   2. Place identification on the side of the piping systems for pipe systems located at the normal line of sight or below.
   3. Place identification at approximate line of sight for vertical pipe systems.



### 3.02 INSTALLATION OF DETECTABLE WARNING TAPE

A. Install a continuous ribbon of Detectable Warning Tape as specified for ALL buried piping.

B. Multiple pipes less than 4 inches in diameter installed in a common trench may be provided with a single ribbon of tape per trench. If the total width of such utilities within the common trench exceeds 3 feet, provide two parallel ribbons of tape spaced equally.

C. Provide a separate detectable warning tape for each pipe that is 4 inches or greater in size.

D. Install the tape in accordance with manufacturer recommendations.

E. At end-to-end and branch connections, provide electrical continuity connectors for detectable tape to mechanically and electrically connect ends together as recommended by the manufacturer.

F. Provide a single line of tape 2.5 feet above the centerline of buried pipe. For pipelines buried 8 feet or greater below finished grade, provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Spread tape flat with message side up before backfilling.

## 3.03 INSTALLATION OF TRACER WIRE

A. Tracer wire shall be a continuous, fully functioning, and tested system to include all appurtenances including splices and wire access boxes at grade.

B. Tracer wire laid along the top of the pipe prior to backfilling. Secure in place with tape every 20 feet. Where the pipe is encased or provided with concrete collars or cut-off walls, lay the wire on top of the encasement (do not encase the wire). Do not pull the wire taut; leave sufficient slack to allow for pipe movement and future repairs.

C. Splice tracer wire using the specified silicone-filled splice kits in accordance with manufacturer recommendations. Ensure the silicone fully encapsulates un-insulated wire ends and are made watertight.

D. Pull tracer wire up into all valve boxes, cleanout access boxes, and into all utility cabinets and meter boxes installed on the pipeline. For each wire end, provide an 18-inch long length of extra wire (coiled and tucked out of the way in an accessible location) for connection to utility locating equipment.

E. Where the pipeline enters structures, vaults, tanks, or buildings, provide a wire access box at grade adjacent to the structure or building for termination of the tracer wire. Provide an 18-inch long length of extra wire (coiled and tucked into the box) for connection to utility locating equipment. Also provide boxes at each pipeline branch, cross or tee, and at intermediate spacing along the pipeline not to exceed 1,000 feet (except where pipeline valves with valve boxes provide the required wire access at those locations and intervals).

F. Upon completion and backfill of the pipeline, test and demonstrate electrical continuity of each segment of tracer wire. Submit test results to the Owner indicating the location of the tested segment. Use conductive testing method; inductive test methods are not acceptable. Repair all faulty work at no additional cost to the Owner until the system is functional and approved.



## 3.04 FIELD QUALITY CONTROL

A. Comply with manufacturer's handling and installation instructions.

B. Provide continuity testing of tracer wire as specified herein.

**END OF SECTION**

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SECTION 40 05 57.13

MANUAL ACTUATORS

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies manual operators for valves and gates, and operator appurtenances.

### 1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or at the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| AWWA C500 | Gate Valves 3 through 48 inch NPS, for Water and Sewage Systems |



## PART 2 PRODUCTS

### 2.01 GENERAL

A. Except as specified in valve and gate specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve or gate and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

### 2.02 OPERATORS

A. General:

1. Manual operators shall have operating torques less than 80 foot-pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

B. Wrench Nuts:

1. Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

C. Chain Wheels:

1. Chain wheels shall be ductile iron. Operating chains shall be galvanized.

## 2.03 OPERATOR APPURTENANCES

A. Valve Boxes:

1. Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized.

B. Floor Boxes:

1. Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

C. Adjustable Shaft Valve Boxes:

1. Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

## 2.04 PRODUCT DATA

A. Manufacturer's catalog information and other data confirming conformance to design and material requirements shall be provided in accordance with Section 01 33 00.



# PART 3 EXECUTION

## 3.01 GENERAL

A. Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access, but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

## 3.02 OPERATORS

A. General:

1. Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

B. Wrench Nuts:

1. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.

C. Chain Wheels:

1. Unless otherwise specified, valves with centerlines more than 7 feet, 6 inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within 4 feet of the specified operating level below the valve. For plug-type valves 8 inches and larger, the operator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where the chain may hang in a walkway.

## 3.03 OPERATOR APPURTENANCES

A. Valve Boxes:

1. Valve boxes extending to finished surfaces shall be provided for buried valves.

B. Floor Boxes:

1. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.



**END OF SECTION**

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SECTION 40 05 57.23

ELECTRIC MOTOR ACTUATORS

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section includes requirements for electric motor actuators to produce rotary and linear motion to activate quarter-turn and multi-turn valves and gates in open-close, throttling, and modulating services.

### 1.02 RELATED SECTIONS

A. Section 40 06 20.13 Power Actuated Valve and Gate Schedule

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

B. Unless otherwise specified, references to documents mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.



| Reference | Title |
|---|---|
| ANSI/AWWA C542-16 | Electric Motor Actuators for Valves and Slide Gates. |
| ANSI/NEMA 250 | Enclosures for Electrical Equipment (1,000 Volts Maximum). |
| ANSI/NEMA MG1 | Motor and Generators. |
| ANSI/NFPA 70 | National Electrical Code. |
| UL 429 | Electrically Operated Valves. |
| UL 1002 | Electrically Operated Valves for Use in Hazardous (Classified) Locations. |
| NEMA ICS-2 | Industrial Control Devices, Controllers and Assemblies |

## 1.04 DEFINITIONS:

A. Use ANSI/AWWA C542-16, Electric Motor Actuators for Valves and Slide Gates definitions, unless otherwise noted.

B. For purposes of this Section, the word “valve” refers to both valves and gates.

C. Electric motor actuators are defined using the following code system which appears in the actuator specification (ACTUSPEC) sheets:

| Actuator Type (ACTUSPEC) | Service | Definition |
|---|---|---|
| EMTT | Throttling (Modulating) | Electric motor multi-turn |
| EQTT | Throttling (Modulating) | Electric motor quarter-turn |
| EMTI | Isolating (Open-Close) | Electric motor multi-turn |
| EQTI | Isolating (Open-Close) | Electric motor quarter-turn |

D. Service:
   1. Modulating: Operation characterized by the continuous positioning of a valve betweeen between fully open and closed, in response to a continuous control signal.
   2. Open-Close or Isolation: To move valve to fully open or fully closed position in one continuous operation. Alternative terms used are ON-OFF and isolating.
   3. Throttling: Operation characterized by the deliberate and/or the infrequent movement of a valve to an intermediate position, between fully open and fully closed, and maintaining that position for periods of time.



## 1.05 ADMINISTRATIVE REQUIREMENTS:

A. Unit Responsibility:
   1. Provide unit responsibility, as specified in Division 46, for the valve specified in Section 40 06 20.13 and the electric motor actuator specified in this section.
   2. Provide a completed and signed Unit Responsibility Certification Form (Form 46 05 11-C, Section 01 31 30).

B. Coordination:
   1. Data: Ensure the valve data is provided to the actuator manufacturer. Transmit the required torque or thrust, shaft diameter, thread characteristics (including right or left-hand), keyway dimensions, seating requirements (torque or position) for open and close.
   2. Conditions: Identify most adverse conditions to be encountered at any time when actuation is necessary.
      a. For multi-turn, the following additional data is required for actuator sizing:
         1) Maximum torque and thrust running load over the full cycle.
         2) Desired speed of actuation or stroking time.
         3) The stall torque or maximum thrust output of the actuator not to exceed the torque or thrust capability as determined by the valve manufacturer.
      b. For quarter-turn, the following additional data is required for actuator sizing:
         1) The required actuator torque over the full cycle of operation.

2) Desired speed of actuation or stroking time.

## 1.06 SUBMITTALS

A. Procedures:Submittal shall be provided in accordance with Section 01 33 00 and the following:.

B. Action Submittals.
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from Section requirements.
   2. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with "no changes required".
   3. Manufacturer's catalog information and other data confirming conformance to design and material requirements.
   4. Actuator Data Sheet: An information data sheet for each actuator showing required mounting, operating torque for driven equipment, torque capacity of actuator, actuator speed, associated valve torque ratings, motor data (power, hp; full load amps, locked rotor amps, rpm, duty rating). Provide actuator identification (tag) number clearly for each application on the actuator data sheet.
   5. List of components being provided for each actuator.
   6. Shop drawings:
      a. Actuator assembly.
      b. Dimensions.
      c. Electrical wiring diagrams.
   7. Actuator sizing report correlating to the coupled valve or gate type, operating torque and specified safety factor.

C. Informational Submittals:
   1. Application manuals for configuring and set up of actuator for control, monitoring and alarming.
   2. Application software and software manuals for programming communication network bus when specified. Include electronic data sheet or generic station description files for network configuration.
   3. Recommended storage practice. In addition, place this information on the outside of the actuator or shipping container as delivered to the site.

D. Closeout Submittals:
   1. Operation and Maintenance Data: Submit manufacturer’s standard operating and maintenance instructions as specified in Section 01 78 23.
   2. Training Certification Section 43 05 11-Form B.
   3. Maintenance Material:
      a. Spare Part Inventory Listing.
      b. Spare Parts.

c. Special Tools.
d. Lubrication guide.
e. Certified drawings.

4. Actuator Configuration Settings: The final settings used for configuration of the actuator to meet field operation requirements. Include both the electronic files and a hard copy printout in pdf format.

## 1.07 QUALITY ASSURANCE

A. Identification of Listed Products:
1. Provide equipment and materials listed for the purpose for which they are to be used, by an independent testing laboratory. Three such organizations are Underwriters Laboratories (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). Provide independent testing laboratory acceptable to the inspection authority having jurisdiction.

## 1.08 DELIVERY, STORAGE AND HANDLING

A. Procedures: In accordance with Section 01 66 00.

## 1.09 WARRANTY

A. Manufacturer to warrant all actuators furnished under this Section against defects in materials and workmanship for a period of two years, unless otherwise specified.



# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. Candidate manufacturers are specified on the actuator specification (ACTUSPEC) sheets. The manufacturer's standard models or products may require modification to conform to the specified requirements.

## 2.02 PERFORMANCE

A. Size actuators to produce an operating torque equal to twice the maximum required valve operating torque under the specified flow and pressure conditions. Specific requirements for each type of actuator are specified on the actuator specification (ACTUSPEC) sheets located at the end of this Section.

B. Seat valve or stopping method based on valve manufacturer's recommendation:
1. Torque
2. Position/Limit

C. Ambient Temperature Range: -20 to +140 degree Fahrenheit (up to 100% relative humidity).

D. Travel Speed: The most stringent among specification in this section, specification in Section 40 06 20.13, or the actuator manufacturer's recommendation. Travel speed to be approved by Engineer prior to procurement.

E. Rotation:
   1. Quarter-Turn: 90 degrees, with +/- 5 degree adjustable mechanical travel stops. Stops designed to withstand maximum actuator torque.
   2. Multi-Turn: Position setting range of 2.5 to 8,000 turns with a minimum angular resolution of 7.5 degrees at the output.

## 2.03 CONFIGURATION, COMPONENTS AND FEATURES

A. General: Unless otherwise specified, provide electric motor actuators in accordance with the actuator specification (ACTUSPEC) sheets and the following requirements.

B. Motor:
   1. General:
      a. Specifically designed for valve actuator service.
      b. Totally-enclosed, non-ventilated construction.
      c. Internal heater for anti-condensation protection in outdoor installations.
      d. Compliance to ANSI/NEMA MG1.
   2. Duty Rating based on Actuator Service:
      a. Modulating: 50% (30 minutes) or 100% (continuous) duty motor rated for minimum of 900 starts per hour.
      b. Open-Close: 25% (15 minutes) or 50% (30 minutes) duty motor rated for minimum of 60 starts per hour.
      c. Throttling: 25% (15 minutes) or 50% (30 minutes) duty motor rated for minimum of 60 starts per hour.
   3. Motor Starter: Provide actuator with a full voltage reversing starter rated for the motor's locked rotor and full load currents for 10,000 cycles with mechanical and electrical interlocks and overload protection in each phase pole.
   4. Three Phase:
      a. Reversible, Squirrel Cage Motor.
         1) 460 volt, 3 phase, 60 hertz power with +/- 10 percent voltage fluctuation.
         2) Four-pole 1800 RPM or provide pole-speed as required for the application.
         3) NEMA Class H insulation.
         4) Thermistor or thermostat for thermal protection embedded in the motor windings.
         5) Automatic motor thermal reset once motor has cooled sufficiently after overload.
         6) Three conduit openings, minimum.
      b. Control Transformer:
         1) Epoxy encapsulated and impregnated with short-circuit and overload protection.
         2) Rated, at a minimum, to handle 80 percent of the connected load with 120 VAC secondary or other secondary voltage of 24 VDC as required.
         3) Adequately rated to provide power for the following functions:
            a. Energizing of the contactor coils.
            b. Internally sourced power for remote controls.
            c. Internal electrical circuits.

d. Heater.

5. Single Phase (AC):
   a. Reversible, Capacitor Induction Motor.
      1) 120 volt, 1 phase, 60 hertz power with +/- 10 percent voltage fluctuation.
      2) NEMA Class B or F insulation.
      3) Thermal overload protection with automatic reset.
      4) Two conduit openings, minimum.

C. Enclosure: Provide NEMA 250 electrical enclosures rated for the application and location specified:
   1. Non-hazardous, indoor and outdoor locations.
      a. Type 4, Weatherproof.
      b. Type 4X, Corrosive.
      c. Type 6, Submersible.
   2. Hazardous locations, indoor and outdoor locations.
      a. Type 4/7, Class I, Divisions 1 and 2, Groups C & D certification.
   3. All external fasteners stainless steel.

D. Disconnect Switch: Provide a lockable, heavy-duty, NEMA 4X, non-fused, UL listed disconnect switch for mounting near actuator. Where actuated valve is out-of-reach, locate the disconnect switch on an adjacent wall at an accessible level.
   1. Where depicted on the drawings provide auxiliary contact. The contact to close when disconnect switch is in close position. The contact to open when disconnect switch is in open position.

E. Gearing:
   1. Totally enclosed in an oil or grease filled gearcase suitable for operation at any angle.
   2. All drive gearing and components must be of metal construction and machine cut.
   3. For rising stem valve (multi-turn), provide hollow output shaft accepting a rising stem and incorporating thrust bearings of the ball or roller type at the base of the actuator. Permit the opening of the gearcase for inspection, and disassembly without releasing the stem thrust or taking the valve out of service.
   4. For quarter-turn, self-locking drive gearing to prevent the valve back-driving the actuator. Multi-turn actuator combined with part-turn gearbox for 90-degree rotation can be used for high torque applications or for large nominal diameter quarter-turn valves being used for isolating, throttling or modulating service.
   5. Design all gearing to withstand a 100 percent overload.

F. Torque Switches: Provide electric motor actuators with a double-torque switch set to disengage motor power at 40 to 100 percent of actuator rated torque and less than 75 percent of the shaft's design torque. Operate the torque switch in both the opening and closing directions and operate during the complete cycle without the use of auxiliary relays, linkages, latches, or other devices.
   1. Provide each side of the torque switch with set point adjustment. Mount a calibration tag near each switch for correlating the settings with output torque activation.

G. Position Switches: Provide electrical or electro-mechanical confirmation of valve position. Position limit switches to indicate various positions between the fully opened and fully closed. Provide limit switches for visual local position indication of the valve and for extermal position monitoring through solid-state relay or electro-mechanical relays. Provide at least two relays with dry contacts for external position monitoring.

H. Hammer Blow Device: Provide electric motor actuators with a built-in lost-motion device that allows sufficient travel of the motor, prior to engaging the stem nut, for the motor to reach full speed. This action to impart a "hammer blow" to start the valve in motion in either direction. Share the load equally by two lugs cast integrally on the drive sleeve.

I. Handwheel: Provide electric motor actuators with a handwheel for manual operation. Do not rotate the handwheel during motor operation. Do not prevent handwheel operation when motor is locked. Accomplish motor or manual selection by a positive declutching knob or lever which disengages the motor and motor gearing mechanically but not electrically. Prohibit manual and motor simultaneous operation. Do not require more than 80 pounds of rim effort at maximum torque for hand operation.

## 2.04 CONTROL PANEL

A. Provide an integral operator control unit to serve as a control station for each actuator unless otherwise specified.

B. Control station to include pilot devices:
   1. LOCAL (or HAND), OFF, REMOTE (or AUTO), STOP, OPEN, and CLOSE controls through selector switches and/or pushbuttons.
      a. In LOCAL, use the control station's OPEN and CLOSE devices to position the valve to full open or full close. Configure for inching "maintained or sealed in" action in either travel direction.
      b. In REMOTE:
         1) Open-Close (Isolating) Service:
            a) Contacts Closure: Use momentary operation of external OPEN or CLOSE contacts to open and close the valve.
         2) Modulating or Throttling Service:
            a) Analog: Use external 4-20 mA input DC isolated signal to position the valve with maximum impedance of 250 ohms. On loss of 4-20 mA input DC provide adjustable configuration to fail to the "open", "closed", "% open" or "last" position. Unless otherwise specified initially set to fail to the "last" and reconfigure during system start-up if required for operations to go to a percent open position on loss of the external 4-20 mA.
         3) Prevent the controls station's local OPEN and CLOSE devices from operating the valve.
      c. In STOP, prevent travel in either open or close direction in both LOCAL and REMOTE.
   2. Indication:
      a. OPEN and CLOSE Status Lights: Color of lights: green for full open and red for full close.

b. Position for Modulating/Throttling Service: In addition to the above status lights, provide digital readout display for the valve position in 1 percent increments from 0 to 100 percent.

C. Location of Control Station:
1. Local: NEMA 4X/7 Control station factory mounted directly to the electric motor actuator.
2. Remote: NEMA 4X/7 Control station mounted separate from the electric motor actuator when specified. Provide one of the following options:
a. Add another control station if the factory mounted control station can not be detached from the electric motor actuator. If two control stations are provided then both control stations must have identical operations.
b. Remote mount the entire actuator control package compartment including control power transformers, motor contactors and positioners.

D. External Monitoring:
1. Status and Alarms: Provide single pole double throw (SPDT) or single pole single throw (SPST) dry contacts rated at 0.5 amps for 24 V DC, and 3 amps for 120 V AC. Provide contacts as normally open or normally closed:
a. Open Status: Representing valve in full open position.
b. Close Status: Representing valve in full close position.
c. Remote or Auto Status: LOR or HOA in Remote or Auto, representing actuator operation from external source enabled.
d. Local or Hand Status: LOR or HOA in Local or Hand, representing actuator operation from the control station enabled.
e. Alarm Status: Representing valve or actuator trouble.
2. Position:
a. Modulating or Throttling Service: In addition to the above external status and alarms, provide a 4-20 mA DC isolated output signal to indicate valve position at a minimum impedance of 500 ohms.



## 2.05 NETWORK COMMUNICATIONS

A. Provide Ethernet digital bus-network and use for REMOTE operation and external monitoring when specified.
1. Configuration: Electronic Data Sheet (EDS), Generic Station Description (GDS) or Device Type Manager (DTM) files for bus.
2. Compliance: IEC 61158.
3. Connection: RJ-45, M12, Open Terminal Style, or Quick Connect.
4. Baud Rates: Manual selection and automatic baud rate detection for communication data exchange speeds.
5. Node Address: Change default address by coordinating node address with System Integrator.
6. Programmable action of actuator on loss of communication as fail last. Allow remote operation of actuator to return without fault on communication recovery.
7. Termination Resistor: Default in the off position for serial based communication protocals.

8. I/O Data Exchange Requirements: Coordinate with the Division 40 system integrator.

## 2.06 CONFIGURATION

A. Features:
   1. Non-intrusive or wireless access to view and setup the actuator parameters.
   2. Transfer diagnostic data logged in the actuator memory to a personal computer (PC).
   3. PC graphical user interface software allowing actuator set-up configuration and data logging information to be reviewed, analyzed and reconfigured.

## 2.07 NAMEPLATES

A. Control Station: Provide nameplates for each control station.
   1. Functional Nameplate: Engrave a white phenolic plate with black lettering with valve functional description and valve equipment number as specified or shown. Permanantly fasten functional nameplate to control station. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.
   2. Marking Nameplate: Engrave or stamped stainless steel. Permanantly fasten nameplate to the control station. Provide the information on nameplate as required by NFPA 70 (NEC) for industrial control panel markings.

B. Motor: Engrave or stamped stainless steel. Permanantly fasten nameplate to the motor frame and ensure visibly positioned for inspection. Provide the information on nameplate as required by NFPA 70 (NEC).

C. Actuator: Engrave or stamped stainless steel. Provide the following information on nameplate: manufacturer, model number, serial number, ambient temperatrure minimum/maximum, rated torque, and opening time.



## 2.08 ASSEMBLY/FABRICATION

A. Factory-mount electric motor actuators on the valve as a unit. Provide each valve body or actuator with the word "OPEN" cast thereon, an arrow indicating the direction to open, and flow direction arrows.

# PART 3 EXECUTION

## 3.01 PREPARATION

A. Prior to installation of the electric motor actuator assemblies, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that sufficient space and accessibility is available for electric motor actuators.

## 3.02 INSTALLATION

A. Equipment Mounting.
   1. Locate actuator with unobstructed access for operation and maintenance.
      a. Do not obstruct walkways.

b. Do not attach to handrails, process piping, or mechanical equipment.
c. Do not locate where shock or vibration impairs its operation.

2. Locate remote control station with unobstructed access for operation and maintenance between 48 inches and 60 inches above the floor or a permanent work platform, and within site of the actuator.
3. Mount actuators to have their manual operating accessory, where possible, located between 48 inches and 60 inches above the floor or a permanent work platform.

B. Nameplates: Locate nameplates in a clearly visible location. If necessary, reposition and reattach with stainless steel screws or wire.
1. Electrical Interconnection: Comply with Division 26 for power wiring, control wiring and signal wiring.

## 3.03 FIELD QUALITY CONTROL

A. Provide a factory-trained manufacturer's representative at the site for the following activities.
1. Inspect actuator's electrical power, control, signal, communication and grounding wiring for proper termination.
2. Configure actuator and include:
a. Actuator Settings: Limit switch, torque position, travel speed, emergency shutdown function, loss of position signal function, and relay functions.



## 3.04 SYSTEM START UP

A. General Requirements:
1. Perform testing in accordance with Section 01 45 20, and this Section. Apply no required test without prior notice to the Engineer to witness any test. At least 14 days before the commencement of any testing activity, provide a detailed step-by-step test procedure, complete with forms for the recording of test results. Provide all equipment necessary to perform the required tests.
2. Test each electric motor actuator for each mode of operation including but not limited to both local and remote- open, close, stop, emergency shutdown, position control,and network operation, as well as, the travel rates, limit switches, jam and torque settings, and loss of control signals.
3. Ensure electric motor actuator control can be re-initiated locally and remotely after power loss recovery without faulting.
4. Provide a factory-trained manufacturer's representative at the site to re-adjust actuator setting under normal operating conditions with the specified design process fluid.

## 3.05 TRAINING

A. Provide operation and maintenance training for the equipment provided under this Section for the Owner's personnel in accordance with Section 01 79 00 and taught by a factory-trained manufacturer's representative. Certify training on Form 43 05 11-B specified in Section 01 99 90.

B. Include in training sessions preventive maintenance requirements, overhaul and troubleshooting instructions, normal operating practices, actuator parameter configuration set-up, and changing actuator parameter settings.

## PART 4 APPENDIX – ACTUSPECS

### 4.01 ACTUATOR SPECIFICATION SHEETS (ACTUSPEC)

A. General requirements for actuators specified in this Section are listed on ACTUSPEC sheets herein.

**Table A**

| ACTUSPEC Symbol | Actuator Description | Actuator Service Power |
|---|---|---|
| EMTI | Electric Multi-Turn Actuator for Isolating (Open-Close) Service | 480 V AC, 3 phase |
| EMTM | Electric Multi-Turn Actuator for Modulating Service | 480 V AC, 3 phase |
| EMTT | Electric Multi-Turn Actuator for Throttling Service | 480 V AC, 3 phase |
| EQTI | Electric Quarter-Turn Actuator for Isolating (Open-Close) Service | 480 V AC, 3 phase |
| EQTM | Electric Quarter-Turn Actuator for Modulating Service | 480 V AC, 3 phase |
| EQTT | Electric Quarter-Turn Actuator for Throttling Service | 480 V AC, 3 phase |
| EQTI | Electric Quarter-Turn Actuator for Isolating (Open-Close) Service | 120 V AC, 1 phase |
| EQTI | Electric Quarter-Turn Actuator for Isolating (Open-Close) Service, Spring Return CW or CCW | 120 V AC, 1 phase |



### 4.02 ACTUATOR IDENTIFICATION: EMTI (480V)

A. Actuator Description: Electric Multi-Turn Actuator for Isolating (Open-Close) Service.

B. Manufacturers:
   1. Rotork, IQ3 Range IQ.
   2. Flowserve Limitorque, MX.
   3. Emerson EIM, TEC 2.
   4. AUMA, SA.
   5. Approved equal.

C. Features:
   1. Actuator Power Supply: 480 V AC, 3-phase, 60 Hz.
   2. Controller: Unfused disconnect type combination starter in compliance with NEMA ICS.
   3. Controls:
      a. Power Source: Internal or external 120 volts AC or 24 volts DC.
      b. Remote Control Type: Contact Closure.

c. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.

## 4.03 ACTUATOR IDENTIFICATION: EMTM (480V)

A. Actuator Description: Electric Multi-Turn Actuator for Modulating Service.

B. Manufacturers:
1. AUMA, SAR.
2. Rotork, IQ3 Range IQM.
3. Flowserve Limitorque.
4. Emerson EIM.
5. Approved equal.

C. Features:
1. Actuator Power Supply: 480 V AC, 3-phase, 60 Hz.
2. Controller: Solid-state electronic, servo-amplifier comparator and an electro-mechanical reversing starter.
3. Controls:
a. Power Source: Internal or external 120 volts AC or 24 volts DC.
b. Remote Control Type: Analog.
c. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.

## 4.04 ACTUATOR IDENTIFICATION: EMTT (480V)

A. Actuator Description: Electric Multi-Turn Actuator for Throttling Service.

B. Manufacturers:
1. AUMA, SAR.
2. Rotork, IQ3 Range IQM.
3. Flowserve Limitorque.
4. Emerson EIM.
5. Approved equal.

C. Features:
1. Actuator Power Supply: 480 V AC, 3-phase, 60 Hz.
2. Controller: Solid-state electronic, servo-amplifier comparator and an electro-mechanical reversing starter.
3. Controls:
a. Power Source: Internal or external 120 volts AC or 24 volts DC.
b. Remote Control Type: Analog.

c. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.

## 4.05 ACTUATOR IDENTIFICATION: EQTI (480V)

A. Actuator Description: Electric Quarter-Turn Actuator or Multi-Turn Actuator with 90-Degree Gearbox for Isolation Service.

B. Manufacturers:
   1. AUMA, SG, SA/GS or SQ.
   2. Rotork, IQT or IQ Pro Series.
   3. Limitorque, MXA.
   4. EIM, Series 2000.
   5. Approved equal.

C. Features:
   1. Power Supply: 480 V AC, 3-phase, 60 Hz.
   2. Controller: An unfused disconnect type combination starter in compliance with NEMA ICS.
   3. Controls:
      a. Power Source: Internal or external 120 volts AC or 24 volts DC.
      b. Remote Control Type: Contact Closure.
      c. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
   4. Gear Train: 90-degree gear box.

## 4.06 ACTUATOR IDENTIFICATION: EQTM (480V)

A. Actuator Description: Electric Quarter-Turn Actuator or Multi-Turn Actuator with 90-Degree Gearbox for Modulating Service.

B. Manufacturers:
   1. AUMA, SGR, SAR/GS or SQR.
   2. Rotork, IQ Pro Series.
   3. Limitorque.
   4. EIM.
   5. Approved equal.

C. Features:
   1. Power Supply: 480 V AC, 3-phase, 60 Hz.
   2. Controller: Solid-state electronic, servo-amplifier comparator and an electro-mechanical reversing starter.
   3. Controls:
      a. Power Source: Internal or external 120 volts AC or 24 volts DC.

b. Remote Control Type: Analog.
c. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.

4. Gear Train: 90-degree gear box.

## 4.07 ACTUATOR IDENTIFICATION: EQTT (480V)

A. Actuator Description: Electric Quarter-Turn Actuator or Multi-Turn Actuator with 90-Degree Gearbox for Throttling Service.

B. Manufacturers:
1. AUMA, SGR, SAR/GS or SQR.
2. Rotork, IQ Pro Series.
3. Limitorque.
4. EIM.
5. Approved equal.

C. Features:
1. Power Supply: 480 V AC, 3-phase, 60 Hz.
2. Controller: Solid-state electronic, servo-amplifier comparator and an electro-mechanical reversing starter.
3. Controls:
a. Power Source: Internal or external 120 volts AC or 24 volts DC.
b. Remote Control Type: Analog.
c. Emergency Shutdown: A minimum of one independent signal when applied to the actuator overrides any existing command signal and sends valve in a preselected shut down position.
4. Gear Train: 90-degree gear box.

## 4.08 ACTUATOR IDENTIFICATION: EQTI (120V)

A. Actuator Description: Electric Quarter-Turn Actuator for Isolation (Open/Close) Service.

B. Manufacturers:
1. Flowserve Worchester, Series 75.
2. GE Remote Control Series (RCS), Model MAR.
3. Emerson Bettis TorqPlus, Series EM.
4. Approved equal.

C. Features:
1. Power Supply: 120 V AC, 1-phase, 60 Hz.
2. Applications:
a. Stall Torque: 150 to 900 lb-in.
b. Current at Rated Stall Torque: Less than 2 amps for 25% duty.

3. Controls:
    a. Voltage: 120 V AC.
    b. Voltage Source: External fed.
    c. Remote Control Type: Contact Closures.
    d. Location of Control Station: Remote.
    e. Manual Override: Required.
4. Indication- Open/Close Position: Required.
5. Gear Train: Direct attach to actuator with no intermediate gearings or linkage.
    a. Lubrication: Permanently lubricated.

## 4.09 ACTUATOR IDENTIFICATION: EQTI (120V-O OR C)

A. Actuator Description: Electric Quarter-Turn Actuator for Isolation Service, Spring Return CW or CCW.

B. Manufacturers:
1. GE Remote Control Series (RCS), Model SURE.
2. Emerson Bettis TorqPlus, Series EM.
3. Approved equal.

C. Features:
1. Power Supply: 120 V AC, 1-phase, 60 Hz.
2. Fail Position: Open or Close (OC) as specified in Section 40 06 20.13.
3. Applications:
    a. Stall Torque: 300 to 1200 lb-in.
    b. Current at Rated Stall Torque: Less than 1.5 amps for 50 % duty or better.
4. Controls:
    a. Voltage: 120 V AC.
    b. Voltage Source: External fed.
    c. Remote Control Type: Contact Closures.
    d. Location of Control Station: Remote and not specified in this Section.
    e. Manual Override: Required.
5. Indication- Open/Close Position: Required.
6. Gear Train: Direct attach to actuator with no intermediate gearings or linkage.
7. Lubrication: Permanently lubricated.



**END OF SECTION**

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SECTION 40 05 60

VALVES

## PART 1 GENERAL

### 1.01 SUMMARY

A. This Section specifies the supply, installation and testing of valves. Materials and performance requirements for valves are specified in Detailed Valve Specifications. Detailed Valve Specifications are provided in Sections 40 05 61.01 through 40 05 89.99. Additional Detailed Valve Specifications for some valves used for HVAC service are provided in Division 23.

B. Determining Valve Type:
   1. Drawings specify valve types (gate, plug, butterfly, check, globe, etc.) used in each pipeline. Process fluids that will be conveyed in pipelines are identified by the Process Service Identifiers shown on the Drawings.
   2. Piping System Schedules (Sections 40 05 02.01 through 40 05 02.99) specify piping system materials and components, including valve requirements, based on the Process Service Identifier specified on the Drawings for the pipeline or piping system. Piping System Schedules reference Detailed Valve Specifications that specify requirements for each valve type used in the pipeline or piping system.
   3. Provide valves conforming to the Detailed Valve Specifications listed in the Piping System Schedule for the valve/line size, process service, and valve type specified on the Drawings. Example: The Drawings specify a ball valve on a 1-inch line. The Piping System Schedule for the process service specified on the Drawings refers to Section 40 05 63.01 for 1/2 through 2 1/2 inch ball valves. For this example, provide the subject ball valve per the requirements specified in 40 05 63.01.



### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 58 01 – Identification Systems
   2. Section 01 78 23 – Operation and Maintenance Manual
   3. Section 40 05 02 – Detailed Piping Specification Sheets

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no

replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ANSI 16.10 | Face-to-Face and End-to-End Dimensions of Valves |
| ANSI B1.20.1 | Pipe Threads, General Purpose |
| ANSI B16.1 | Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, and 250 |
| ANSI B16.5 | Pipe Flanges and Flanged Fittings |
| ANSI B16.34 | Valves—Flanged, Threaded, and Welding End |
| API 607 | Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats |
| ASTM A48 | Gray Iron Castings |
| ASTM A108 | Steel Bars, Carbon, Cold-Finished, Standard Quality |
| ASTM A126 | Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM A216/A216M | Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service |
| ASTM A276 | Stainless and Heat Resisting Steel Bars and Shapes |
| ASTM A351 | Castings, Austenitic, for Pressure-Containing Parts |
| ASTM A516 | Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service |
| ASTM A536 | Ductile Iron Castings |
| ASTM A571 | Austenitic Ductile Iron Castings |
| ASTM A995/A995M-13 | Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts |
| ASTM B124 | Copper and Copper Alloy Forging Rod, Bar, and Shapes |
| ASTM B148 | Aluminum-Bronze Sand Castings |
| ASTM C283 | Resistance of Porcelain Enameled Utensils to Boiling Acid |
| ASTM D1784 | Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D5162 | Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates |
| AWWA C500 | Metal-Seated Gate Valves for Water Supply Service |
| AWWA C504 | Rubber-Seated Butterfly Valves |
| AWWA C507 | Standard for Ball Valves |
| AWWA C508 | Swing Check Valves for Waterworks Service, 2 – 24 Inches NPS |
| AWWA C517 | Resilient-Seated Cast Iron Eccentric Plug Valves |
| AWWA C550 | Protective Interior Coatings for Valves and Hydrants |
| MSS SP-70 | Gray Iron Gate Valves, Flanged and Threaded Ends |
| MSS SP-80 | Bronze Gate, Globe, Angle and Check Valves |
| MSS SP-81 | Stainless Steel, Bonnetless, Flanged, Knife Gate Valves |
| MSS SP-110 | Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |
| NSF 61 | Drinking Water System Components - Health Effects |
| UL 429 | Electrically Operated Valves |
| UL 1002 | Electrically Operated Valves for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G |

## 1.04 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00
   2. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) denote full compliance with a paragraph as a whole. Underline deviations and denote with a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined signify compliance on the part of the Contractor with the specifications. Include a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal will be sufficient cause for rejection of the entire submittal with no further consideration.
   3. Catalog cuts and/or shop drawings for each type of valve indicating the valve type (Detailed Valve Specification Section Number), materials of construction, dimensions, operating torque, valve end connection configuration, pressure rating, and operating temperature range.
   4. An amended Detailed Valve Specification for all valve types provided for this contract. Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.
   5. Factory Acceptance Test results and/or Certified Statement of Proof-of-Design testing results when specified in Detailed Valve Specifications.
   6. Action Submittal Items listed on Detailed Valve Specifications

B. Informational Submittals:
   1. Affidavits and registration numbers as specified.
   2. Operating and Maintenance data for incorporation in operation and maintenance manual, as specified in Section 01 78 23. Include complete description of operation together with detailed drawings, a complete list of replacement and repair parts, and parts manufacturer's identifying numbers.
   3. Informational Submittal Items listed on Detailed Valve Specifications.



## 1.05 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00.

B. Deliver valves to site in accordance with Section 01 66 00 and using loading methods which do not damage any valve components or coatings.

C. Tag loose valves as specified in Section 01 66 00, stating size, type, coatings and mating parts shipped loose or separate.

D. Store on site until ready for incorporation in the work using methods recommended by the manufacturer to prevent damage, undue stresses, or weathering.

## 1.06 WARRANTY

A. Procedures: In accordance with Division 01.

B. Where a warranty duration is specified by the Detailed Valve Specification, provide a special warranty valid for the specified duration.

C. Where no special warranty requirements are specified in the Detailed Valve Specification, provide manufacturer's standard warranty.

## PART 2 PRODUCTS

### 2.01 VALVE CONFIGURATION REQUIREMENTS

A. General
   1. Provide valves of the same type, size range and service from a single manufacturer.
   2. Provide new, unused valves for the work.
   3. Provide valve materials free from defects or flaws, with true alignment and bores.
   4. Provide valves that open by turning the valve shaft to rotate counter-clockwise unless otherwise specified in the Detailed Valve Specification Section.

B. Provide padlockable lockout feature on all valves.

C. Manual Operators
   1. Provide valves with manual operators as specified in the Detailed Valve Specification.
   2. For hand wheels, clearly show the direction of opening in raised lettering and symbols.
   3. The maximum rim pull on a hand wheel is not to exceed 65 lb. when one side of the valve is at test pressure and the other side is at atmospheric pressure. Where a shaft mounted hand wheel would require greater force to operate, provide a torque reduction gearbox operator. Unless different operators are scheduled or specified on the Drawings, conform to the following minimum requirements.
   4. Provide 6 (total) eight-point operating wrenches for use on all valves with square nut operators.
   5. Quarter turn lever operators are to be perpendicular to the pipe runs when the valves are closed.
   6. Provide butterfly valves with 10 position latching levers except where used to balance air flows. Where used to balance air flows provide infinite position, screw down levers.
   7. The maximum pull at the end of the lever arm is not to exceed 65 lb. when one side of the valve is at test pressure and other side is at atmospheric pressure. Where greater force would be required to operate the valve with a lever, provide a torque reduction gearbox operator.
   8. Provide grease lubricated, worm gear type operators for torque reduction gearbox operators. Gearbox operators equipped with a hand wheel and a visual indicator of the valve position. Provide gear operators with adjustable mechanical stop-limiting devices to prevent over travel of the disc/ball/plug in the open and closed positions and which are self-locking and designed to hold the valve in any intermediate position between full open and full closed. Where gearbox operators are intended for direct bury or submergence, seal units with long life lubricant.

9. For manual valves on lines 3 inches and greater, mounted over 7.0 feet above the operating floor, provide chain wheel gear operators. Design chain wheel operators so that a force of 30 lb. is sufficient to open the valve when one side of the valve is at test pressure and the other side is at atmospheric pressure. Provide chain pulley that positively engages the chain links. The chain will extend from the valve operator to an operating height of 4 feet above the floor or as directed by the Owner. The exact dimensions will be field determined. Provide approved chain hooks where required to prevent chain from hanging within traffic paths.
10. Where manual operators are installed over 7.0 feet above the operating floor and the Drawings specify a vertical valve shaft, revise the gear operator and/or chain wheel position to provide a horizontal chain wheel shaft. Retain the valve orientation specified on the Drawings.
11. Provide ductile iron chain wheels. Provide galvanized steel operating chains.

D. Valve Stem Extensions and Wrench Nuts
   1. Provide valve stem extensions where additional clearance is required for pipe insulation or where valve operation without the extension is difficult; and in manholes.
   2. Where angle valve stem extensions are employed, they will be angle geared. Universal joint types are not permitted.
   3. Wrench nuts shall comply with AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of wrench nut operated valves.

E. Operator Appurtenances
   1. Valve Boxes: Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay-put covers. Covers shall be hot-dip galvanized. Valve boxes extending to finished surfaces shall be provided for buried valves.
   2. Floor Boxes: Floor boxes shall be hot-dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.
   3. Adjustable Shaft Valve Boxes: Adjustable shaft valve boxes shall be concrete or cast iron Brooks No. 3RT, Christie G5, Empire 7-1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."



## 2.02 VALVE IDENTIFICATION TAGS

A. Provide valve identification tags for all valves with an identification tag number on the drawings (Mechanical and PI&D drawings).

B. Match tag numbers shown on the drawings.

C. Type 316 stainless steel tags, minimum 2.5-inches x 0.75 inches, with 0.1875 inch numbers and letters. Complete tag number shall be embossed on the tag. Tags shall be attached using stainless steel wire.

## PART 3 EXECUTION

### 3.01 PREPARATION

A. The valve and piping arrangement indicated on the Drawings is based on typical dimensions for valves of the specified type. Make the necessary modifications in the piping to allow for discrepancies between the valve dimensions shown and those supplied for the Work.

B. Prior to installation of valves, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that the valve location and orientation provides suitable access to manual operators and that sufficient space and accessibility is available for hydraulic, pneumatic, and electric power actuators.

C. Where conflicts are identified, inform the Owner and follow any of the Owner's or Owner's Representative's directions regarding the conflict(s).

### 3.02 INSTALLATION

A. Install valves in conjunction with the piping specified in the Piping System Schedules (Sections 40 05 02.01 through 40 05 02.99).

B. In horizontal pipe runs, other than in locations where space does not permit, install all valves (except for butterfly valves, eccentric plug valves, and trunnion ball valves) with a vertical operating shaft with the actuator at the top. In no case install a valve with the operator below the valve.

C. Unless otherwise specified on the drawings, install butterfly valves, eccentric plug valves, and trunnion ball valves with the shaft in a horizontal orientation. Install eccentric plug valves with the plug above the valve shaft centreline when the valve is full open.

D. When joining valves to pipe or fittings, do not over torque bolts to correct for misalignment.

E. Support valves in position using temporary supports until valves are fixed in place.

F. Permanently support valves to prevent transmission of loads to adjacent pipework and/or equipment.

G. Where valves are installed in plastic pipelines (PVC, CPVC, HDPE, polypropylene etc.) greater than 4-inch diameter, support valves independent of the piping and brace valves against operating loads and torque to prevent transmission of stresses to the adjacent pipework.

H. Install gate valves in the closed position.

I. Install valves which are bubble tight in one direction to provide bubble tight seal of flow in normal direction of flow unless otherwise noted or directed by the Owner.

J. Unless otherwise specified, install single seated valves with the seat downstream. Install valves at tank connections with seat away from tank. Install valves on pump discharge and suction lines with seat end towards the pump.

K. Install all valves in accordance with the manufacturer's recommendations.

L. Protect valves installed below grade with a shrink sleeve or polyethylene sheath attached to the pipe with tape wrap.

M. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within 6 inches of the valve box cover.

## 3.03 FIELD QUALITY CONTROL

A. Field or Site Tests and Inspections per Detailed Valve Specifications.

B. Pressure test all valves in conjunction with the pipes in which the valves are installed at test pressures specified in the applicable Piping System Schedule.

**END OF SECTION**

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40 05 61.91

KNIFE GATE VALVE, STAINLESS STEEL BONNETED

| GENERAL |
|---|
| 1. Line Size: 2 through 24 inches<br>2. Rated Limits: Pressure 150 psi; Temperature 122 °F<br>1. Line Size: 30 through 36 inches<br>2. Rated Limits: Pressure 80 psi; Temperature 122 °F |
| **VALVE MATERIALS** |
| 1. Body: Stainless Steel (304 or 316)<br>2. Gate: Stainless Steel (304 or 316)<br>3. Packing: PTFE-impregnated synthetic fiber<br>4. Seat Rings: Buna N, FKM, Neoprene, or EPDM<br>5. Stem: Stainless Steel (304 or 316) |
| **VALVE CONFIGURATION** |
| 1. Valve End/Connections: Lugged, ANSI B16.1 Class 150<br>2. Operator: Handwheel, bonneted; rising stem, outside screw and yoke; provide geared operators for valves 6 inches and larger, valves 4 inches and less shall have direct acting handwheels |
| **SUBMITTALS** |
| 3. Per Section 40 05 60. |
| **CANDIDATE MANUFACTURERS** |
| 1. DeZurik KGC<br>2. Fabri-Valve C67 |

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SECTION 40 05 62.12

GLASS LINED, AWWA C517, FULL (100%) PORT, CAST OR DUCTILE IRON, ECCENTRIC PLUG VALVES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: Requirements for Glass Lined, Full Port, Cast Iron or Ductile Iron, Eccentric Plug Valves conforming to AWWA C517 are listed in this Section. Comply with the provisions of Section 40 05 60 - Valves in addition to the requirements specified herein.

### 1.02 SUBMITTALS

A. Submittals as specified in Section 40 05 60 - Valves.

B. In addition to submittals specified in 40 05 60 - Valves, provide the following Action Submittal items:

1. Certified copy of a report from an independent testing laboratory certifying successful completion of proof-of-design testing conducted in accordance with AWWA C517, Section 5.2. In lieu of testing the valves at an independent testing laboratory, proof-of-design testing may be performed at the valve manufacturer's laboratory, but must be witnessed by a representative of a qualified independent testing laboratory, and all test reports certified by the laboratory representative. Proof-of-design testing performed on not less than three 6-inch diameter valves, with all three test units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.



## PART 2 PRODUCTS

### 2.01 CANDIDATE MANUFACTURERS

| | Manufacturer | Model/Series |
|---|---|---|
| A. | Dezurik | PEF |
| B. | Valmatic | Cam-Centric |
| C. | Approved Equal | |

### 2.02 VALVE TYPE/CONFIGURATION

| | Component | Configuration Requirement |
|---|---|---|
| A. | Design, Manufacture, and Testing | AWWA C517 |
| B. | Valve End/Connections | Flanged, ASME B16.1 Class 125 Flange |
| C. | Pattern | Eccentric Plug with resilient facing |
| D. | Port | Full 100% Port |
| E. | Bearings | Sleeve Type, permanently lubricated |
| F. | Seat | 1/8 inch thick welded overlay with raised surface seat |

| | Component | Configuration Requirement |
|---|---|---|
| G. | Manual Actuator, valve size less than 8-inch | Lever or Handwheel |
| H. | Manual Actuator, valve size 8-inch or greater | Handwheel with totally enclosed, permanently lubricated, worm gear reduction |
| I. | Powered Actuator | Refer to Section 40 06 20.13 – Power Actuated Valve Schedule for actuator type |
| J. | Packing | Externally adjustable and replaceable without removing actuator, multiple V-ring or chevron type with a packing gland follower |

## 2.03 VALVE MATERIALS

| | Component | Material |
|---|---|---|
| A. | Body | Cast Iron, ASTM A126 Class B or Ductile Iron, ASTM A536 Grade 65-45-12 |
| B. | Plug | Cast Iron, ASTM A126 Class B or Ductile Iron, ASTM A536 Grade 65-45-12 |
| C. | Plug face | Chloroprene, Neoprene, or Buna-N |
| D. | Lining and Coating | See glass lining requirements below |
| E. | Bearings | Stainless Steel, Type 316 or ASTM A743 Grade CF8M |
| F. | Shaft | Cast Iron or Ductile Iron ASTM A 536 |
| G. | Seat | Nickel |
| H. | Packing | Nitrile/NBR/Buna-N or TFE |
| I. | Nuts, Bolts, Hardware, and Fasteners | Stainless Steel |
| J. | Grit Excluder | PTFE or Buna N |



## 2.04 GLASS LINING

A. Glass lining per ASTM B1000

B. Glass lining applied to interior of valve
   1. Provide a dual layer coating system of vitreous material
   2. 10 mils minimum thickness
   3. Continuous coverage of glass lining as verified by a low voltage holiday detector
   4. Voids, other than isolated pinholes, shall be cause for rejection
   5. Isolated voids due to casting anomalies are not cause for rejection

C. Candidate manufacturers for glass lining material:
   1. Ferrock MEH 32
   2. Vitco SG 14
   3. Approved equal

## 2.05 DESIGN REQUIREMENTS

| Item | Value |
|---|---|
| **Valve End Connections** | |
| A. Line Size, Inches | 3 thru 72 |
| **Rated Limits** | |
| B. Pressure, psi | 175 (3 to 12 inches), 150 (14 to 72) |
| C. Temperature, degrees Fahrenheit | 125 |

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install valve with shaft or plug horizontal. (Axis of rotation for plug lies in a horizontal plane.)

B. Vertical Pipe: Valve seat at the top or upper valve port.

C. Horizontal Pipe: Valve seat and plug face upstream (against the normal flow direction) when the valve is closed. Plug rotates up (away from the invert of the valve) to open the valve.

**END OF SECTION**

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40 05 63.03

BALL VALVE, STAINLESS STEEL THREADED

| GENERAL |
|---|
| 1. Line Size: ¼ through 3 inches<br>2. Rated Limits: Pressure 800 psi; Temperature 100 °F (WOG) |
| **VALVE MATERIALS** |
| 1. Body: Stainless Steel (304 or 316)<br>2. Ball: Stainless Steel (304 or 316)<br>3. Seats: PTFE<br>4. Packing: RPTFE<br>5. Stem: Stainless Steel (304 or 316); blowout-proof stem |
| **VALVE CONFIGURATION** |
| 1. Valve End/Connections: Threaded, Female<br>2. Pattern: Compact, Regular Port<br>3. Ball Mount: Floating<br>4. Manual Operator: Lever/Handwheel |
| **SUBMITTALS** |
| 1. Per 40 05 60. |
| **CANDIDATE MANUFACTURERS** |
| 1. Apollo 76J-100<br>2. Elite E1500<br>3. Nibco T-580 (only for valve 2” or smaller) |

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SECTION 40 05 65.30

NONCLOG BALL CHECK VALVES

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:
   1. This section specifies nonclog ball check valves.

B. Type:
   1. The nonclog check valves shall consist of three components: body, cover, and ball–one moving part. The design of the valve shall keep solids, stringy material, grit, rags, etc., moving without the need for backflushing. The ball shall clear the waterway providing "full flow" equal to the nominal size. There shall be no outside levers, weights, springs, dashpots, or other accessories.
   2. Ball shall be sinking ball type.

### 1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ANSI B16.1 | Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800 |



## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. The Owner and Engineer believe the following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Flygt and Golden Anderson, or approved equal.

## 2.02 COMPONENTS

A. Body and Cover:
   1. Valve body and cover shall be of gray cast iron or ductile iron. Flange drilling shall be according to ANSI B16.1, Class 125.

B. Ball:
   1. The valve ball shall be hollow steel or aluminum core with an exterior of rubber. It shall be installed on on a line carrying Fats, Oil, and Grease at a temperature of 100F with a pH of approximately 3. The materials shall be resistant to grease, petroleum products, animal and vegetable fats, diluted concentrations of acids and alkalines (pH 3 to 10), tearing, and abrasion.

C. 316 Stainless steel bolts and fasteners.

D. Internal and external 2-part epoxy.

## 2.03 PRODUCT DATA

A. Applicable operation and maintenance information specified in Section 01 78 23 shall be provided in accordance with Section 01 33 00.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations.

**END OF SECTION**

SECTION 40 06 20.13

POWER ACTUATED VALVE AND GATE SCHEDULE FOR PROCESS SERVICES

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. This section specifies requirements for actuators for valves and gates that are positioned or controlled by means other than manual actuation. For the purposes of this Section, actuated valves and gates include valves and/or gates that are operated and/or controlled using hydraulic, pneumatic, or electric power.

### 1.02 RELATED SECTIONS

A. Section 40 05 02 – Piping Systems Schedules

B. Section 40 05 57.23 – Powered Actuators

C. Section 40 05 60 – Valves

D. Section 43 05 11 – General Requirements for Equipment

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section prevail.

| Reference | Title |
|---|---|
| ISA-S75.02 | Standard Control Valve Capacity Test Procedure |



### 1.04 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility:

1. Assign Unit Responsibility, as specified in Section 43 05 11, to the actuator manufacturer. The actuator manufacturer has Unit Responsibility, as defined in Section 43 05 11, for each valve or gate and the associated actuator. Assemble the valve/gate and actuator at the factory for shipment to the project site.

### 1.05 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00
2. Valve Specifications for all valve types (Valve Specifications in Sections 40 05 60 through 40 05 90). Indicate with check marks where the valve supplied meets the requirements specified and with written amendments where the product differs from the specification.

3. Catalog cuts and/or shop drawings for each valve type listed in the Actuated Valve and Gate Schedule. For each valve type (Valve Specification in Sections 40 05 60 through 40 05 90) indicate materials of construction, dimensions, operating torque, fail position, valve end connection configuration, pressure rating, and operating temperature range.
4. Open/Close time. Where open/close times are specified in the Actuated Valve and Gate Schedule, submit information documenting valve operating speed. Include information on motor operating speed, gear ratio, exhaust port flow restriction, or other means of speed control.
5. For each solenoid valve type and size combination, submit manufacturer's literature listing enclosure type, solenoid valve model number/type, maximum differential operating pressure, and minimum operating pressure.
6. List actuator type for each equipment number listed in the Actuated Valve and Gate Schedule.
7. Submittal information listed in actuator specification.
8. Certificate of Unit Responsibility attesting that the Contractor has assigned unit responsibility in accordance with the requirements of this section and Section 43 05 11.

B. Closeout Submittals:
1. Procedures: Section 01 78 23.
2. Operating and maintenance submittals per Section 01 78 23.



## 1.06 ACTUATED VALVE AND GATE SCHEDULE

A. Furnish valves and gates conforming to the requirements specified in the Actuated Valve and Gate Schedule

B. Equipment Tag:
1. Refer to Section Division 01 for identification requirements.

C. Valve / Gate Type:
1. The Gate/Valve Type column identifies a Valve Specification or Gate Specification for each valve/Gate and Actuator combination.
2. Refer to the listed specification for the required valve or gate characteristics (i.e., valve/gate materials, dimensions, and configuration).

D. Powered actuator types are specified in Section 40 05 57.23. Actuator types used in the valve and gate schedule are defined as follows:

| Actuator Type (ACTUSPEC) | Service | Definition |
|---|---|---|
| EMTT | Throttling (Modulating) | Electric motor multi-turn |
| EQTT | Throttling (Modulating) | Electric motor quarter-turn |
| EMTI | Isolating (Open-Close) | Electric motor multi-turn |
| EQTI | Isolating (Open-Close) | Electric motor quarter-turn |
| PCI | Isolating (Open-Close) | Pneumatic cylinder |
| SOL | Isolating (Open-Close) | Solenoid |

E. Actuator Enclosure, NEMA Type: Enclosure requirements for actuators are specified by NEMA enclosure type.

F. Maximum Pressure Differential: Pressure drop across each valve is specified for the purpose of actuator and gear box sizing. If no value is specified in this column, use the test pressure from the specified Piping System Schedule (Section 40 05 02.00 through 40 05 02.99) as the maximum pressure differential. Seating and unseating head requirements for gates are specified in the gate specification and are not included in this Section.

G. Open/Close Time: The open/close time refers to the time required for the valve to travel from full closed to full open. Open/close times are based on continuous operation of the actuator. Entries in this column are minimum values. Configure the actuator to provide an open/close time greater than the value listed in this column. Actuators that include programmed stops or steps are not acceptable.

H. Fail Position: Fail position indicates the position that the actuator will default to upon loss of electric, pneumatic, or hydraulic power supply for control of the actuator:
   1. Closed. (Fail Closed) Configure actuator to close upon loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.
   2. Open. (Fail Open) Configure actuator to open upon loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.
   3. Last. (Fail Last Position) Configure actuator to remain in the position last held by the actuator prior to loss of electric, pneumatic, or hydraulic power supply for control of the valve or gate.

I. Voltage: This column specifies the supply power voltage and number of phases for the power supply to solenoids, electric motor actuators, and electro-hydraulic actuators. Provide actuators for operation with the specified power supply voltage and phase.

**PART 2 NOT USED**

**PART 3 NOT USED**

## PART 4 SCHEDULE

### 4.01 ACTUATED VALVE AND GATE SCHEDULE

| Equipment Number | Valve/Gate Specification | Actuator Type | Actuator Enclosure, NEMA Type | Maximum Differential Pressure (psi) | Open/Close Time (seconds) | Fail Position | Voltage (Voltage / Phase) | Remote Control Station |
|---|---|---|---|---|---|---|---|---|
| V-210 | 40 05 61.91 | EMTI | 4X | 5 | 60 | LAST | 460/3480/3 | |
| V-220 | 40 05 61.91 | EMTI | 4X | 5 | 60 | LAST | 460/3120/1 | |
| V-311 | 40 05 62.12 | EMQT | 4X | 35 | 30 | LAST | 460/3 | YES |
| V-312 | 40 05 62.12 | EMQT | 4X | 35 | 30 | LAST | 460/3 | YES |

**END OF SECTION**

SECTION 40 42 00

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes thermal insulation for exposed piping, related equipment, and appurtenant surfaces.

### 1.02 RELATED SECTIONS

A. Section 40 05 02 – Detailed Piping Specification Sheets

B. Section 40 05 07 – Pipe Supports and Hangers

C. Section 40 05 07.13 – Seismic Restraints for Piping

D. Section 40 05 45 – Piping System Identification

### 1.03 REFERENCES

A. This Section incorporates by reference the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of a listed document, the requirements of this Section prevail.

B. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate

C. ASTM C533 – Calcium Silicate Block and Pipe Thermal Insulation

D. ASTM C534 – Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

E. ASTM C547 – Standard Specification for Mineral Fiber Pipe Insulation

F. ASTM C553 – Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

G. ASTM C592 – Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation

H. ASTM C610 – Expanded Perlite Block and Pipe Thermal Insulation

I. ASTM C795 – Thermal Insulation for Use in Contact with Austenitic Stainless Steel

J. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials

K. ASTM E96 – Water Vapor Transmission of Materials

L. FEDSPEC L-P-535E -- Plastic Sheet (Sheeting) “Plastic Strip” Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate), Rigid

M. ASTM C1676 – Microporous Thermal Insulation

N. ASTM C1729 – Aluminum Jacketing and Insulation

## 1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

B. Low-temperature range: operating temperature range of -100 to +100 degrees F.

C. Medium-temperature range: operating temperature range of 100 to 800 degrees F.

D. High-temperature range: operating temperature range of 800 to 1200 degrees F.

E. Very-high-temperature range: operating temperature range of 1200 to 1800 degrees F.

F. Jacket: protective outer layer placed over insulation on straight runs of pipe

G. Cover: protective outer layer placed over insulation on valves, strainers, expansion joints, flanges, pipe fittings, couplings, and equipment.

H. Exposed: All area exposures specified in Section 01 61 45 other than buried, submerged, or encased/embedded.



## 1.05 ADMINISTRATIVE REQUIREMENTS

A. Sequencing: After installation of insulation for pipe and equipment is complete, provide identification as described in Section 40 05 45.

## 1.06 SUBMITTALS

A. Procedures: Section 01 33 00

B. Action Submittals:
   1. A copy of this Section, addendum updates included, with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.
   2. Manufacturer's descriptive literature, including insulation and jacket thickness, heat transfer coefficient, and methods of installation.
   3. Certification of jacket ratings for water vapor transmission, puncture and stiffness as specified.
   4. ASTM C795 certification, for insulation applied to stainless steel pipe.

C. Informational Submittals:
   1. Samples of each insulation material type and thickness along with typical jackets and covers for pipe, fittings, valves and appurtenances. Provide a full diameter segment for each insulation sample, 6 inches in length.

D. Closeout Submittals:
   1. Warranty Documentation

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00

B. Deliver insulation, jackets and covering to site using methods which do not damage the materials.

C. Deliver insulation materials to site clearly identified as to type and temperature rating.

D. Store insulation materials on site as recommended by the manufacturer to prevent damage or and weathering.

E. Replace damaged or weathered insulation materials with new materials.

## PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. Manufacturers: Candidate manufacturers and models are listed below. The manufacturer's standard product may require modification to conform to specified requirements.

B. Cellular Elastomeric Tube
   1. Armacell, AP Armaflex
   2. K-Flex, Insul-Tube
   3. Approved Equal

C. Mineral Wool
   1. Roxul, ProRox PS960
   2. Johns Manville, MinWool-1200
   3. Owens Corning, Thermafiber Pro Section WR
   4. Approved Equal

D. Fiberglass
   1. Johns Manville, Micro-Lok HP
   2. Owens Corning, FIBERGLAS
   3. Approved Equal

E. Calcium Silicate
   1. Johns Manville, Thermo-1200
   2. Approved Equal

F. Cellular Elastomeric Flexible Blanket
   1. Armacell, AP Armaflex
   2. K-flex, Insul-Sheet
   3. Approved Equal

G. Fiberglass Flexible Blanket
   1. Amatex, Amamat
   2. Lewco, E Glass
   3. Approved Equal

H. Mineral Wool Flexible Blanket
   1. Johns Manville, Min-Wool 1200 Pipe and Tank Wrap
   2. Roxul, Enerwrap MA 960
   3. Approved Equal

I. Silica or Ceramic Fiber Flexible Blanket (Very High Temperature Range)
   1. Morgan Thermal Ceramics, Superwool 607 Blanket AC2
   2. Unifrax, Fiberfrax
   3. Harbison Walker, Inswool-HP
   4. Hitco, Refrasil
   5. Approved Equal

J. Expanded Perlite
   1. Johns Manville, Sproule WR-1200
   2. Approved Equal

K. Thin Flexible Blanket
   1. Johns Manville, InsulThin HT
   2. Approved Equal



## 2.02 INSULATION SERVICE CONDITIONS

A. Insulation Service Types
   1. Insulation service types define the function of the insulation. The extent and location of insulation application is based on the function of the insulation. This Section specifies the following insulation service types: Condensate Control, Personnel Protection, Freeze Protection, and Energy Conservation. Insulation Service Types and insulation materials for piping systems are specified in Piping System Schedules.
   2. Condensate Control is specified for piping that is to be insulated for condensate control. Where Condensate Control is specified for a piping service, furnish insulation for all pipe and pipeline appurtenances with a line size of ½-inch and larger that are located in Indoor Dry or Indoor Wet areas.
   3. Personnel Protection is specified for piping that is to be insulated to protect personnel from injury related to exposure to temperatures above 140 degrees F or below 32 degrees F. Where Personnel Protection is specified for a piping service in the Piping System Schedules, furnish insulation for all pipe and pipeline appurtenances where all of the following conditions are present:
      a. Piping is connected to the discharge or exhaust of equipment (includes equipment and pipeline appurtenances).
      b. Equipment, pipe, or pipeline appurtenances are located within 0.0 to 8.0 feet above a floor, stair, landing, or other type of walkway accessible by plant staff, or within 4.0 feet of a guardrail or ladder cage. Pipe, pipeline appurtenances, joints,

flanges, valves, and equipment in vaults, utilidors, and other spaces that are not designed for pedestrian access by plant staff are not insulated for Personnel Protection.

4. Freeze Protection is specified for piping that is to be insulated and heat traced to protect against freezing the contents of the pipe. Where Freeze Protection is specified for a piping service in the Piping System Schedules, furnish insulation for all piping to be freeze protected by electric heat trace tape as required by the Engineer. Coordinate electric heat trace tape installation with specified insulation requirements for freeze protection to provide freeze protection for piping throughout installation and usage.
5. Energy Conservation is specified for piping that is to be insulated to conserve energy. Where Energy Conservation is specified for a piping service in the Piping System Schedules, furnish insulation for all pipe and pipeline appurtenances for the entire portion of the piping system that is exposed.

## 2.03 MATERIALS

A. General:
   1. Provide materials that are new and undamaged.
   2. Match specified pipe insulation and jacket/cover material for insulation on valves, strainers, fittings, expansion joints, flanges, and other pipe couplings. Furnish flexible blanket insulation and soft covers if insulation on valves, strainers, fittings, expansion joints, flanges, and other pipe couplings is not available in the same materials as the specified pipe insulation and jacket/cover.
   3. Provide rigid insulation and shields at pipe supports for insulated pipe. Match specified jacket/cover material for pipe shields at pipe supports.
   4. Provide insulating and sealing materials, including cements, coverings, etc., that do not contain asbestos, mercury, or lead.
   5. When covering stainless steel pipe, pipeline appurtenances, or equipment, use insulation that complies with ASTM C795.
   6. Flame spread classification for insulation materials is not to exceed 25 when tested in accordance with ASTM E84.
   7. Use fibrous loose fill insulation for joint filler around insulated expansion joints.



B. Fiberglass Flexible Blanket: Flexible fiberglass blanket insulation designed for continuous 1200-degree F service. 8.0 pounds per cubic foot density, minimum. Long fiber, random orientation, needled.

C. Mineral Wool Flexible Blanket: Flexible mineral wool blanket insulation designed for continuous 1200 degree F service.

D. Silica or Ceramic Fiber Flexible Blanket: High purity alumina and silica non-asbestos white ceramic fiber insulation designed for continuous 1800 degree F service.

E. Aluminum Insulation Jackets/Covers
   1. Aluminum jackets and covers constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 3003, or 3105 temper H14, with integral vapor barrier.

2. Pipe Insulation Jacket thickness per ASTM C1729, as follows.

| Outer Insulation Diameter (inches) | Aluminum jacket thickness, rigid insulation (inch) | Aluminum jacket thickness, flexible and semi-rigid insulation (inch) |
|---|---|---|
| ≤ 8 | 0.016 | 0.016 |
| 8 thru 11 | 0.016 | 0.020 |
| 11 thru 24 | 0.016 | 0.024 |
| 24 thru 36 | 0.020 | 0.032 |
| ≥ 36 | 0.024 | 0.040 |

3. Furnish 0.030 inch, minimum thickness, for aluminum insulation covers at valves, strainers, fittings, expansion joints, flanges, and other pipe couplings.
4. Aluminum or stainless steel sheet metal screws.
5. Jackets secured with 0.020 inch thick by ¾ inch wide Type 304 stainless steel expansion bands.
6. Flashing includes aluminum caps, sealant and reinforcing.
7. Provide aluminum caps, 20 gauge. Cut to completely cover the insulation.
8. Provide sealants as recommended by the insulation manufacturer.
9. Provide wire mesh reinforcement or nylon fabric reinforcement in sealant at jacket and cover joints. Reinforcement material as recommended by the insulation manufacturer.

F. PVC Insulation Jackets and Covers
1. One piece PVC covers and jackets, 20 mil thickness, minimum.
2. Pre-molded polyvinylchloride conforming to FEDSPEC L-P-535E, Composition A, Type II, Grade E4.

G. Non-combustible Fabric Cover
1. Custom fit reusable covers. Sewn or stapled covers encapsulating insulation with stainless steel staples/hog rings. Close fit to the piping, pipeline appurtenance, or equipment housing.
2. Fabricated from 32 ounce TFE-coated or silicone coated fiberglass cloth with concealed/interior stitching, staples or hog rings (not exposed). For flexible blanket insulation installed for High-Temperature and Very High-Temperature Range applications, eliminate non-combustible fabric material on hot face of covers and provide stainless steel wire mesh on hot face of covers.
3. Fabric rated for continuous exposure to the temperature range of the insulation (Low, Medium, High, or Very High Temperature Range).
4. Secured in place with stainless steel lacing hooks, lock washers, and lacing wire.
5. Stitched or quilted to prevent consolidation, shifting, or settlement of insulation when subjected to vibration.



## PART 3 EXECUTION

### 3.01 PREPARATION

A. Apply insulation over clean, dry surfaces.

B. Ensure insulation is dry before and during application.

C. Do not apply protective pipe coatings to outside surface of insulation jackets or covers.

D. Do not paint PVC, aluminum, or fabric covers.

E. Do not install insulation or jackets/covers before piping and equipment has been tested and approved. Thermal shields at pipe hangers and supports may be installed prior to testing.

F. Provide thermal pipe hanger shields at pipe supports and bracing as specified on the Drawings, Details, Section 40 05 07 and Section 40 05 07.13.

## 3.02 INSTALLATION

A. General

1. Where insulation thickness exceeds 3 inches, double layer insulation must be provided. Install double layer insulation with staggered section joints.
2. Supply insulated thermal pipe hanger shields and install during pipe support installation. Where insulated thermal pipe hanger shields are used, apply the following to all butt joints:
   a. For pipe insulation with a medium, high, or very high Operating Temperature Range, apply 3 inch wide vapor barrier tape or band over the butt joints.
   b. For pipe with a low Operating Temperature Range, apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3 inch wide vapor barrier tape or band.

B. Protect insulation and jackets from crushing, denting, and similar damage during construction. Do not penetrate or otherwise damage vapor barriers. Remove any insulation, jacket, and vapor barriers damaged during construction and install new material.

C. Provide flashing at joints between insulation jackets, between insulation jackets and insulation covers, and at endcaps. Provide flashing around flange sets, pipe couplings, connections, and joint fittings. Allow adequate clearance between insulation rings, jackets and the joint connection for the removal and reinstallation of hardware during inspection and maintenance activities.

D. Piping Insulation

1. Install uninterrupted (continuous) insulation as indicated for the specified Insulation Service Conditions (Condensation Control, Energy Conservation, Personnel Protection, or Freeze Protection). Insulate over pipe and all in-line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Butt insulation firmly together and provide jacket laps and joint strips with lap adhesive. Provide a minimum of 2 inches of lap length. Install jackets with their seams located on the underside of pipe.
2. Covers overlap the adjoining pipe insulation and jackets.
3. Install covers with their seams located on the underside of valves, fittings, flanges, couplings, strainers and other piping appurtenances.

4. Low Operating Temperature Range
    a. Seal off ends of pipe insulation with a vapor barrier coating.
    b. Seal covers at edges with vapor barrier adhesive. Secure the ends of covers with vinyl tape. Overlap the jacket and the cover at least one inch with vinyl tape. Do not penetrate vapor barrier.
5. Medium, High, and Very High Operating Temperature Range
    a. Seal ends of insulation with end joint strips and use waterproof adhesive to hold them in place.
    b. Mechanically secure covers using corrosion-resistant tacks pushed into the overlapping throat joint.
6. Insulation for Outdoor Piping
    a. Where insulated pipe emerges from soil, concrete or asphalt terminate insulation for exposed pipe at the interface with insulation for buried pipe. If buried pipe is not insulated, extend insulation to within an inch above the finished surface. Do not push insulation into contact with soil, finished concrete, or asphalt surface.
    b. Provide heat tracing as required by the Engineer. Install insulation over heat tracing according to the specifications of the heat trace tape and insulation manufacturers.

E. Mechanical Equipment Insulation
1. Unless otherwise specified in this Section, fit insulation to the contours of equipment and secure it with 1/2 by 0.015 inch stainless steel bands. Weld pins or stick clips with washers may be used for flat surfaces and spaced a maximum 18 inches apart. Stagger joints and fill voids with insulating cement.
2. Overlap ends of blanket segments to prevent gaps and voids when the piping and equipment are heated.
3. Secure blankets snugly under nuts and bolt heads to assure complete coverage during operation and to prevent vibration-induced gaps or voids.
4. Secure blankets in strict accordance with the manufacturer's instructions.

F. Flashing
1. Provide flashing at jacket penetrations and terminations. Provide clearance for flashing between insulation system and piping supports.
2. Form aluminum caps to fit over the adjacent jacketing and to completely cover coated insulation. Hold cap in place with a jacket strap.

**END OF SECTION**

SECTION 40 42 13.33

INSULATED UNDERGROUND PIPING

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:

1. This section specifies pre-insulated liquid piping for direct burial installation. This section does not provide specifications for insulation for piping installed in galleries, rooms, pipe chases, or exposed to view. Fluid temperatures are limited to the range 40 degrees F to 210 degrees F.

B. Type:

1. Insulation shall be of the factory applied urethane foam type with a polyvinyl chloride (PVC) jacket.

C. Performance And Service Requirements:

1. Insulated piping furnished under this specification shall be suitable for direct burial or installation in pipe trenches. Fluid temperature shall be as listed in Section 40 05 01. Ground temperatures will range from 35 degrees F to 70 degrees F, and the piping may be installed below the water table.

D. Design Requirements:

1. Minimum insulation thicknesses, exclusive of jacket, shall be as follows:

| Pipe O.D., inches | Insulation thickness, inches |
|---|---|
| 2 or smaller | 1 |
| 3 through 6 | 1-1/2 |
| 8 through 12 | 2 |

2. A minus 15 percent tolerance, on the insulation thicknesses listed above, shall be permitted for manufacturers' standard insulation systems.
3. The piping manufacturer shall be informed of the intended application and asked for a minimum insulation thickness. If that provided by the pipe manufacturer is more stringent than as noted in this section, the manufacturer’s minimum requirement(s) shall prevail.

E. Piping Systems:

1. All pipe, which is noted to be insulated in Section 40 05 01, 40 05 02, or any related sections and which is to be run underground, as called for in the Design Drawings, shall be insulated in accordance with this section:

### 1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ANSI B31 | Code for Pressure Piping |
| ASTM C591 | Unfaced Preformed Rigid Cellular Polyurethane Thermal Insulation |
| ASTM D1784 | Rigid Poly (vinylchloride); (PVC) Compounds and Chorinated Poly (vinyl-chloride) (CPVC) Compounds |
| ASTM D2341 | Rigid urethane foam |



## 1.03 SUBMITTALS

A. The following submittals shall be provided in accordance with Section 01 33 00:
   1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
   2. Dimensioned shop drawings and location of each expansion loop, including clearances provided for carrier pipe expansion.
   3. A complete description of the preinsulated piping and accessories in sufficient detail to demonstrate compliance with these specifications.

# PART 2 PRODUCTS

## 2.01 ACCEPTABLE MANUFACTURERS

A. Preinsulated piping systems shall be Perma-Pipe/Ricwil, Thermal Pipe Systems Weldtite, or equal, modified as necessary to provide the specified performance and features.

## 2.02 MATERIALS

A. Carrier Pipe:
   1. Unless otherwise specified, carrier pipe materials shall be as specified in Section 40 05 01, Piping System Specification Sheets, for each piping system.

B. Urethane Foam Insulation:
   1. The urethane foam shall conform to ASTM C591, Type II.

C. Insulation Jacket:
   1. All PVC shall conform to ASTM D1784, Class 12454-B. The minimum jacket thickness shall be 60 mils and shall be suitable for H-20 highway loading with 2 feet of cover.

D. Shrinkable Sleeves:
   1. Shrinkable sleeves for field joints shall be compatible with the PVC jacket. Shrinkable sleeves shall be fabricated from radiation cross-linked semirigid polyethylene, coated on all inside surfaces with thixotropic adhesive designed to flow and provide a complete seal when heated.



## 2.03 MANUFACTURING

A. General:
   1. Pipe sections shall be prefabricated in such a way that the urethane completely fills the annular space between the carrier pipe and the PVC jacket. The exposed insulation at the end of each section shall be sealed with a factory-applied, high temperature, watertight sealant. The carrier pipe shall extend a minimum of 6 inches beyond the insulation for field welding.

B. Anchors:
   1. Anchor plates shall be factory fabricated and welded to the carrier pipe. The PVC jacket shall extend up to the anchor plate and be factory sealed to the anchor plate.

C. Fittings:
   1. Fittings shall be factory fabricated and pre-insulated with urethane foam insulation. The insulation shall be protected with a PVC plastic jacket of the same thickness and quality as that of the straight pipe. All miters on the PVC jacket at fittings shall be welded by a thermal set welding process to provide a continuous jacket integrity.

D. Expansion Elbows And Loops:
   1. Prefabricated elbows, expansion loops, and tees shall be provided, where specified. All pre-insulated fittings that must provide compensation for pipe expansion and/or contraction shall be installed in a suitably sized jacket and insulated with flexible polyurethane foam insulation. The straight units adjoining expansion fittings shall also be insulated with flexible polyurethane foam insulation to compensate for lateral pipe movement.

E. End Seals:
   1. End seals shall be provided on ends of each section of preinsulated pipe. The end seals shall be watertight to protect the exposed insulation.

## 2.04 PRODUCT DATA

A. The following information shall be provided in accordance with Section 01 33 00:
   1. Manufacturer's certification in accordance with paragraph 3.06.
   2. Certification that the jacket meets the requirement of paragraph 2.02 Insulation Jacket.
   3. Manufacturer's recommended field installation instructions including pipe jointing techniques, joint insulation, and jacket sealing.

# PART 3 EXECUTION

## 3.01 GENERAL

A. The preinsulated piping system shall be installed in strict accordance with the manufacturer's recommendations.

## 3.02 FIELD TESTING

A. Prior to insulating any field joints, individual pipe sections shall be hydrostatically tested at the test pressure and temperature indicated in Section 40 05 01. The Engineer shall be notified in writing 48 hours prior to testing. Any leaks shall be repaired, and the system shall be retested until no leaks are detected by the Engineer. Field joints shall be insulated after hydrostatic testing has been completed.



## 3.03 EXPANSION LOOPS AND ELBOWS

A. Prefabricated expansion loops shall be located in the locations shown on the drawings. Field fabricated expansion loops will not be accepted.

## 3.04 FIELD JOINTS

A. Carrier pipe field joints shall be as specified in Section 40 05 01. After jointing and pressure testing, rigid urethane insulating material or foamed-in-place urethane of the same density and thickness as the pipe section shall be applied to the joint area. The insulation shall be sealed to the PVC jacket using heat shrinkable sleeves. All material used to insulate and seal field joints shall be supplied by the piping system manufacturer.

## 3.05 ANCHOR BLOCKS

A. Concrete anchor blocks shall be provided at locations shown on the drawings. Concrete shall comply with Section 03 30 00. Anchor blocks shall be poured against undisturbed soil and shall have minimum dimensions as shown on the drawings. Pipe joints encased in anchor blocks shall be pressure tested prior to pouring anchor blocks. No valves shall be encased in anchor blocks.

## 3.06 FACTORY REPRESENTATIVE

A. A qualified factory representative of the piping system shall be present during the initiation of the buried piping installation, during major field relocations or changes, and during piping system testing. The factory representative shall supervise the pipe

installation, joint insulation process, and installation of the protective jacket at joints during the first day of installation, or for longer, if the qualitifed factory representative deems necessary. On completion and testing of the work, the Contractor shall provide a certificate from the manufacturer stating that the installation, including any field relocation or modifications to the system, has been made in accordance with the manufacturer's recommendations.

**END OF SECTION**

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SECTION 40 61 13.01

PROCESS CONTROL SYSTEM GENERAL PROVISIONS FOR SMALL PROJECTS

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:

1. This section specifies requirements which are applicable to all process control, instrumentation, communication, and signal systems. The Contractor is to supply and install the equipment for a complete, functional system as shown and specified.
2. Furnish, install, and test the following equipment for the new FOG receiving area:
   a. Field Instrumentation:
      1) Submerged level transmitters
      2) Guided wave radar level transmitters
      3) Temperature transmitters and indicators
      4) Flow switches
      5) Pressure indicators
      6) Gas detection systems and notification systems
      7) Valve position switches and indicators
   b. Process Control Hardware:
      1) Install the Authority-provided IO panel, to aggregate all signals, valve control, variable frequency drives, and motor starters added for the new FOG receiving area to operate cohesively as outlined in this section, Part 3.05-Control Strategies.
      2) Install wire, signal cables, and conduit as shown on contract drawings to provide the necessary signals to the plant control systems from all associated drives, vendor control panels and controllers Install all wiring, cables, and conduit to provide the necessary signals to the plant controls systems.
3. Furnish, install, and test the following equipment for the Maintenance Building:
   a. Field Instrumentation
      1) Temperature switches, transmitters, and indicators
      2) Pressure transmitters, and indicators
      3) Install wire, cables, and conduit as shown on contract drawings to provide the necessary signals to the plant control systems.
4. Furnish, install, and test the following equipment for the Administration Building:
   a. Field Instrumentation
      1) Temperature switches, transmitters, and indicators
      2) Pressure switches, transmitters, and indicators
      3) Provide wiring and conduit as necessary to bring signal from existing magnetic flowmeter into the existing PLC.
      4) Install wire, cables, and conduit as shown on contract drawings to provide the necessary signals to the plant control systems.

5. Furnish, install, and integrate the new fuel oil transfer tank, fill station, recirculating pumps, and transfer pump skid.
    a. Install wire, signal cables, and conduit as shown on contract drawings to allow all associated vendor provided fuel oil systems to act cohesively and satisfy the control strategies per Section 3.05.
    b. Install signal cable to provide remote monitoring to the plant's SCADA system.
    c. After demolition of the existing fuel oil pump skids, move and reinstall the underground leak detection alarm signal to the PLC 1. Provide all wire and conduit.
6. Train maintenance technicians and plant operators on the equipment provided above.
7. The above is a general summary of the major items and is not intended to be all inclusive.

B. Work included:
1. Major constituents of this system shall include, but are not limited to, all materials, equipment and labor required to implement a complete and operating system of instrumentation and controls. The Contractor shall supply, install, calibrate, test, and document each instrument. The Contractor shall provide the services of NICET certified instrument technicians for testing and adjustment activities. The Contractor shall examine all contract drawings and specifications to determine actual locations, sizes, materials, and ratings of process connections. Process taps shall be indicated on pipe shop drawings as specified in paragraph 40 05 01-2.04. The completed system shall include control panels containing microprocessor-based display and control devices, electronic signal conditioning equipment, programmable logic controllers, and power supplies. Field mounted equipment shall include electronic transmitters and control devices as well as final control elements, and primary elements for process variable measurements. Process variables shall include, but are not limited to, flow, level, pressure, and temperature measurements.

C. Related Work:
1. Raceways, signal cables, and their requirements are specified in Division 26.

D. Definitions:
1. General: The definitions of terminology used in these specifications shall be defined in ISA Standard S51.1 unless otherwise specified.
2. Solid State: Circuitry or components of the type which convey electrons by means of solid material such as crystals or which work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, stepping motors, or other devices are not acceptable substitutes for solid state components or circuitry.
3. Integrated Circuit: A number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.
4. Two-Wire Transmitter: A transducer which derives operating power supply from the signal transmission circuit and therefore requires no separate power supply connections. As used in this specification, two-wire transmitter refers to a transmitter which produces a 4 to 20 milliampere current regulated signal in a series circuit with a 24-volt direct current driving potential and a maximum circuit resistance of 600 ohms.

5. Galvanic Isolation: Pertaining to an electrical node having no direct current path to another electrical node. As used in this specification, galvanic isolation refers to a device with electrical inputs and/or outputs which are galvanically isolated from ground, the device case, the process fluid, and any separate power supply terminals, but such inputs and/or outputs are capable of being externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.
6. Panel: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Panels may provide mechanical protection, electrical isolation, and protection from dust, dirt, and chemical contaminants which may be present in the atmosphere. Panel shall include consoles, cabinets and racks.
7. Data Sheets: Data sheets as used in this specification shall refer to ISA S20.
8. Signal Types: The following types of signals are used in systems specified in this division.
    a. Low Level Analog: A signal that has a full output level of 100 millivolts or less. This group includes thermocouples and resistance temperature detectors.
    b. Digital Code: Coded information such as that derived from the output of an analog to digital converter or the coded output from a digital computer or other digital transmission terminal. This type includes those cases where direct line driving is utilized and not those cases where the signal is modulated.
    c. Pulse Frequency: Counting pulses such as those emitted from speed transmitters.
    d. High Level Analog: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4-20 mAdc transmission.
    e. Modulated Signals: Signals emanating from modems or low level audio signals. Normal signal level is plus 4 dBm to minus 22 dBm. Frequency range is 300 to 10,000 hertz.
    f. Discrete Events: Dry contact closures monitored by solid state equipment. If the conductors connecting to dry contacts enter enclosures containing power or control circuits and cannot be isolated from such circuits in accordance with NEC Article 725, this signal shall be treated as low voltage control.
    g. Low Voltage Control: Contact closures monitored by relays, or control circuits operating at less than 30 volts and 250 milliamperes.
    h. High Level Audio Signals: Audio signals exceeding plus 4 dBm, including loudspeaker circuits.
    i. Radio Frequency Signals: Continuous wave alternating current signals with fundamental frequency greater than 10 kilohertz.



## 1.02 QUALITY ASSURANCE

A. References:
1. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective

date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| API RP550 | Manual on Installation of Refinery Instruments and Control Systems, Part I-Process Instrumentation and Control Sections 1 Through 13 |
| ASME Section VII | Rules for Construction of Pressure Vessels |
| ASTM B68 | Seamless Copper Tube |
| ASTM B209 | Aluminum and Aluminum Alloy Sheet and Plate |
| ASTM D883 | Terms Relating to Plastics |
| ASTM D1248 | Polyethylene Plastics Molding and Extrusion Materials |
| IEEE 100 | Dictionary of Electrical and Electronic Terms |
| IEEE C37.90.1 | Guide to Surge Withstand Capability (SWC) Tests |
| ISA RP7.1 | Pneumatic Control Circuit Pressure Test |
| ISA RP12.6 | Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations |
| ISA S5.4 | Instrument Loop Diagrams |
| ISA S18.1 | Annunciator Sequences and Specifications |
| ISA S51.1 | Process Instrumentation Terminology |
| MILSPEC MIL-I-46058C | Insulating Compound, Electrical (For Coating Printed Circuit Assemblies) |
| NEMA 250 | Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ICS 1 | General Standards for Industrial Control and Systems |
| NEMA ICS 2 | Industrial Control Devices, Controllers, and Assemblies |
| NFPA 70 | National Electrical Code (NEC) |
| SAMA PMC 17-1.0-63 | Bushings and Wells for Temperature Sensing Elements |
| UBC | Uniform Building Code |
| UL 1012 | Power Supplies |
| UL 94 | Tests for Flammability of Plastic Materials for Parts in Devices and Appliances |
| Weik, Martin H. | Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983 |



B. Pre-Submittal Conference:

1. Schedule a pre-submittal conference with the Authority and Contractor within 30 calendar days after Contract award to discuss the work, equipment, submittal format, and establish the framework for project coordination and communication.
2. Provide materials 10 days prior to the conference:
   a. Instrument Index that lists the devices and instruments specified in Division 40 identify each by tag number, description, function, manufacturer, and model number.
   b. Product descriptive literature with a statement that the item is as specified.
   c. Proposed equal products with comparative listing of the published specifications for the specified item and the proposed item.

d. Project schedule with deliverables and milestones.

3. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.

C. Process Equipment Coordination:

1. Division 40 specified equipment shall be coordinated for proper operation with equipment related process equipment specified in other Divisions.
2. Equipment shall be integrated, furnished, and installed in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.
3. Contractor shall obtain a copy of the manufacturer's submittal with technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.
4. Contractor shall coordinate with project subcontractors and equipment suppliers.
5. Contractor shall provide installation supervision for the duration of the project.
6. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Contractor for resolution before proceeding.

D. Manufacturer:

1. Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of 5 years.

E. Installer:

1. Installation, calibration, and testing of equipment furnished under this section shall be performed by qualified, skilled, NICET certified technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

F. Identification of Listed Products:

1. Electrical equipment and materials shall be listed, for the purpose for which they are to serve, by an independent testing laboratory. Three such organizations are Underwriters Laboratory (UL), Canadian Standards Association (CSA), and Electrical Testing Laboratories (ETL). The Independent laboratory under which a product is listed shall be acceptable to the inspection authority having jurisdiction.
2. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority, to undergo a special inspection at the Manufacturer's place of assembly. All costs and expenses for such inspections shall be included in the original Contract Price.

## 1.03 PROJECT/SITE CONDITIONS

A. General:

1. Specified communication and process control equipment shall be modified, if necessary, to make it suitable for operation in the following ambient conditions. Indoor and outdoor field location temperatures and relative humidity are specified in Section 01 11 80.

B. Hazardous Locations:

1. Hazardous locations shall be as specified in Division 26 and or shown on the drawings.

C. Corrosive Locations:

1. Corrosive locations shall be as specified in Division 26 and or shown on the drawings.

D. Electric Power:

1. Electric power for instrumentation and communication systems shall be obtained from the power distribution system specified in Division 26. This power is not regulated, wave forms may be distorted, and significant amounts of electrical noise may be present. Equipment shall be configured to withstand a momentary power outage where the equipment when energized returns to the ready state.
2. The Contractor shall provide all necessary power supply and conditioning equipment to provide electrical power of the required voltages and current capacities and of adequate quality to ensure reliable operation of the instrumentation and communication systems. Unless otherwise specified, the Contractor shall assume that the power supply for instrumentation systems is 120 volts plus or minus 15 percent, 60 hertz plus or minus 3 hertz, 5 percent maximum harmonic distortion.

## 1.04 SUBMITTALS

A. General:

1. Procedures: Submittals shall be provided in accordance with Section 01 33 00.
   a. Deviations: A copy of each specification section in this division, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked (✓) to indicate specification compliance or marked to indicate requested deviations from specification requirements. 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. 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 consideration.
   b. Completeness: A separate submittal shall be provided for each section of this division requiring a submittal. The submittal for each section shall be bound separately and shall include all the information required for each item specified in the subject section. Submittals which do not have all the information required to be submitted, including deviations, are not acceptable and will be returned without review.

B. Additional Information:

1. Test Forms: Test report forms shall, where appropriate, conform to the requirements of reference forms 40 95 10-A through 40 95 10-K included in Section 01 99 90. Additional and/or more detailed forms shall be developed as necessary to suit more complex instrumentation. Usage of terms used on test forms shall be in compliance with ISA S51.1.

2. Data Sheets: Data sheets for all instruments and accessories to be provided shall be submitted. Data sheets shall be in accordance with ISA S20. All applicable entries on the data sheet shall be completed.
3. Drawings:
   a. General: The drawings included in this project manual are functional in nature and do not show exact locations of equipment or interconnections between equipment. Detailed construction drawings as specified below shall be provided. Drawings shall be prepared on 11-inch by 17-inch drafting media. Drawings shall have borders and title blocks identifying the project, system, revisions to the drawing, and type of drawing. Each revision of a drawing shall carry a date and brief description of the revisions. Diagrams shall be developed using NEMA standards, carry a uniform and coordinated set of wire numbers and terminal block numbers in compliance with this section.
   b. Connection Diagrams: initial connection diagrams for panels shall be provided by the Authority for this project. Connection diagrams shall show components of a control panel in an arrangement like the actual layout of the panel. Internal wiring between devices within the panel shall be shown on these diagrams. Connection diagrams shall show all terminal blocks whether used for internal or field wiring. Those used for field wiring shall be clearly identified as such. Wiring diagrams shall indicate insulation color code, signal polarities, and shall show wire numbers and terminal block numbers.
   c. Interconnection Diagrams: It shall be the Contractor's responsibility to submit interconnection diagrams based on the initial connection diagrams provided by the Authority. Interconnection diagrams shall be provided for field wiring. Interconnection diagrams shall show each panel and field device. Wire numbers, cable numbers, raceway numbers, terminal box numbers, panel numbers, and field device tag numbers shall be shown.
   d. Following start-up but prior to acceptance of the work, the Contractor shall provide electronic copy of drawings using ACAD format and full-size reproducible prints of elementary, interconnection diagrams and reproducible prints of other drawings, and PDF format for equipment data sheets. Documentation shall reflect the final constructed state of the instrumentation and control systems.
4. PRODUCT DATA
   a. Material List: Within 60 days after "Notice to Proceed", a list of the manufacturer and model series for each major category of equipment, system, and instrument to be provided shall be submitted.
   b. Catalog Cuts: Catalog cuts showing pertinent information and features for the proposed equipment shall be provided. Catalog information shall include technical specifications and application information for each piece of equipment. Catalog cuts shall be edited to indicate only those items, model or series of equipment which are being provided. All extraneous materials shall be crossed out or otherwise obliterated.
   c. Component Fabrication Drawings: Detailed circuit schematics, printed circuit board drawings, and chassis layouts shall be provided for electrical and electronic components.
   d. Certification:
      1) Temperature: Test data, certified by the manufacturer, shall be provided to demonstrate that field electronic devices are suitable for the specified ambient temperatures.

2) Corrosion: Data shall be provided showing design features of the electronic equipment provided to protect against damage by the specified atmospheric contaminants and specific evidence that similarly protected electronic equipment has operated in similar environments for a period of not less than 5 years without failure due to corrosion.

e. Record Documentation: Data sheets included in paragraph 1.04 of this section, and all schedules included in this section shall be provided as record drawings in accordance with Section 01 78 39.

C. Operation and Maintenance Information: Operation and maintenance information shall be provided in accordance with Section 01 78 23.

D. Test Results: Test data sheets, printouts, and other records of testing as specified in paragraph 3.02 of this section shall be provided.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Materials and Quality:

1. Material shall be new, free from defects, and of the quality specified. Each type of instrument, instrument accessory, and device shall be by the same manufacturer throughout the work.
2. Electronic equipment shall be of solid state construction unless otherwise specified. Printed or etched circuit boards shall be glass epoxy of sufficient thickness to prevent warping. Solder shall be tin-lead plate, 55 to 75 percent tin, electrodeposited followed by tin emersion and reflow (fusing). Printed wiring shall have solder finish with no exposed copper on surfaces, edges, or in holes of finished product. Printed circuit boards in field mounted equipment shall be coated with 2 mils of a solderable conformal coating complying with MILSPEC MIL-I-46058C. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers. Components of standard electronic assemblies shall not be replaced with components of different characteristics to meet the performance requirements of this specification. Parts shall be as shown in the instruction manuals and shall be replaceable with standard commercial components of the same description without degrading the performance of the completed assembly.

B. Instrumentation Specification Sheets (INSTRUSPEC):

1. General requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

C. Instrument Schedule:

1. The Instrument Schedule, paragraph 3.04 of this section, lists major instruments required to provide the process instrumentation system. All instrument functions specified on this list shall be provided. Additional instruments may be required to complete the instrument loops because of certain characteristics of the specific equipment provided. Such additional instruments shall be provided at no additional cost even though not specified in the Instrument Schedule or on the Contract Drawings.

2. In some cases, it is possible to combine the functions of two or more instruments specified in the Instrument Schedule into a single instrument. Functions which may be ordinarily combined into a single instrument are multiple alarms derived from a common transmission signal, and signal linearization may be combined into transmitters except where the nonlinear signal is used for specific purposes such as standardized flow calculations. Flow computers may be used in lieu of individual function modules for standardized flow calculations providing equivalent performance is provided. Alarm or safety functions shall be derived directly from process measurements and shall not be derived from transmission signals unless specifically shown. Alarm or safety functions shall not be combined into any instrument used for process control, indication, recording, or any combination thereof unless specifically shown.
3. Standard instruments shall be modified as necessary to meet the specified application requirements.

## 2.02 PANELS

A. General:

1. Support systems including panels shall be designed in accordance with the Standard Building Code and to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction. Panels shall be designed and manufactured in accordance with UL-508A and shall include a UL-508A label.
2. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose or UL recognized.
3. All panels shall be labeled in accordance with NEC Article 409. Table A specifies the instrument and control panel enclosure material and minimum NEMA rating for the location and application where not identified in other specification sections.



**Table A**

| Location | Enclosure Material and NEMA Rating |
|---|---|
| Indoor: architecturally finished area | NEMA 12: mild steel |
| Indoor: electrical room | NEMA 12: mild steel |
| Indoor: process areas | NEMA 4X: 316 stainless steel |
| Indoor: corrosive area | NEMA 4X: 316 stainless steel |
| Outdoor: corrosive area | NEMA 4X: 316 stainless steel |
| Outdoor: non-corrosive areas | NEMA 4X: 316 stainless steel |
| Corrosive area (hypochlorite) | NEMA 4X: non-metallic |
| Hazardous area | NEMA 7: galvanized malleable iron or aluminum or NEMA 4X and UL listed or FM approved for the hazardous area. Where no such enclosure is available, enclosure ratings shall be for the indoor or outdoor area and shall be made intrinsically safe. |
| Hazardous and corrosive area | NEMA 7: iron or aluminum with factory-applied corrosion-resistant coating or NEMA 4X and UL listed or FM approved for the hazardous area. Where no such enclosure is available, enclosure ratings shall be for the indoor or outdoor area and shall be made intrinsically safe. |

B. Enclosed Panels:

1. General Services: Cabinet shall be a NEMA 250, Type 12 enclosure fabricated from 1/8-inch minimum thickness sheet steel. Face-mounted instruments and devices shall be mounted in the door a minimum of 36 inches above the finished grade. Cabinet shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Doors shall be hung on full-length piano-type hinges and equipped with vault-type latch capable of accepting a 3/8-inch-shackle padlock. Three-point latch hardware shall be provided for doors exceeding 30 inches height. Where cabinet width exceeds 36 inches, multiple doors no wider than 34 inches shall be provided. The enclosure sub-panel shall be painted white.
2. Provide print pocket on inside of enclosure door with As-Installed drawings properly wrapped and stored. Provide a fold up shelf on the inside door to accommodate a laptop.
3. Within the enclosure provide a 60-watt convenience fluorescent light with guard and light switch; provide a GFCI-type convenience receptacle. Enclosures over 36 inches shall have a 60-watt fluorescent light each 24- to 36-inch increments.
4. Enclosures with 208 or 480 VAC motor circuits shall include a safety barrier to separate the 120 V or less control circuits from the motor control circuits.
5. Enclosure subpanel:
   a. Shall include wireway dedicated for field wire installation.
   b. Shall include a minimum of 20 percent space for future use. Din rails for terminal blocks and relays shall include space for future addition.
   c. Shall provide clear free space at the top of the panel and the bottom of the panel for cable entry, minimum 6 inches at the top and 12 inches at the bottom.
6. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons.
7. Process Areas and/or Outdoors: Cabinet shall be similar to those specified in paragraph 2.02 C.1 above, except it shall be fabricated from Type 316 stainless steel, provided with suitable door clamps and gaskets as required for NEMA 250, Type 4X requirements. Enclosure shall also be provided with a rain and sun shield when mounted outdoors.
8. Heating and Ventilating: Forced air ventilation shall be provided for enclosed cabinets. Fans shall be equipped with UL-approved washable filters and provide at least 240 cfm. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units. Fans for field cabinets and outdoor consoles shall be thermostatically controlled. Outdoor cabinets shall also be provided with thermostatically controlled space heaters. If space heater surface temperature exceeds 120 degrees F, an expanded metal guard shall be provided. Thermostats shall be Hoffman, Honeywell T631B1013, Penn Controls A28AA-4, or equal.

C. Panel Nameplates:

1. Comply with section 2.10 of this specification.
2. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels.
3. Nameplates shall be attached to panel surfaces, not to instruments.

D. Panel Wiring and Accessories:

1. Power and control wiring shall be single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum. Wiring for signal shall be No. 16 AWG stranded copper NFPA No. 70 Type MTW.
2. Terminal blocks shall be tubular clamp type with closed cable funnels rated for 300 volts. Each terminal strip shall have a unique identifying alphanumeric code at one end and a vinyl marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high. Connections between adjacent terminals, if required, shall be made by means of prefabricated metal comb type jumpers. Terminal blocks shall be Phoenix Contact UK 2,5 N, or equal.
3. Surge protection:
   a. General: surge protection shall be provided to protect electronic instrumentation systems from surges propagating along the signal and power supply lines.
   b. Surge protectors shall be provided at panel terminal blocks for signal circuits which extend outside the building where the control panel is located. Surge protectors shall be multi-stage plug-in type and shall be selected in accordance with the requirements of the equipment to be protected. Surge protectors shall be removable without changing the impedance of the circuit. Surge protectors shall be Phoenix Contact PT2X2-24DC-ST or equal.
   c. Surge protectors shall be provided at panel incoming power supply. Surge protectors for three phase power shall be as specified in Division 26 or as shown on the drawings. Surge protection for 120 VAC shall be ASCO 252 or equal.
   d. Field instruments mounted outside the building where the control panel is located shall include surge protection for two-wire and four-wire instruments and shall be ASCO 157, or equal.
4. Circuits shall be fused. Fuses shall be 1/4 x 1 1/4 inch; fuses on 120V AC circuits shall be ceramic tube type with 35,000 amperes interrupting capacity at 125 volts. Fuses for 24V DC circuits shall be fast-acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops and 1/2 amp for the power supply to individual instruments. Fuse holders for 120V AC control circuits shall be drawout type and molded from melamine plastic. Fuses shall include a neon blown fuse indicator lamp.
5. AC power circuits within the panel shall utilize circuit breakers.

E. Control Relays:

1. Load-Switching Control Relays:
   a. Control relays used for switching loads such as solenoids, actuators, contactors, motor starter coils, remote interlocking, etc. shall be heavy-duty machine tool type.
   b. Contacts shall be 4-pole and be field interchangeable to either normally-open or normally-closed. Relay shall be capable of accepting a 4-pole adder.
   c. AC relays shall have NEMA A600 contact ratings and electrical clearances for 600 volts. DC relays shall have NEMA P300 contact ratings and electrical clearances for 250 volts.
   d. Manufacturer: Allen Bradley Bulletin-700, Square D Class 8501, or equal.
2. Logic Level Switching Control Relays:
   a. Control relays for signal circuits shall have a minimum of three SPDT, gold-flashed, fine silver contacts rated 10-ampere resistive at 120Vac or 28Vdc.

b. Control relays shall be plug-in type with heavy-duty, barrier-protected screw terminal sockets and clear polycarbonate dust cover with clip fastener.
c. AC models shall have neon lamp indicator wired in parallel with coil. DC models shall have LED lamp indicator wired in parallel with coil.
d. Manufacturer: IDEC Series RH; Potter Brumfield series KUP; or equal

3. Timers:
   a. Multi-function, micro-controller based, socket mounted timing relay.
   b. Single functions:
      1) Delay on Make
      2) Delay on Break
      3) Recycle (on time first, equal recycle delays)
      4) Single shot
      5) Interval
      6) Trailing edge single shot
      7) Inverted single shot
      8) Inverted delay on break
      9) Accumulative delay on make
      10) Re-triggerable single shot
   c. Dual functions:
      1) Delay on make/delay on break
      2) Delay on make/recycle (on time first, equal recycle delays.)
      3) Delay on make/interval
      4) Delay on make/single shot
      5) Interval/recycle (on time first, equal recycle delays)
      6) Delay on break/recycle (on time first, equal recycle delays)
      7) Single shot/recycle (on time first, equal recycle delays)
      8) Recycle – both times adjustable (on time first)
      9) Recycle – both times adjustable (off time first)
      10) Interval/delay on make
      11) Accumulative delay on make/interval
   d. Time delay range, switch selectable:
      1) Single function 0.1 second to 1,705 hours in 8 ranges.
      2) Dual function 0.1 second to 3,100 minutes in 8 ranges.
      3) Setting accuracy +/- 1 percent or 50 milliseconds, whichever is greater.
      4) Repeat accuracy +/- 0.1 percent or 16 milliseconds, whichever is greater.
   e. Output:
      1) Two Form-C electromechanical isolated contacts rated 10-amperes resistive at 240Vac
      2) Rated 1/3-horsepower at 120 or 240Vac
      3) Double-pole double-throw: DPDT.
      4) Mechanical life: 10,000,000 operations
      5) Electrical life: 1,000,000 operations at full load.

f. Mounting: Magnal Plug 11-pin socket
g. Environment: -20 to +65 degree C.
h. Manufacturer: Square D or equal

F. ABB / SSAC's multifunction type TRDU time delay relay with dip-switch function setting with 12Vdc, 24Vac, 120Vac, 240Vac inputs as required or indicated or equal.

G. Pilot devices shall be heavy duty, NEMA 4/13, 30.5 mm as manufactured by Allen Bradley 800H or approved equal. Pilot lights shall be push to test type and LED type.

## 2.03 POWER SUPPLY AND CONDITIONING EQUIPMENT

A. General:
1. Electric power for instrumentation and communication systems shall be obtained from the site distribution system. This power is not regulated. Waveforms may be distorted, and significant amounts of electrical noise may be present. All necessary power supply and conditioning equipment required to provide electrical power of the required voltages and current capacities and of adequate quality to ensure reliable operation of the instrumentation and communication system shall be provided. The power supply for instrumentation systems shall be 120 volts plus or minus 15 percent, 60 hertz plus or minus three hertz, 5 percent maximum total harmonic distortion unless note otherwise. Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems. Diode isolation shall be provided for redundant direct current supply units, and the power supply negative output terminal shall be grounded. An alarm shall be indicated locally and on SCADA upon a power supply failure.



B. Surge Protection:
1. Surge protectors shall be provided panel incoming power supply. Surge protectors for three phase power shall be as specified in Division 26 or as shown on the drawings. Surge protection for 120 VAC shall be Bussmann, ASCO 252 or equal.

C. Direct-Current Power Supplies:
1. Provide redundant DC power supply and provide alarm input to the PLC when in the fault condition. Direct-current supplies for bulk 24-volt nominal instrumentation power shall be convection-cooled switching type. Line regulation shall be 0.4 percent for line variations from 105 to 132 volts, and load regulation shall be 0.4 percent for load variations from 0 to full load. Ripple and noise shall not exceed 100 mV peak-to-peak. Hold-up time at maximum load shall be not less than 15 milliseconds. Efficiency shall be a better than 70 percent. Power supply shall be rated for continuous duty from 0 to 50 degrees C at rated load. Output shall be electronically current limited, and over voltage crowbar shutdown shall be provided. Power supply output voltage shall be rated 28 volts DC, adjustable plus or minus 5 percent, and shall be set to provide 26.4 volts on the panel direct current bus. Power supplies shall be Power One, Phoenix Contact Quint Series or equal.

D. Uninterruptible Power System (UPS):

1. General: Each PLC and PC workstation shall include a UPS as part of the package. This paragraph specifies requirements for uninterruptible power supply (UPS) systems consisting of a battery charger, battery, rectifier inverter, and bypass line transfer switch. The uninterruptible power supply shall be an on-line, computer-grade system with isolated neutral. The uninterruptible power supply system shall use a double conversion to provide isolation and power conditioning under normal operation. When power the fails, an inverter shall provide AC power from batteries through the transformer to provide continuous uninterrupted power. Uninterruptible power supply systems shall be as manufactured by Eaton, Necedah, American Power Conversion, Wisconsin, or equal.
2. System Performance: The UPS shall be completely isolated from the incoming 120 Vac power with less than 2 pf of effective capacitance. It shall qualify as a separately derived power source per NEC article 250-5D. The unit shall suppress surges as described by IEEE 587A and B to safe levels. Output voltage regulation shall be ±3 percent maximum single harmonic and 5 percent total harmonic distortion at 120 Vac. Frequency distortion shall not exceed ±0.5 hertz. Operating condition shall be 0 to 40 degrees C at 95 percent relative humidity, noncondensing.
3. The system shall be monitored by a microprocessor allowing remote monitoring of the UPS internal alarms. LED indicators shall be provided on the front of the cabinet for systems status and alarms. Include status contacts, dry contacts for UPS Fail and UPS On, to monitor the UPS status on the SCADA system.
4. The UPS shall provide continuous unity power factor with no interruption from line to inverter and return. The UPS shall be capable of delivering 125 percent of rated capacity for 10 minutes and shall have a surge capability of 150 percent. Unit shall be sized with 25 percent spare capacity. Submit load calculations for review.
5. Battery: Batteries shall be maintenance-free, sealed type, installed in cabinet. Provide 30 minutes of battery backup at full load.
6. Battery Charger: The battery charger shall be the constant voltage type and shall provide equalization capability with a manually initiated timer.
7. Transfer Switch: No-break transfer line to inverter and return. UPS shall be able to be switched to the utility source bypassing the UPS should service be required.
8. Inverter: The inverter system shall be low frequency pulse width modulated type using power MOSFETS."



## 2.04 PROCESS TAPS AND ACCESSORIES

A. Valves:

1. Valves shall be full port ball valves with ASTM A276, 316 stainless steel trim and body and with Teflon seats and packing. Valves shall be Whitey series 40, Hoke Flowmite, or equal.
2. Gauge Valves: Gauge valves shall be globe or angle pattern units machined from ASTM A276 bar stock and shall be provided with two 1/2-inch NPT ports. Valves shall be Anderson, Greenwood & Company M9 series, Hoke 2100 series, or equal. Valve material shall be compatible with that of the gauge.
3. Root Valves: Root valves shall be ASTM A276, type 316 stainless steel bar stock with 1/2-inch NPT male process connection and three 1/2-inch NPT female instrument connections. One instrument connection shall be provided with an ASTM A276, type 316 stainless steel bleed valve. ASTM276, type 316 stainless steel

plugs shall be provided for unused ports. Lagging type units shall be provided for insulated vessels and pipes. Root valves shall be Anderson, Greenwood & Company M5A VS-44, Hoke 6802L8Y, or equal.

4. Manifolds: Manifolds shall be three-valve bar-stock type. Manifold body shall be machined from ASTM, type 316 stainless steel bar stock. Valves shall be globe configuration with 316 stainless steel ball seats and Teflon stem packing. Manifolds shall be designed for direct mounting to differential pressure transmitters in place of the flanges normally furnished. Fabricated manifolds or manifolds employing needle or soft seat valves are not acceptable. Purge taps, 1/8-inch NPT shall be furnished on manifolds where water purge is specified. Manifolds shall be Anderson Greenwood M4T VS, HEX 8123F8Y, or equal.

B. Tubing and Tubing Fittings:

1. Instrument tubing between the process connection and instruments shall be 1/2-inch x 0.035-inch seamless annealed Type 316 stainless steel.
2. Tubing fittings shall be Type 316 stainless steel. Fittings shall be of the double-ferrule swage type. Flare, ball sleeve compression or single-ferrule swage type are not acceptable. Fittings shall be Crawford "Swagelok", Hoke "Gyrolok", or equal.

C. Chemical Seals:

1. Diaphragm: Seal shall be the diaphragm type with flushing connection, Type 316 stainless steel body and Type 316L diaphragm unless otherwise specified. Fill fluid shall be DC200 silicone oil and the process connection shall be 1" unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.
2. Annular: Seal shall be the in-line full stream captive sensing liquid type. Metallic wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated 200 PSIG with not more than 5-inch WC hysteresis. Fill fluid shall be DC200 silicone oil unless otherwise specified. Seals shall be Ronningen-Petter Iso-Ring / Red Valve series 40, or equal.

D. Bushings and Thermowells:

1. Bushings or thermowells shall comply with SAMA PMC17-10. Temperature taps shall be 1-inch NPT and lagging extensions shall be provided on insulated vessels or pipes. Thermowells and bushings shall be brass unless otherwise specified. To ensure proper fit, thermowells shall be provided by the same supplier as the instrument or device to be installed therein.



## 2.05 TRANSMITTERS

A. General: Unless otherwise specified in paragraph 3.03 of this section, Instruspec Sheets, or in paragraph 3.04 of this section, Instrument Schedule, measuring elements and transmitters shall comply with the following requirements:

1. Output indicators complying with paragraph 2.05 B of this section shall be provided with any transmitter that does not include an integral process variable indicator.
2. Transmitters shall be two-wire type with operating power derived from the signal transmission circuit.
3. Transmitter output shall be 4 to 20 milliamperes, current regulated and shall drive any load between 0 and 550 ohms with the power supply at 23 volts DC.

4. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at 24 volts DC.
5. Transmitter output shall be galvanically isolated.
6. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.5 to 5.0 seconds.
7. Transmitter output shall increase with increasing measurement.
8. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
9. Transmitters located outdoors shall be provided with surge protectors: Eaton MTL TP 48-4(4-wire type), Eaton MTL TP 48-2 (2-wire type), or equal.
10. Transmitters located outdoors shall be provided with aluminum or 316 stainless steel sunshields to protect the instrument from direct sunlight.
11. Two-wire transmitters located in Class 1, Division 1 and 2 areas shall be made safe by suitable intrinsic safety barriers as specified in paragraph 2.09 of this section.

B. Output Indicators:
1. Integral: When available, transmitters shall be provided with integral output indicators. Indicators shall be 2 1/2 inches 90 degree movement or LCD milliammeters. Output indicators connect into the transmission circuit by means of banana jacks, and a permanently connected diode shall be provided to bypass the jacks if the meter is removed. Error shall not exceed ±2 percent of span.
2. Separate: If output indicators for integral mounting in the transmitters is not available, a separate indicator shall be provided. Separate output indicators shall be installed in the conduit immediately adjacent to the transmitter. Indicators shall be loop-powered, two-wire, 3 1/2 digit, 7 segment, 0.8-inch high liquid crystal display milliammeters. The enclosure shall be rated NEMA 4X, suitable for outdoor mounting. The enclosure shall be suitable for in-line conduit mounting, unless otherwise specified. The indicator shall be suitable for operation within a temperature range of -15 to + 150 degrees F. Accuracy shall be ±0.1 percent of span + 1 count. Voltage drop shall not exceed 4 volts at 40 mA. A/D conversion time shall be no greater than 500 milliseconds and display update time shall be no greater than 0.5 second. Separate output indicators shall be Action Instruments Visipak V560 or equal.

C. Signal Current Isolator: Isolator shall provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits. Isolator shall be housed in a NEMA 250, Type 4/7 conduit body and shall derive its operating power from the signal input circuit. Input and output signals shall be 4 to 20 milliamperes, and error shall not exceed 0.1 percent of span. Input resistance shall not exceed 550 ohms with an output load of 250 ohms. Isolator shall be Moore Industries SCX/4-20MA/4-20/MA/5.5DC/-RF/EX.

## 2.06 PROCESS SWITCHES

A. Unless otherwise specified in paragraph 3.03 of this section, Instruspec Sheets, or in paragraph 3.04 of this section, Instrument Schedule, switches shall comply with the following requirements:
1. Contact outputs used for alarm actuation shall be ordinarily closed and shall open to initiate the alarm.

2. Contact outputs used to control equipment shall be ordinarily open and shall close to start the equipment.
3. Contacts monitored by solid state equipment such as programmable controllers or annunciators shall be hermetically sealed and designed for switching currents from 20 to 100 mA at 24 volts DC.
4. Contacts monitored by electro-magnetic devices such as mechanical relays shall be rated NEMA ICS 2, designation B300.
5. Double barriers shall be provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
6. Switch electrical enclosures shall be rated NEMA 250, Type 4 minimum.
7. Contacts located in Class 1, Division 1 and 2 areas shall be made safe by suitable intrinsic safety barriers or relays as specified in paragraph 2.07 of this section.

## 2.07 INTRINSIC SAFETY BARRIERS AND RELAYS

A. Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type; MTL Type MTL5500, Stahl 9000 Series, PHF 2 System series, or equal. Intrinsic safety barriers for process switches shall be dual type; Macromatic ISD, MTL 7700, or equal. Intrinsic safety relays shall be Gems, Square D, Warrick, or equal.

## 2.08 SIGNAL CONDITIONING MODULES

A. Unless otherwise specified in paragraph 3.03 of this section, Instruspec Sheets, or in paragraph 3.04 of this section, Instrument Schedule, signal conditioning modules shall comply with the following requirements:
1. Analog signal inputs shall be 1 to 5 volts DC into 20 megohms.
2. Analog signal outputs shall be 1 to 5 volts DC into 20 kOhms.
3. Discrete output contacts shall be SPDT rated 5 amperes at 117 volts AC and 28 volts DC.
4. Power supply shall be 24 volts DC, plus or minus 10 percent. Power supply effect shall not exceed 0.005 percent per 1.0 percent change.
5. Electronic trips shall be arranged so that output contact opens in case of loss of signal or loss of power supply.
6. Modules shall be rated for continuous operation in an ambient temperature of 0 to 80 degrees C. Ambient temperature effect shall not exceed plus or minus 0.01 percent per degree C within that range.
7. Span and zero adjustments shall be made by front accessible multi-turn potentiometers.
8. Electronic trip modules shall be provided with LED indicators for relay status.
9. Modules shall withstand 30 volts per meter radio frequency radiation between 200 and 500 MHz with not more than 0.25 percent calibration effect. Modules shall also be provided with traps on the terminals to shunt conducted radio frequency interference to ground.
10. Signal and power supply terminals shall be galvanically isolated from the case.

B. All modules specified in this section shall be the product of a single manufacturer and shall be of matching construction.

## 2.09 ETHERNET SWITCHES

A. Ethernet switch used for this station must:
   1. Possess at least 16 ports 10/100BASE-TX for copper cable.
   2. DIN rail mount
   3. Communicate via port protocol TCP/IP
   4. Switch Requirements:
      a. Ports – Four fast ethernet ports
      b. Ports – Four Gigabit SFP uplinks
      c. PoE+ Support
      d. Power: 24 Vdc power supply.
   5. Operating temperature: 14 degrees Fahrenheit to 140 degrees Fahrenheit
   6. Ethernet switches shall be manufactured by Allen Bradley, Cisco, or equal

## 2.10 NAMEPLATES

A. Nameplates shall be machine engraved white phenolic with black lettering. Where nameplate engraving is not specifically specified, it shall include the equipment or instrument loop title as specified in the Instrument Schedule, paragraph 3.04 of this section, and the instrument or equipment tag number. Lettering shall be 5/32-inch minimum unless otherwise specified. Nameplate wording may be changed without additional cost or time if changes are made prior to commencement of engraving. Name plates shall be mechanically fastened with stainless steel self-tapping screws.

## 2.11 HORNS AND BEACONS

A. The alarm beacon shall be a 75-watt sealed-beam lamp with motor driven rotating reflector; Beacon shall be for 120-volt AC service and shall be Federal Signal Model 121XL or equal.

B. The horn shall be a surface mount 120-volt AC enclosed buzzer and shall be Federal Signal Model WB350 (NEMA 4X); Model 31X (NEMA 7) or equal.

C. The above equipment shall be NEMA 4 and or NEMA 7 to meet the respective area classification.

D. Where gas is monitored each horn and beacon shall include a 6-inch by 10-inch red with white letter lamacoid nameplate with the specific warning.
   1. DANGER GAS
   2. VENTILATION SYSTEM FAILURE
   3. As needed for each application.

E. Where FOG Receiving tank levels are monitored each horn shall include a 6-inch by 10-inch red with white letter lamacoid nameplate with the specific warning.
   1. DANGER- HIGH LEVEL

## 2.12 SPARE PARTS

A. Furnish a spare power supply of each type provided.

B. Furnish a spare ethernet switch of each type provided.

C. Furnish a spare surge protector of each type provided.

D. Furnish 5 spare fuses of each type provided.

E. Furnish 5 spare relays of each type provided.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. General: Equipment shall be installed in accordance with manufacturer's instructions, NFPA 70, API RP550, this section, and as shown on the drawings. Equipment shall be located so that it is readily accessible.

B. Electrical Power Supply and Conditioning Equipment:

1. Electric power wiring and equipment shall comply with Division 26. Power disconnect switches shall be provided within sight of equipment and shall be labeled to indicate opened and closed positions and specific equipment served. "Within sight of" is defined as having a clear unobstructed view from the equipment served and within 50 feet of the equipment served. Disconnect switches shall be mounted between 36 and 72 inches above the floor or permanent work platform. Line and load side overcurrent protection shall be provided for power supply and conditioning equipment in compliance with NFPA 70. Power supply and conditioning equipment larger than 5 kVA load capacity supported by surfaces other than concrete shall be provided with sound isolators.
2. Each disconnect switch serving equipment located outdoors shall be provided with a surge arrestor, General Electric 9L15CCB001, or equal. The surge arrestor shall be bonded to the plant ground grid with a No. 8 AWG bare copper conductor.

C. Panels:

1. Mounting: Panels shall be shimmed to precise alignment, so doors operate without binding. Floor mounted panels shall be installed per the manufactures instructions and the details shown.
2. Floor-mounted cabinets except in dry control rooms or electrical equipment rooms shall be mounted on 3 1/2-inch minimum height concrete pads or grouted bases as specified.
3. Wiring:
   a. Wiring shall comply with the requirements of NFPA No. 70 as a minimum standard. Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment. Where unconditioned power is brought into control panels, it shall be enclosed in metallic raceways within the panel. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels. Wiring channels shall comply with UL 94, Type V. Wiring channel fill shall not exceed 50 percent.
   b. Interconnection Wiring:
      1) Panel Interconnecting Wiring:

2) Panel control wiring: Single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum, with an exception for factory supplied PLC wiring harnesses that are U.L. approved.
3) Panel instrument wiring: Twisted No. 16 AWG shielded pair or tri conductors.
4) Panel power wiring: Conductors specified in Division 26 and meet the NFPA No. 70 NEC requirements for power including phase, grounded, and grounding conductors.
5) Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels.

c. Field connections shall be on separate terminal blocks. Terminal blocks for field terminations shall be in a separate part of the panel close to where the field cables enter the panel. Field terminals shall have no internal panel wiring attached thereto.

d. Wiring shall be tagged at terminations with machine printed plastic sleeves. Wire numbers shall consist of three parts. The prefix of the wire number shall be the respective drawing sheet number. Following the prefix shall be respective sheet rung number. The third part of the wire number shall be a number that identifies wires in a circuit that are electrically identical. The field wiring number shall consist of the terminal number the wire is landed on at each end for ease of reference.

e. Code letters and wire colors are given in the following tables:

**Item**

| Code | 120 Vac Wire | Color |
|---|---|---|
| L | Power | Black |
| C | Control | Red |
| N | Neutral | White |
| PG | Ground | Green |

**Item**

| Code | 24V DC Wire | Color |
|---|---|---|
| PS | Power Supply | Blue |
| S | Signal (+) | Black |
| SG | Signal Ground | White |
| PG | Equipment Ground | Green |



f. Wire used for dry contacts that are connected to remote devices shall be Yellow in color.

g. No more than two wires shall be connected to a terminal.

h. Each panel shall have a copy of its record connection, interconnection diagrams and as-installed drawings provided in the enclosure print pocket.

4. Grounding: Each panel shall be provided with two copper ground bars. One bar shall be bonded to the panel frame or sheet metal and to the station ground system. The second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the frame ground bar at one point only. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar. Surge protectors and separately derived AC power supplies shall be

bonded to the frame ground bar. In panel line-ups exceeding 30 inches in width, ground bars shall be 1/4 by 1-inch copper bars extending the entire length of the panel.

D. Process Connections:

1. Unless otherwise specified, process taps shall comply with API RP550. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged, where possible, such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment. Where process taps are not readily accessible from instrument locations, a block valve shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.

E. Field Equipment:

1. General: Equipment shall be provided as specified on the drawings such that ports and adjustments are accessible for in-place testing and calibration. Where possible, equipment shall be located between 48 and 60 inches above the floor or a permanent work platform. Instrumentation equipment shall be mounted for unobstructed access but mounting shall not obstruct walkways. Equipment shall not be mounted where shock or vibration will impair its operation. Support systems shall not be attached to handrails, process piping or mechanical equipment except for measuring elements and valve positioners. Instruments and cabinets supported directly by concrete or concrete block walls shall be spaced out not less than 5/8 inch by framing channel between instrument and wall. Steel used for support of equipment shall be 316 stainless steel, unless otherwise specified. Support systems including panels shall be designed in accordance with Standard Building Code and to prevent deformation greater than 1/8 inch under the attached equipment load and an external load of 200 pounds in any direction.
2. Signal Wiring:
   a. General: Electrical signal wiring and equipment shall be in compliance with Division 26. Electric signal connections to equipment shall be made on terminal blocks or by locking plug and receptacle assemblies.
   b. Jacketed flexible conduit shall be used between equipment and rigid raceway systems. Flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 3 feet. Flexible cable, receptacle and plug assemblies shall be used only where specified.
   c. Signal Types: Signal types as specified in paragraph 1.01 D.8. of this section shall be installed in raceways as described below. Signals of different types shall not be run together in common raceways unless expressly stated.
      1) Signal type specified in paragraph 1.01 D.8.a. of this section shall be run in metallic raceways separate from all other signal types.
      2) Signal type specified in paragraph 1.01 D.8.b. of this section shall be run in metallic raceways separate from all other signal types.
      3) Signal type specified in paragraph 1.01 D.8.c. of this section shall be run in metallic raceways separate from all other signal types.

4) Signal type specified in paragraph 1.01 D.8.e. of this section shall be run in metallic raceways separate from all other signal types.

5) Signal types specified in paragraphs 1.01 D.8.d. and 1.01 D.8.f. of this section shall be run in cables separate from each other, but may be run in a common raceway. Where open raceways are used, cable shall be double-shielded.

6) Signal types specified in paragraphs 1.01 D.8.g. and 1.01 D.8.h. of this section shall be run in cables separate from each other, but may be run in a common raceway.

3. Hazardous Areas: Switches and two-wire transmitters located in hazardous areas shall be made intrinsically safe for the specified conditions by use of equipment and barriers or intrinsic safety relays approved by Underwriters Laboratories, Inc. (UL), Factory Mutual (FM), or Canadian Standards Association (CSA). Intrinsically safe systems shall be installed in accordance with ANSI/ISA-RP12.6.

4. Identification Tags: Each field mounted instrument or device shall be provided with a 16-gauge stainless steel identification tag. Identification tags shall bear the complete instrument number as listed in paragraph 3.04 of this section. Characters shall be 1/4 inch, die-stamped. Identification tags shall be securely attached to the equipment in a readily visible location using stainless steel screws or wire.

F. Signal Transmission:

1. Signal transmission between electric or electronic instruments not located within a common panel shall be 4 to 20 milliamperes and shall operate at 24 volts DC unless otherwise specified. Milliampere signals shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Milliampere signals from field shall be converted to a 1- to 5-volt signal by dropping across a plus/minus 0.1 percent, 250-ohm, 0.5 watt resistor at the external terminals of each panel, and all instruments within the panel shall be parallel wired. Measurement loops shall be grounded at external terminals by bonding to the instrument panel signal ground bus. Isolating amplifiers for field equipment possessing a grounded input or output shall be provided.

2. High frequency (greater than 1 kHz) pulse rate signals from field transmitters shall be converted to DC voltage signals at the panel.

3. Platinum resistance temperature detector (RTD) outputs shall be converted to a dc voltage, 4-20 mA signal unless otherwise specified or shown.

4. All other transmission systems, such as impulse duration, low frequency pulse rate, and voltage regulated, will not be permitted except where specifically noted in the Instrument Schedule, paragraph 3.04 of this section. When transmitters with non-standard outputs are specified, their output shall be converted to 4 to 20 milliamperes at the field instrument.

5. Spacing between signal conductors and alternating current power and control conductors shall be maintained at not less than 24 inches, except (1) at terminations on equipment, (2) where both the signal conductors and the power and control conductors are enclosed by separate metallic raceways, the spacing may be reduced to 12 inches, and (3) where power and signal conductors cross at 90 degrees.

## 3.02 TESTS AND INSPECTIONS

A. General Requirements:

1. Materials, equipment, and construction included under this specification shall be inspected in accordance with this section. Testing shall be performed in accordance with Section 01 45 23, and this section. No required test shall be applied without prior notice to the Contractor, who has the right to witness any test. At least 14 days before the commencement of any testing activity, a detailed step-by-step test procedure, complete with report forms for the recording of test results, shall be provided. All equipment necessary to perform the specified tests shall be provided.

B. Delivery Inspection:

1. The Contractor shall notify the Authority upon arrival of any material or equipment to be incorporated into the work and shall remove protective covers or otherwise provide access in order that the Authority may inspect such items.

C. Installed Tests and Inspection:

1. Test Reports: Test reports shall conform to the requirements of reference forms 40 61 13-A through 40 61 13-K included in Section 01 99 90.
2. Test Equipment: Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test. Each test instrument shall be calibrated prior to the commencement of a testing activity and at the completion of a testing activity. Certified calibration reports traceable to the National Bureau of Standards shall be included with the test report. Buffer solutions and reference fluids shall be provided as necessary for tests of analytical equipment.
3. Testing Stages:
   a. General: Each instrument loop shall be tested in the following sequence:

| Testing sequence | Form reference |
|---|---|
| Wiring and piping | 40 61 13-A and B |
| Individual components | 40 61 13-C through I |
| Individual loops | 40 61 13-J |
| Loop commissioning | 40 61 13-K |

Testing of piping and wiring and individual components shall be completed with certified test reports provided to the Authority prior to commencement of individual loop testing, which shall be completed with certified test reports provided to the Authority prior to commencement of loop commissioning.

   b. Piping Testing:
      1) Pneumatic Piping Systems: Pneumatic piping systems shall be tested for leaks in compliance with ISA RP7.1.
      2) Liquid Piping Systems: Liquid piping systems shall be tested for leaks in compliance with Section 40 05 01.
   c. Individual Component Calibration and Test: Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure and then tested in accordance with the Contractor's test procedure. Data shall be entered on the applicable test report form at the time of testing. Alarm trips, control trips, and switches shall be set to the initial values specified

in paragraph 3.04 of this section. Final elements shall be checked for range, dead-band, and speed of response.

d. Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.

e. Loop Test: Each instrument loop shall be tested as an integrated system. This test shall check operation from transmitter to readout components. Test signals shall be injected at the process impulse line connection where the measuring technique permits, and otherwise at the most primary signal access point.

f. If any output device fails to indicate properly, corrections to the loop circuitry shall be made as necessary and the test repeated until all instruments operate properly.

g. SYSTEM ACCEPTANCE TEST: The system test shall be executed after all component and subsystem tests have been completed and be designed to place the completed system in full operation and demonstrate that all functional requirements of this specification have been met. This also includes the Authority's responsibility of programming and placing the PLC for the FOG receiving area in service, and all other PLC programming required to integrate all instrumentation installed by the Contractor as part of this contract. The system test shall, as a minimum demonstrate the following:

1) That each component of the system operates correctly with all other components of the system;
2) That analog control loops operate in a stable manner;
3) That all interlocks perform correctly;
4) That all control sequences perform correctly;
5) That the complete system is reliable and consistent under all conditions of plant operation.



## 3.03 INSTRUSPEC SHEETS

A. Instrument Identification: FPM
   1. Instrument Function: Flow measurement
   2. Instrument Description: Propeller meter
   3. Manufacturer:
      a. McCrometer model MW500
      b. Sparling
      c. Approved equal.
   4. Features:
      a. Power Supply: N/A
      b. Signal Input: Process
      c. Signal Output: N/A
      d. Process Connection: AWWA class D flanges
      e. General: The flow meter system shall be designed to operate continuously at any flow rate within the rated range. Meter accuracy shall be ± 2% of rate, or better, at any flow from minimum rating to 150% of maximum rating.

f. The meter shall be wet flow calibrated against a primary standard with an accuracy of ± 0.25% or better, traceable to the U.S. NIS. Comparisons shall be made at or near the minimum flow rating, at mid-range and at or near the maximum rating. Two certified copies of the calibration results shall be furnished.

g. Register: The register shall consist of a 6-digit totalizer shall be, and an instantaneous rate of flow indicator. The totalizer and flow rate indicator shall be calibrated in process units. The register shall be hermetically sealed in a die cast aluminum case.

h. Drive Assembly: The propeller shaft shall be Type 316 stainless steel running in Type 440C stainless steel bearings. The propeller shaft shall be magnetically coupled to the register. The propeller and drive assembly shall be mounted to the meter tube on a flanged connection to allow removal of the assembly without the necessity of removing the tube from the process line. The propeller shall be constructed of high impact plastic.

i. Meter: The meter tube shall be steel coated inside and out with fusion-bonded epoxy and shall have a maximum working temperature of 160 deg. F and a maximum working pressure of 150 psig. The meter tube shall be equipped with integral straightening vanes.

5. Execution:

a. Installation: Install in accordance with manufacturer's instructions, Section 40 06 70-3.01, and the specified functional requirements.

b. Test: In accordance with Section 40 61 21.

c. Application/ Calibration: Application, calibration, and set points shall be as specified in Section 40 06 70.

B. Instrument Identification: FVS

1. Instrument Function: Flow Measurement
2. Instrument Description: Paddle Flow Switch
3. Signal Input: Process
4. Signal Output: Contacts, in accordance with paragraph 2.02 of this section.
5. Process Connection: Female NPT
6. Product Data:

a. Vane actuated flow switch shall consist of a vane and a magnetically actuated switch. The body of the switch divided into upper and lower sections so that the upper section is isolated from the process fluid. A stainless steel vane and a primary magnet located in the lower section.

b. The force of the process fluid impinging on the vane shall produce movement of the primary magnet. The primary magnet shall produce movement of the secondary magnet located in the upper body section, actuating the switch.

c. The switch shall be DPDT and enclosed in an explosion-proof housing. The switch body and vane shall be type 316 stainless steel unless otherwise specified. Minimum pressure rating of 400 psig and minimum temperature rating of 220 degrees F.

7. Execution:

a. Installation: Install in accordance with the manufacturer's instructions, Section 40 06 70-3.01, and the specified functional requirements.

b. Test: In accordance with Section 40 06 70-3.02.
c. Application/Calibration: Application, calibration and set points as specified in Section 40 06 70-3.03.

8. Approved Manufacturers: Dwyer Series V4, McDonnell and Miller AF Series, or equal.

C. Instrument Identification: LRFM
1. Instrument Function: Level Measurement
2. Instrument Description: Radar Level Transmitter: Guided Wave Type
2. Power Supply: 24 VDC loop powered or 120 Vac, 60-Hertz nominal, 10-Watt maximum.
3. Signal Input: Process
4. Signal Output: 4-20 mA DC
5. Signal Converter/Transmitter:
a. Enclosure: Integral mount; FM Approved for Class I Division 1 when used with approved barrier.
b. Operator Interface: LCD display, scaled in engineering units, with soft-keys for scrolling and configuration.
c. Networks: HART standard.
d. Measuring range: 0-10.5 ft.
e. Accuracy: ±0.5 inch
6. Sensor: enlarged COAX with external cage, TFE Viton process seal
a. Ambient Temperature Range: -20 to +140 degrees F.
b. Process Temperature Range: -40 to +400 degrees F
c. Pressure Range: full vacuum to 270 psig.
d. Process Connection: 4" minimum, 150# minimum ANSI Raised Face flange.
e. Wetted Materials: 316 SS, PTFE, PVDF, Viton, or as approved.
7. Accessories:
a. Provide mounting hardware and cable length glands.
8. Acceptable Manufacturer:
a. Magnetrol Eclipse Enhanced Model 706
b. Endress Hauser Levelflex FMP 52
c. Accepted equal.
9. Execution:
a. Installation: Install in accordance with manufacturer's instructions and installation detail.
b. Contractor to verify size and type of specified tank connection with approved tank submittals.

D. Instrument Identification: LST2
1. Instrument Function: Level Measurement
2. Instrument Description: Submerged Level Transmitter and Meter – Wastewater
3. Power Supply: 24 Vdc Loop Powered
4. Signal Output: 4 to 20 milliamperes into 0 to 550 ohms
5. Process Connection: Submerged and suspended.

6. Product Requirements:
    a. Sensor/Transmitter: Minimum 3" large diameter diaphragm with 316 Stainless Steel housing and separate suspension cable. FM Approved for Class I Division 1 when used with approved barrier. Accuracy of 0.25% of full scale and operating temperature from -25 degrees F to 180 degrees F. Cable is shielded and includes vent tube. Separate junction box with built-in breather assembly. Provide cable length to reach junction box without splicing.
    b. Manufacturers:
        1) Blue Ribbon Corp. Model BC001.
        2) Endress+Hauser FMB53.
        3) Siemens Model A1000i.
        4) Accepted equal.
    c. Meter:
        1) NEMA 4X enclosure, surface mount, 120Vac, power.
        2) Accepts, 4-20 mA DC (from transmitter), outputs 4-20 mA DC isolated into a minimum of 500 Ω.
        3) LCD display with digital scalable process level indicator.
        4) Manufacturers:
            a) Delta Controls Corp.
            b) Endress+Hauser.
            c) Siemens Model HydroRanger 200.
            d) Accepted equal.
7. Execution:
    a. Installation: Install in accordance with manufacturer's instructions.
    b. Manufacturer to provide sensor/transmitter, full length cables and meter. Calibration: Switch set point and reset point adjusted as specified.

E. Instrument Identification: IMCI
1. Instrument Function: Ambient air pollution monitor
2. Instrument Description: Combustible gas infrared adsorption principle detector (single-point)
    a. Power Supply: three wire 24 VDC power.
    b. Signal Input: Process
    c. Signal Output: 4-20 mAdc analog signal.
    d. Process Connection: N/A
3. General Product Data: The gas detector system shall consist of an integral sensor and transmitter, an entry panel, and power supply. The sensor/transmitter shall be remotely mounted in the area to be monitored. Up to 50 feet of cable shall be permitted between the sensor/transmitter and the entry panel. The sensor/transmitter and entry panel shall share the same power supply. The gas detection system shall have the capability to detect an over-range condition. This condition shall be indicated on the transmitter LCD display and the output shall be locked at the maximum valve. All components of the sensor/transmitter shall be approved for mounting in Class I, Division 1, Group C and D hazardous locations. All components of the sensor/transmitter shall also be designed to meet NEMA 7

requirements. All components of the system shall also be capable of operation in an ambient temperature range of -40 to +150 degrees F and relative humidity of 0 to 100 percent, non-condensing. The unit shall include a remote calibration kit and 1-year supply of test gas.

4. Sensor:The sensor shall employ the principle of infrared adsorption. As the combustible gas and air mixture contacts the sensor, it shall measure the adsorption of infrared light between temperature compensated non-imaging optics with double-compensated optical bench (2 lamps, 2 detectors). A splashguard shall be supplied with each sensor.
5. Transmitter: The transmitter shall be microprocessor-based with self-diagnostics, capable of non-intrusive calibration using a HART handheld terminal or controller. Combustible gas concentration shall be continuously indicated, on the entry panel display, in percent of lower explosive limit (LEL) of the specified gas. The display shall be visible from a minimum of 5 feet and be displayed all times and will not require being turned ON or OFF. The readout shall be 3½-digit Liquid Crystal Display (LCD). Output shall be user-configurable 0 to 20 mAdc, with 4 to 20 mAdc configured to represent 0 to 100 percent LEL. 0 to 1.2 mAdc shall be configured to represent system fault. 2 mAdc shall be configured to represent beam block warning. Unit shall have one-man-inhibited calibration with configurable output signal of 4 mAdc ± 1 mAdc, 1 Hz modulation to indicate that calibration is in progress.
6. Cable: The signal and power cable between the sensor/transmitter and the entry panel shall be provided by the instrument manufacturer. A sufficient length of cable shall be provided for installation of a continuous run between the sensor and the electronics package.
7. Calibration shall be by means of a non-intrusive calibration system. The calibration values, and zero and span shall be set without opening the transmitter enclosure. The transmitter shall not be affected by ambient light either natural or man-made.
    a. Unless otherwise specified, the system shall be calibrated for methane gas and petroleum. The warning setpoint shall be 7 percent lower explosive limit and danger setpoint shall be 10 percent lower explosive limit.
8. Execution:
    a. Installation: Install in accordance with the manufacturer's instructions, paragraph 40 61 13.01-3.01, and the specified functional requirements.
    b. Test: The combustible gas detector shall be factory tested by the manufacturer prior to shipment. The manufacturer shall provide three certified copies of the test report. After installation, the unit shall be field tested in accordance with paragraph 40 61 13.01-3.02.
9. Accessories: Provide one calibration kit including zero and/or span gas as required, calibration hood, all required fittings, gauges, handheld calibration devices, etc.
10. Approved Manufacturers: MSA Ultima XIR, or equal.

F. Instrument Identification: PDI
    1. Instrument Function: Pressure measurement
    2. Instrument Description: Differential pressure indicator
    3. Manufacturer:
        a. Ashcroft 5503
        b. Dwyer Series PTGD
        c. Approved equal.

4. Features:
    a. Power Supply: N/A
    b. Signal Input: Process
    c. Signal Output: N/A
    d. Process Connection: 1/4-inch female NPT
    e. Product Data:
        1) Pressure differential indicator shall have a 4-inch diameter, 90-degree scale. Sensing unit shall consist of two pressure-tight compartments separated by a piston or operated via bourdon tube.
        2) Piston shall be opposed by a calibrated leaf spring. The motion of the spring shall be transferred to the pointer by magnetic coupling. Bearings shall be sapphire.
        3) Housing material shall be die cast aluminum with a salt resistant coating. Unit shall be capable of withstanding a static working pressure of up to 100 psig. Accuracy shall be plus or minus 2 percent of scale. Zero pointer adjustment shall be accessible from the face.
5. Execution:
    a. Installation: Install in accordance with the manufacturer's instructions and installation details.

G. Instrument Identification: PG
1. Instrument Function: Pressure measurement
2. Instrument Description: Pressure Gauge
3. Power Supply: N/A
4. Signal Input: N/A
5. Signal Output: N/A
6. Process Connection: 1/2-inch male NPT
7. Product Data: Pressure gauges shall be 4 1/2-inch, solid-front units with phenolic turret cases, bourdon tube elements, 270 degree milled stainless steel movements, and shatterproof glass windows. Bourdon tube shall be bronze unless otherwise specified. Gauges shall be manufactured to Grade 2A accuracy (±0.5%) in compliance with ANSI specification B40.1. Gauges shall be provided with a porous metal type snubber unless otherwise specified. Snubber material shall be compatible with that of the gauge.
8. Execution:
    a. Installation:
        1) Install in accordance with manufacturer's instructions and the specified functional requirements.
        2) Pressure gauges may be supported from the process tap if this location permits observation from the floor or a permanent work platform. Pressure gauges shall be installed in such a manner that blowout discs are not obstructed.
    b. Test: In accordance with paragraph 40 61 13.01-3.02.
9. Application/Calibration: Application, calibration, and setpoints shall be as specified in paragraph 40 61 13.01-3.02.

10. Approved Manufacturers:
    a. Ashcroft Model 1279,
    b. U.S. Gauge Model 1980,
    c. or equal.

H. Instrument Identification: PGT
1. Instrument Function: Pressure Measurement
2. Instrument Description: Gage Pressure Transmitter
3. Power Supply: Loop Powered, 24 VDC
4. Signal Input: Process
5. Signal Output:4-20 mA VDC
6. Process Connection: 1/2-inch female NPT flange adapter
7. Product Requirements: Capacitance or piezoresistive type.
8. Wetted Parts: Type 316 stainless steel
9. Range: 100:1.
10. Accuracy: 0.25 percent of calibrated span.
11. Static Pressure Rating: 2,000 psi.
12. Indicator: LCD display.
13. HART standard data communication protocol
14. Acceptable Manufacturer:
    a. Rosemount 2051CG,
    b. ABB
    c. Foxboro,
    d. or Equal
15. Execution:
    a. Installation: Install in accordance with manufacturer's instructions and the Engineer's installation detail.
    b. Root valves provided at all process pressure taps.
    c. Gauge valves provided at the instrument where the instrument is not within sight of the root valve or where two or more instruments are connected to a single tap.
    d. Safety instruments shall not be connected to the same process tap as instruments used for control, indication, or recording.
    e. Pressure instruments located as close as practical to the process tap and be positioned to permit observation and maintenance.
    f. Pressure instruments shall not be supported from process piping.
    g. Pressure instruments for use with integral seals, or remote seals and capillary tubing provided by a single manufacturer, and all components factory-assembled prior to shipping.

I. Instrument Identification: TI
1. Instrument Function: Temperature measurement
2. Instrument Description: Temperature indicator
3. Power Supply: N/A
4. Signal Input: Process

5. Signal Output: N/A
6. Process Connection: 1/2-inch male NPT
7. Product Requirements: Temperature indicators shall be 4-1/2-inch gas pressure operated bourdon tube elements, 270-degree movement, phenolic case, shatterproof glass window, and 1/2-inch NPT process connection.

   Bulb shall be 3 inches long by 3/8-inch diameter for all ranges. Stem lengths shall be selected to place bulb in middle third of pipe. Indicator head shall be swivel mounted to the stem.
8. Temperature indicator manufacturer:
   a. Ashcroft Duratemp Type 600B,
   b. Approved equal.
9. Execution:
   a. Installation: Temperature instruments shall be installed in accordance with the manufacturer's instructions and the recommendations of API RP551 to the specified requirements.
   b. For pipelines less than 4-inch diameter, temperature elements shall be installed at a pipeline elbow if possible.
   c. Where an elbow is not available, a wye fitting shall be installed in the pipeline for installation of the temperature element at a 45-degree angle with the flow.

J. Instrument Identification: TMP
   1. Instrument Function: Temperature Measurement
   2. Instrument Description: Temperature Transmitter
   3. Power Supply: As specified in paragraph 2.03
   4. Signal Input: Process temperature monitored by RTD
   5. Signal Output: Analog Transmission - 24 VDC, 4-20 mA
   6. Process Connection: Integral
   7. Product Requirements:
      a. Temperature Transmitter: 2-wire device, powered from the PLC analog input power supply.
      b. Temperature Limits: 0-160 degrees F.
      c. Humidity Limits: 0-100% RH.
      d. Accuracy: 0.25 degrees F + 0.02% span, using 100 Ohm Platinum RTD.
      e. Output: One isolated 4-20 mA into a maximum of 600 ohms.
      f. Sensor update time: 0.5 seconds.
      g. Failure mode: transmitter shall have a configurable failure mode to drive the analog signal either high (>21 mA) or low (<3.75 mA) in the event of microprocessor failure.
      h. Rating: The above equipment shall be NEMA 4 and or NEMA 7 to meet the respective area classification.
      i. Indicator: LCD display.
   8. Acceptable Manufacturer:
      a. Rosemount 3144P.
      b. Accepted equal.

9. Execution:
    a. Installation: Install in accordance with manufacturer's instructions and the Engineer's installation detail.

K. Instrument Identification: TRE
    1. Instrument Function: Temperature measurement
    2. Instrument Description: Resistance temperature detector element, inserting type
    3. Power Supply: N/A
    4. Signal Input: Process
    5. Signal Output: 100 ohms nominal at 0 degrees C, resistance temperature coefficient of 0.385%/degree C
    6. Process Connection: 1/2-inch male NPT
    7. Product Requirements:
        a. Temperature element shall be tip sensitive, three-wire platinum resistance temperature detector (RTD) in 1/4-inch ASTM A269, Type 316 stainless steel sheath with watertight connection head.
        b. Time constant in agitated water shall not exceed 8 seconds. RTD shall comply with ASTM E1137, tolerance Grade A
        c. RTDs for installation in wells shall be provided with spring loading device and union coupler. Union shall extend out beyond pipe lagging.
        d. Three-wire lead configuration for ambient temperature compensation shall be provided. RTD extension cable conductors shall be shielded triads.
        e. Bushings and wells for temperature elements shall comply with ASME B40.200 and unless otherwise specified shall be machined from ASTM A276, Type 316 stainless steel bar stock. Union couplers shall be provided for all temperature elements.
    8. Execution:
        a. Installation: Temperature elements shall be installed in accordance with the manufacturer's instructions.



## 3.04 INSTRUMENT SCHEDULE

A. General: The following is a schedule of instrumentation equipment and devices to be provided as part of this Contract.

B. Clarification:
    1. Tag Number: The instrument number consists of a unique alpha-numeric identifier for each instrument or device.
    2. Device Function: Provides a brief description of the process variable being measured by the instrument.
    3. INSTRUSPEC ID: Lists the INSTRUSPEC ID covered in this Section that governs the instrument requirements.
    4. Setpoint/Range: Specifies setpoints, ranges and scales for the instrument.
    5. Units: Specifies the unit of measurement for the specific instrument.
    6. Signal Type: Specifies the electrical signal provided by the instrument based on the process variable.

C. Instrument List:

| Tag No. | Device Function | INSTRUSPEC ID | Setpoint/Range | Units | Signal Type |
|---|---|---|---|---|---|
| AE/AIT-300 | FOG Receiving Area Combustible Gas Sensor and Transmitter | MCL | 0-100 | %LEL | 4-20 mA |
| FM-400 | Main Heating Loop Makeup Water Flowmeter | FPM | 40-250 | GPM | - |
| FSL-100 | AHU 401 Low Air Flow | FVS | 1450 and falling Reset at 1475 | cfm | Discrete |
| LIT-211 | FOG Tank 1 Interface Level | LRFM | 0-10.5 | Ft | 4-20 mA |
| LIT-221 | FOG Tank 2 Interface Level | LRFM | 0-10.5 | ft | 4-20 mA |
| LS-212 | Chopper pump P-212 Low Oil Level Switch | N/A | Vendor Provided | - | Discrete |
| LS-222 | Chopper Pump P-222 Low Oil Level Switch | N/A | Vendor Provided | - | Discrete |
| LT-210 | FOG Tank 1 Sub. Level | LST2 | 0-10.5 | ft | 4-20 Ma |
| LT-220 | FOG Tank 2 Sub. Level | LST2 | 0-10.5 | Ft | 4-20 Ma |
| PDI-100 | Differential Pressure Indicator | PDI | 0-100 | Inches Hg | - |
| PDI-410 | Differential Pressure Indicator | PDI | 0-50 | PSID | - |
| PI-100 | Protected Water Inlet Pressure | PG | 0-100 | PSIG | - |
| PI-101 | Heated Water Inlet Pressure | PG | 0-60 | PSIG | - |
| PI-211 | FOG Tank 1 Discharge Pressure | PG | 0-50 | PSIG | - |
| PI-221 | FOG Tank 2 Discharge Pressure | PG | 0-50 | PSIG | - |
| PI-401 | Boiler Outlet Pressure | PG | Vendor Provided | PSIG | - |
| PI-401 | AHU-401 Inlet Pressure | PG | 0-60 | PSIG | - |
| | | | | | |
| PI-403 | Hot water Boiler Inlet Pressure | PG | 0-60 | PSIG | - |
| PIT-301 | FOG Receiving Tanks Heat Loop Pressure | PGT | 0-60 | PSIG | 4-20 mA |
| PIT-310 | FOG Receiving Tanks Heating Loop Inlet Pressure | PGT | 0-60 | PSIG | 4-20 mA |
| PIT-402 | Main Hot Water Pump Outlet Pressure | PGT | 0-60 | PSIG | 4-20 mA |
| TE -210 | FOG Tank 1 Temperature | TRE | -76 - +1,112 | Deg F | Low level analog |
| TE -220 | FOG Tank 2 Temperature | TRE | -76- +1,112 | Deg F | Low level analog |
| TE-304 | FOG Receiving Tanks Heating Loop Temperature Sensor | TRE | -76 - +1,112 | Deg F | Low Level Analog |
| TE-400-1 | FOG Building Interior Temperature Indicator | TRE | Vendor Provided | Deg F | Low level analog |
| TE-400-2 | FOG Building Interior Temperature Indicator | TRE | Vendor Provided | Deg F | Low level analog |
| TE-401 | FOG Building Interior Temperature Indicator | TRE | -76-+1,112 | Deg F | Low level analog |
| TI-100 | Heated Water Inlet Temperature | TI | 0-240 | Deg F | - |
| TI-101 | Heated Water to Screening FOG Screening Temperature | TI | 0-240 | Deg F | - |
| TI-301 | FOG Hex Heating Loop Inlet Temperature | TI | 0-240 | Deg F | - |
| TI-302 | FOG Hex Heating Loop Outlet Temperature | TI | 0-240 | Deg F | - |
| TI-303 | FOG Heating Loop Inlet Temperature | TI | 0-240 | Deg F | - |
| TI-401 | AHU-401 Inlet Temperature | TI | 0-240 | Deg F | - |

| Tag No. | Device Function | INSTRUSPEC ID | Setpoint/Range | Units | Signal Type |
|---|---|---|---|---|---|
| TIT-210 | FOG Tank 1 Temperature Transmitter | TMP | 0-250 | Deg F | 4-20 mA |
| TIT-220 | FOG Tank 2 Temperature Transmitter | TMP | 0-250 | Deg F | 4-20 mA |
| TIT-304 | FOG Receiving Tanks Heating Loop Temperature | TMP | 0-240 | Deg F | 4-20 mA |
| TIT-400-1 | Boiler Outlet Temperature | N/A | Vendor Provided | - | 4-20 mA |
| TIT-400-2 | Boiler Outlet Temperature | N/A | Vendor Provided | - | 4-20 mA |
| TIT-401 | FOG Building Interior Temperature Transmitter | TMP | 0-150 | Deg F | 4-20 Ma |
| LS-501 | Fuel Oil Tank Leak Level Switch | N/A | Vendor Provided | - | Discrete |
| FS-501 | Fuel Oil Vent Leak | N/A | Vendor Provided | - | Discrete |
| LIT-501 | Fuel Oil Tank Level | N/A | Vendor Provided | - | 4-20 mA |
| LSH-501 | Fuel Oil Tank Level High | N/A | Vendor Provided | - | Discrete |
| LSL-501 | Fuel Oil Tank Level Low | N/A | Vendor Provided | - | Discrete |
| LS-504 | Fuel Oil Pump Skid Leak | N/A | Vendor Provided | - | Discrete |
| FSL-504 | Fuel Oil Pumps Low Flow | N/A | Vendor Provided | - | Discrete |
| PI-504-1 | Fuel Oil Pump Suction Pressure Indicator | N/A | Vendor Provided | Vendor Provided | - |
| PI-504-2 | Fuel Oil Pump #1 Discharge Pressure Indicator | N/A | Vendor Provided | Vendor Provided | - |
| PI-504-3 | Fuel Oil Pump #2 Discharge Pressure Indicator | N/A | Vendor Provided | Vendor Provided | - |



## 3.05 CONTROL STRATEGY

A. P&ID I-63-101 – FOG Screening
   1. Description:
      a. FOG (Fats, Oils, Greases) will be unloaded through a 6” camlock connection to a vendor provided screening system. The screening system will be utilized to remove debris from the FOG as it is received before it enters the FOG receiving tank(s). Hot water and protected water will be utilized to wash down and clean the screening system during and after use. Debris removed by the screening system will be unloaded to a dumpster located in the FOG receiving room while FOG will be drained to the selected FOG receiving tank.
   2. Normal Operation:
      a. Automatic operation:
         1) Placing the H-O-A switches in AUTO mode on the vendor control panel enables the automatic control of the screw, drum, tank spray wash, drum spray wash, hot wash for the screw and hot wash for the drum by the Screening unit vendor control panel.
         2) The screening system can also be turned on/off from the unloading station situated outside from remote indicating station.
         3) When placed in “AUTO” from the H-O-A switch at the P-111 starter, Pump P-111 will operate when commanded by the screening unit.
         4) A three-way valve is used to automatically control the inlet flow of hot water to AHU 401 based on temperature when HS-401-2 is in “REMOTE”. When the

temperature inside of the building as sensed by TIT-401 begins to decrease, the three-way valve will switch position and allow hot water to enter the air handling unit.

b. Manual operation:

1) The screening system will be brought online locally from the OIT on the vendor provided control panel or the remote loading station located outside the building during the unloading process. The screening unit will continue to operate until it experiences an equipment fault, emergency stop command, interlock condition, or is commanded to stop from the OIT on the vendor control panel.

2) Several motors and valves controlled by the screening system can be controlled by placing the H-O-A switches in HAND mode from the vendor provided control panel. Those switches are related to screening systems:

a) Screw motor

b) Drum motor

c) Tank spray wash solenoid

d) Drum spray wash solenoid

e) Hot wash screw solenoid

f) Hot wash drum solenoid

3) A separate pump, P-111, that is normally used to provide hot water to the screening unit during operation, can be operated manually by a separate H-O-A switch located at the Motor Control Center (MCC).

4) A three-way valve is used to automatically control the inlet flow of hot water to AHU 401 based on temperature. The three-way valve can be opened and closed manually locally if you place HS-401-2 in “LOCAL” mode and actuate HS-401-1 to switch the position of the valve.

3. Interlocks:

a. The FOG screening unit will stop if it experiences a fault when attempting to operate any of the motors and valves associated with the equipment skid.

b. The FOG Screening unit will stop if hot water pump P-111, fails to operate when commanded by the FOG screening unit.

c. The FOG screening unit will stop if both FOG receiving tank inlet valves are closed.

d. The FOG Screening unit will be commanded to stop by SCADA if the FOG receiving tank inlet valve (either V-210 or V-220) is open and a high high level alarm is active for the corresponding FOG receiving tank.

4. Fault Conditions:

a. Fault conditions generated by any of the equipment controlled by the FOG screening system will stop the unit and alert the operator at the Local OIT and generate a corresponding alarm on the SCADA system. The fault must be reset at the screening unit control panel prior to restarting it.

5. Status indication:

a. Refer to the P&ID(s), elementary diagrams and per the screening system manufacturer.

6. Alarms:
    a. Refer to the P&ID(s), elementary diagrams and per the screening system manufacturer.
    b. When the FOG receiving building gas detector, AE/AIT-300 senses combustible gas levels exceeding 5% of the lower explosive limit, an amber strobe and horn will activate, alerting operators in the area. The horn can be silenced momentarily (initially 30 minutes) via HS-300, located below the horn. The strobe and horn must be reset from the combustible gas detector controller AIC-300 once the alarm condition has cleared.
    c. When the FOG receiving building gas detector, AE/AIT-300 senses combustible gas levels exceeding 10% of the lower explosive limit, a red strobe and horn will activate, alerting operators in the area. The horn can be silenced momentarily (initially 30 minutes) via HS-300, located below the horn. The strobe and horn must be reset from the combustible gas detector controller AIC-300 once the alarm condition has cleared.
    d. If air flow from air handling unit AHU-401, as sensed by FSL-100, drops below the required air flow threshold per NFPA-820, a red strobe and horn will activate, alerting operators in the area. The horn can be silenced momentarily (initially 30 minutes) via HS-300, located below the horn. The strobe and horn must be reset from the controller AIC-300 once the alarm condition has cleared.

B. P&ID I-63-102 & I-80-103- FOG Storage and Pumping
    1. Description:
        a. Screened FOG will enter one of the identical, 15,000 gallon, heated, receiving tanks through their respective FOG influent valves, V210 or V220. As the contents of the tank are heated, the screened FOG will separate into a centrate on the bottom layer and a concentrated FOG layer at the top.
        b. Each tank will be heated via a submersed plate fin heat exchangers that will be warmed by the plant's hot water loop. The temperature inside of the FOG tank will be measured by TIT-210 and TIT-211. As FOG is heated inside each tank, concentrated FOG will separate from the centrate. The interface level where the concentrated FOG and the centrate meet will be measured by guided wave radar level transmitters LIT-211 (FOG receiving tank 1) and LIT-221 (FOG receiving tank 2). A backup submersible level transmitter has been provided for each tank that will be utilized to interlock the FOG screening unit, alert the operator of a high level condition, and prevent the chopper pumps from coming online when there is low product in the tanks.
        c. The chopper pumps (P-212 and P-222) will be used to transfer the contents of the receiving tanks to either the existing FOG tanks or to the centrate discharge line.
        d. As the interface level decreases towards the inlet of the pump, a low-level alarm will alert the operator to open V312 and then close V311, allowing the concentrated FOG to be pumped to the plant's existing FOG storage tanks.
        e. In addition to being used to transfer the contents of the tanks to the centrate drain or the plant's existing FOG storage tanks, the chopper pumps (P-212 and P-222) can be used to recirculate contents of the tank to mix the contents.

2. Normal Operation:
    a. Automatic Operation:
        1) When the plant operators determine that the contents of the receiving tank are ready to process, they can decide to turn on the chopper pump for the receiving tank. When the pump is called to operate and HS-210-2/HS-220-2 are in “REMOTE”, the drain valve for the receiving tank will close, allowing the contents of the tank to be sent through the receiving tank discharge pipe. Once the pump is no longer operating, the drain valve on the discharge line will open, allowing the contents of the discharge line to drain back to the FOG receiving tank.
        2) As the interface level decreases towards the inlet of the pump, a low-level alarm will alert the operator to open V312 and then close V311, allowing the concentrated FOG to be pumped to the plant’s existing FOG storage tanks.
        3) V311 and V312 can be placed in automatic mode in the SCADA system, allowing the SCADA system to determine when to open and close the two valves based on the interface level of tank being emptied. The operator must select which tank is being emptied via software switch HS 310 on the FOG receiving SCADA screen.

            Prior to a pump being started, V311 will be opened. As the interface drops in the tank, the SCADA will first call for V312 to open and then close V311, Directing the concentrated FOG to the existing FOG storage tanks.
        4) If temperature inside of the FOG receiving tanks as measured by TIT-210/TIT-220 decreases, a three-way valve associated with each FOG receiving tank hot water supply loop will switch position, allowing hot water to be supplied to the FOG receiving tank heat exchangers. HS-211-2 and HS-221-2 must at the three-way must be placed in “REMOTE”.
    b. Manual Operation:
        1) The chopper pumps can be operated in manual mode from the variable frequency drive (VFD) by switching in the LOCAL/REMOTE switch to LOCAL mode. The operator can then select to start the pump from the VFD’s local OIT. When the operator places the LOCAL/REMOTE Switch in REMOTE mode, the pump can be stopped and started remotely from the SCADA system.
        2) The drain valve associated with each FOG receiving tank can be placed in “LOCAL” mode at the valve. At which point, the valve may be opened and closed locally.
        3) Thee-way valves V-211 and V-221 can be operated manually in the field by placing HS-211-2/HS-221-2 in “LOCAL” mode and then actuating HS-211-1/HS-221-1.
        4) V311 can be manually opened and closed locally by first placing HS 311-1 in LOCAL mode at the valve. The operator must then use HS 311-2 at the valve to open and close the valve.
        5) V312 can be manually opened and closed locally by first placing HS 312-1 in LOCAL mode at the valve. The operator must then use HS 312-2 at the valve to open and close the valve.
        6)
3. Interlocks:
    a. LIT-210 low low level alarm initially set at .5 Feet (interlocks and shuts down chopper pump, P-212)

b. LIT-220 low low level alarm initially set at .5 Feet (interlocks and shuts down chopper pump, P-222)

c. LIT-210 high high level alarm initially set at 7.6 feet (interlocks and shuts down screening unit, SCN-100 if the corresponding inlet valve, V-210, is open)

d. LIT-220 high high level alarm initially set at 7.6 feet (interlocks and shuts down screening unit, SCN-100 if the corresponding inlet valve, V-220, is open)

4. Pump Fault Conditions:

a. Motor overloads, and conditions as specified by the pump manufacturer should be tied to an individual fault alarm that displays the exact fault condition that caused the failure on the VFD OIT. An on-delay relay shall be included to indicate fault after running signal is received and motor fails to start. A software reset pushbutton for each pump is to be accessible from the overview screen of the VFD's Local OIT to clear all pump related faults. Fault conditions should prevent operation of pumps in HAND and AUTO modes.

5. Status indication:

a. Refer to the P&ID(s), elementary diagrams and per the screening system manufacturer.

6. Alarms:

a. LIT-210 high level alarm initially set at 7 feet (initiates local horns located outside and inside the FOG Receiving Building)

b. LIT-220 high level alarm initially set at 7 feet (initiates local horns located outside and inside FOG Receiving Building)

C. P&ID I-80-103 – FOG Heating System

1. Description:

a. Each FOG Tank is equipped with a heat exchanger (HEX—211 and HEX-221) that are used to heat the contents of each tank. Hot water is pumped through both heat exchangers via VFD pump P-310.

2. Normal Operation:

a. Automatic Operation:

1) P-310 shall be operated in automatic mode, allowing the speed of the drive to be controlled based on the pump discharge pressure, PIT-310.

2) P-310 will operate continuously. The speed of the drive will be dictated by the pump discharge pressure, as measured by PIT-310.

3) A three-way valve, V-304, will be controlled based on the outlet temperature as measured by TIT-304. As TIT-304 rises above the initial set point of 120 degrees F, the valve will switch position and allow hot water flow to bypass heat exchanger, HEX-401. As temperatures begin to decrease below the initial setpoint of 100 degrees Fahrenheit, the valve will switch position, allowing water to flow into the heat exchanger.

b. Manual Operation:

1) If the pressure in the FOG Receiving Hot water system begins to decrease due to disruptions or leaks, plant make up water can be added to the closed loop system. Totalized protected water added to the system will be measured at FM-300.

2) P-310 can only be stopped and started locally from VFD-310.

3) The speed of P-310 can be manually set at the VFD via the local OIT.

4) A three-way valve, V-304, can be controlled manually by pacing HS-304-2 in "LOCAL" mode, and then actuated HS-304-1 to switch position of the valve.

3. Interlocks:
   a. none
4. Pump Fault Conditions:
   a. Motor overloads, and conditions as specified by the pump manufacturer should be tied to an individual fault alarm that displays the exact fault condition that caused the failure on the VFD OIT. An on-delay relay shall be included to indicate fault after running signal is received and motor fails to start. A software reset pushbutton for each pump is to be accessible from the overview screen of the VFD's Local OIT to clear all pump related faults. Fault conditions should prevent operation of the pump in HAND and AUTO modes.
5. Status indication:
   a. Refer to the P&ID(s), elementary diagrams and per the screening system manufacturer.
6. Alarms:
   a. TIT-304 shall be programmed with a high high temperature alarm initially set at 200 Deg F. This will alert the operator that both tanks do not require heating and the pump may be secured. This could occur in situations where no deliveries are scheduled.
   b. A general, P-310 pump fault alarm will be generated and displayed on the SCADA system if any individual fault alarm is active at VFD-310.

D. P&ID I-80-104 –Heating System
1. Description:
   a. A new boiler will heat an expanded hot water loop capable of serving the new loads for the new FOG screening system and FOG receiving tanks. Two new hot water pumps, P-410 and P-420 will serve a hot water loop capable of feeding the existing plant heating loads, new FOG receiving tank heating load, the FOG screening hot water system, and the FOG air handling unit, AHU-401. Hot water Boiler, BLR-400 will operate continuously, heating returning water when required.
   b. Water stored in the new hot water heater, HTR-101, will be pumped to the new FOG screening system via FOG Screening pump, P-111, during operation of the FOG screening system.
2. Normal Operation:
   a. Automatic Mode:
      1) Hot water loop Boiler, BLR-400, will automatically control a temperature setpoint based as adjusted at the control panel, VCP-410.
      2) Main hot water loop pumps, P-410 and P-420, will operate in a duty/standby configuration to maintain pressure through the hot water loop. Under normal operating conditions, the pump speed will increase or decrease to maintain the pressure as measured by PIT-402. The operator can adjust this setpoint based on plant operating conditions from the SCADA.
      3) Hot water receiving pump, P-440 will operate to maintain an acceptable temperature exiting the new FOG receiving tank plate fin heat exchanger. As

the outlet temperature as measured by TIT-440 increases above a setpoint provided by the Operator via SCADA, the speed of the pump will decrease.

4) Under normal conditions, when the H-O-A switch is in "AUTO" mode, FOG hot water screening pump, P-111, will operate when called upon by the FOG screening system.

5) V-101 will automatically control the temperature of the hot water heater via a capillary tube inserted to measure the temperature inside the water heater. As temperature drops below the setpoint, the valve will open and supply heated water from the main hot water loop. As temperature increases above a separate setpoint, the valve will close.

b. Manual Operation:

1) Hot water loop Boiler, BLR-400, can only be operated from the local vendor control panel, VCP-410. Operators must turn on, adjust the set point, and turn off the boiler locally.

2) If the pressure in the Hot water loop begins to decrease due to disruptions or leaks, plant make up water can be added to the closed loop system. Totalized protected water added to the system will be measured at FM-400.

3) Main hot water loop pumps, P-410 and P-420 will operate in a duty/standby configuration. These VFD driven pumps can be turned on/off only at the VFD's Local OIT.

4) FOG Hot water screening pump, P-111 can be operated manually in front of the starter, MCC-111 via an H-O-A switch. When placed in "HAND" mode, the pump will start and run until placed in the "OFF" position.

3. Interlocks:
   a. none
4. Pump Fault Conditions:
   a. Motor overloads and conditions as specified by the pump manufacturer should be tied to an individual fault alarm that displays the exact fault condition that caused the failure on the VFD OIT. An on-delay relay shall be included to indicate fault after running signal is received and motor fails to start. A software reset pushbutton for each pump is to be accessible from the overview screen of the VFD's Local OIT to clear all pump related faults. Fault conditions should prevent operation of the pump in HAND and AUTO modes.
5. Status indication:
   a. Refer to the P&ID(s), elementary diagrams and per the screening system manufacturer.
6. Alarms:
   a. A general, pump/VFD fault alarm will be generated and displayed on the SCADA system if any individual fault alarm is active on any of the pumps listed above.

E. P&ID I-05-105 –Above Ground Fuel Oil Monitoring System
1. Description:
   a. A new fuel oil storage, filling, filtration, and transfer pumping system will be installed to serve existing equipment.
   b. The control panel associated with the transfer pumping system, vendor control panel VCP-504, will be responsible for:
      1) monitoring the conditions at the fuel oil storage tank,

2) activating alarms at the filling system control panel,
3) monitoring the operation of the fuel oil filtration system
4) commanding the duplex fuel pumps to start operation based on signals provided by the plant day tank.
5) Compiling all notifications and alarms associated with the storage tank, fuel oil filtration system, and duplex fuel pumps and transmitting those conditions and alarms to the plant's existing SCADA system.

2. Normal Operation:
   a. Automatic Mode:
   b. The fuel oil storage tank level is measured by a vendor provided level transmitter and high and low fuel oil level switches. Flow through the vent system will be measured by a vendor provided flow switch, and any level of fuel oil that has breached the main tank and entered the interstitial space will be sensed by a vendor provided level switch. Indication, alarming, and monitoring of these signals will be through the vendor control panel, VCP-504, provided with the duplex fuel oil pump system.
   c. The filling system for the fuel oil storage system will alert personnel that are unloading a fuel oil truck that a high-level condition has been reached via a local horn, indicating light, and LCD readout. The LCD readout shows the percentage that the tank is full. Set points to drive the horn and indicating light shall be provided by the vendor of the storage tank.
   d. When control power is on, and the local H-O-A switch is in "AUTO" the filtration system circulates the fuel oil with a pump located on the skid through filters to keep the fuel oil clean and ready for emergency operation. The vendor provided control panel VCP-503 can be used to adjust the interval and duration of this operation.
   e. The duplex fuel oil pumping system consists of two fuel oil transfer pumps, a duplex strainer, two pressure relief valves, and a vendor control panel. The vendor control panel monitors the condition of the fuel oil storage tank, the fuel oil filtration system, and accepts remote start commands from the existing plant day tank. The pumps will operate in a lead/lag configuration, with lead and lag being user configurable through the vendor control panel.
      1) When both pump H-O-A switches are in AUTO and when called upon to supply fuel oil by the day tank, the lead pump will come online and continue to operate until commanded to stop by the day tank.
      2) If the day tank level continues to decrease, the day tank will command the second pump to come online. The second pump will start and continue to operate until commanded to stop by the day tank.
      3) If the lead pump is commanded to start and low flow is sensed by the flow switch located on the discharge of the pump skid, the vendor control panel will automatically call on the lag pump to start and alert operators to the condition.
   f. Manual Operation:
      1) The fuel oil filtration system can be brought online manually by placing the placing the local "H-O-A" switch in "HAND".
      2) The fuel oil filtration system pump can be turned off by placing the H-O-A switch in the "OFF" Position.

3) The fuel oil filtration system vendor control panel can be turned on or off via a locally provided “ON/OFF” switch.

4) Either pump located on the duplex fuel oil system skid can be brought online manually by placing the associated “H-O-A” switch in the “HAND” position. Both can be turned off locally by placing the associated H-O-A switch in the “OFF” position.

3. Interlocks:
   a. none
4. Pump Fault Conditions:
   a. Motor overloads, and conditions as specified by the pump manufacturer should be tied to an individual fault alarm that displays the exact fault condition that caused the failure on the associated vendor control panel. An on-delay relay shall be included to indicate fault after running signal is received and motor fails to start. A software reset pushbutton for each pump is to be accessible from the overview screen of to clear all pump related faults. Fault conditions should prevent operation of the pump in HAND and AUTO modes.
5. Status indication:
   a. Refer to the P&ID(s), elementary diagrams and per the screening system manufacturer.
6. Alarms:
   a. Refer to the P&ID(s), elementary diagrams and per the screening system manufacturer.

## 3.06 TRAINING

A. In accordance with Section 01 79 00 operation and maintenance training on the equipment provided under this section shall be provided for the Authority’s personnel by a representative of the manufacturer, at the Authority’s facility. Subjects shall include operation and troubleshooting of both hardware and software, programming of pump VFDs, and basic program generation. The program written for installation will be used for examples during the training. Training sessions shall not exceed 8 hours per day and shall be held during the Authority's normal daytime working hours. If more than 8 hours of training is required, the sessions shall be held on consecutive business days. The training shall be certified by the manufacturer on Form 43 05 11-B included in Section 01 99 90. A minimum of 8 hours of training shall be provided for the work specified in this section.

**END OF SECTION**

# DIVISION 41

# MATERIAL PROCESSING AND HANDLING EQUIPMENT

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SECTION 41 22 23.19

MONORAIL HOISTS

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:

B. This section specifies a monorail system complete with hoist, trolley, associated drive unit and pendant controls, for installation at the FOG Receiving Building to remove the FOG screening equipment. The monorail is anticipated to be used infrequently for equipment removal for maintenance or replacement.

C. Type:

1. The units shall be underhung, close headroom, single girder monorail. Hoists shall be of the heavy-duty, electric wire rope type with electric driven trolley.
2. The trolleys shall be four wheel type with tracks and appurtenances in accordance with the drawings, Section 05 10 00, and as specified herein.
3. Hoist and trolley motor controller drive types shall be single-speed.

D. Equipment List:

1. Equipment numbers are as follows:

| Item | Equipment No. |
|---|---|
| FOG Screening Equipment Monorail and Hoist | H-100 |



### 1.02 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ANSI/ASME HST-4 | Performance Standard for Electric Wire Rope Hoists |
| CMAA | Crane Manufacturer's Association of America |
| HMI | Hoist Manufacturer's Institute |

3. All equipment furnished under this section shall comply in all respects with the requirements of OSHA, the standards of the Crane Manufacturer's Association of America (CMAA), the Hoist Manufacturer's Institute (HMI), and ANSI/ASME HST-4 Performance Standard for Electric Wire Rope Hoists.

B. Manufacturer's Qualifications:
   1. The monorail and hoist manufacturer shall be one who is regularly engaged in the business of designing, building, and repairing monorail and hoists of the type specified in this section. All monorail components and appurtenances furnished for this contract shall be designed, coordinated and supplied by a single manufacturer.

C. Performance and Design Requirements:
   1. All equipment provided under this section shall be suitable for Class-A, L3, N1 of service as defined by CMAA standards with the heavy-duty hoist suspended from its trolley.
   2. Monorail beams, complete with connections to the structural support systems, splices and runway stops, shall be furnished by the crane manufacturer. Monorail beam shall be designed by a registered civil or structural engineer in accordance with the hoist manufacturer's recommendations. Load bearing connections shall be provided at each beam or girder and where necessary to limit deflection to less than 1/450 of span.
   3. Load carrying parts, except structural members and hoisting ropes, shall be designed so that the calculated static stress in the material, based on rated bond, shall not exceed 20 percent of the assumed ultimate strength of the material. Structural members shall be designed in accordance with the latest edition of the CMAA specifications. The rated capacity load plus the weight of the bottom block divided by the number of parts of hoisting rope shall not exceed 20 percent of the published breaking strength of the rope.
   4. The hoists and trolleys shall be electrified and the drives shall be reversible. Control of motions shall be from a traveling pushbutton pendant on the hoist with strain reliever. All controls shall be clearly marked with etched or engraved nameplates. An emergency stop switch shall be provided on the pendant.
   5. Hoist control shall have separate spring-loaded (deadman) pushbuttons for each direction of the trolley travel. The control shall contain an inching control with a separate set of pushbuttons and allow repetitive motion in either direction. The pushbutton controlling opposite motions shall be mechanically interlocked to avoid being depressed simultaneously.

D. Operating Requirements:
   1. Operating requirements shall be as follows:

| Parameter | |
|---|---|
| Capacity, tons | 3 |
| Vertical lift, feet | 4 |

| Parameter | |
|---|---|
| Approximate hoist lift speed, fpm | 8 |
| Approximate trolley speed, fpm | 50 |
| Maximum hoist motor horsepower | 2 |
| Maximum trolley horsepower | 0.5 |
| Environment | Nonclassified |
| Hoist and trolley Controller Type | 2 step FVR |

2. Hook approach distances shall be as shown on the drawings. The Contractor is advised to examine the drawings for interferences and obstructions which might impose additional limitations upon the equipment.
3. High hook elevation shall be coordinated with the FOG screening equipment manufacturer. Distance between hook and bottom of the monorail beam shall be no greater than 2.25-ft.

E. Unit Responsibility:
1. The Contractor shall assign unit responsibility as specified in Section 43 05 11-1.02 Unit Responsibility to the monorail hoist equipment manufacturer for all equipment specified in this section.



## 1.03 SUBMITTALS

A. The Contractor shall provide the following submittals:
1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. A check mark (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Owner shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration..
2. Completed Certificate of Unit Responsibility attesting that the Contractor has assigned, and that the manufacturer accepts, unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
3. Manufacturer's catalog data confirming rated capacity, equipment speeds, horsepower electrical requirements, and component sizes and dimensions.
4. Motor data in accordance with Section 43 05 21.
5. Electrical diagrams and schematics.
6. Operations and maintenance information as specified in Section 01 78 23.
7. Anchor bolt calculations in accordance with Section 05 05 20.

8. Seismic calculations stamped and signed by a Structural engineer registered in the state of CT.

## 1.04 PROJECT/SITE CONDITIONS

A. General:
   1. Unless otherwise specified, equipment and materials shall be sized and derated for the ambient conditions specified in Section 01 11 80. Across all specified conditions, the equipment shall perform without exceeding the manufacturer's stated tolerances.

B. Seismic:
   1. Electrical equipment, supports, and anchorage shall be designed and installed in accordance with the seismic design requirements specified in Section 01 73 24.

# PART 2 PRODUCTS

## 2.01 ACCEPTABLE PRODUCTS

A. Monorail hoist shall be P&H, Yale Lift Tech's Shaw-Box product series, or equal, modified as necessary to meet the requirements of this section.

## 2.02 MATERIALS

A. Materials for monorail hoists are specified below:

| Component | Material |
|---|---|
| Runway beam | Steel, ASTM A36 |
| Bottom tees | Manganese steel, 225 Brinell hardness |
| Trolleys, wheels, hook | Steel, ASTM A36 |
| Wire rope | StainlessSteel |



## 2.03 EQUIPMENT

A. Monorail Beam:
   1. Monorail beam shall be specially fabricated composite beams comprised of top flange, web and hardened steel bottom tee section, continuously welded to the web. The bottom tee shall be shaped to provide a running surface for the end trucks.

B. End Truck:
   1. The monorail end truck shall carry the rated load between the end truck wheels while the rated load is lifted at one end of the monorail. End truck wheel bases shall be 1/8 of the span or greater.
   2. A rubber bumper shall be mounted on each end of the end truck. Safety lugs shall be provided to limit drop of the end truck to 1 inch or less in the event of wheel or axle failure.
   3. Bearings shall be fitted with seals to exclude dust and moisture and shall be lubricated for life.
   4. Wheels shall be alloy steel or cast iron with tread surfaces hardened to 375 to 425 Brinell. Axles and wheels shall be removable without disturbing other truck elements.

C. Trolley:

1. Trolley wheels shall be hardened steel, mounted on permanently lubricated antifriction bearings. The trolleys shall be motorized and shall be designed for lug connection of the hoist.

D. Hoist:

1. Hoist shall be close headroom. The hoisting drums shall be grooved and designed for one layer of wire rope. Hoist gearing shall be heat-treated hardened steel, running in an oil bath. Gear bearings shall be the oil-lubricated antifriction type, and all bearings shall be designed for a Class M2 (20,000 hour) bearing life.
2. The hoist shall contain an automatic electromechanical type brake designed for long life and positive stopping. The hoist shall contain two brakes designed for long life and positive stopping. One brake shall stop the motor rotation. A second "load brake" shall be applied automatically on lowering and require the motor to drive the load down. Both motor and mechanical load brakes shall be capable of holding 125 percent of load independently of each other.
3. A geared upper and lower limit switch and a plugging upper limit switch shall be provided to assure safe operation and positive stopping under all conditions. The geared limit switch shall automatically stop the motor and engage the hoist brake when the hook reaches either it's upper or lower limit of travel. The hoist shall be provided with a load-limiting device adjusted to 110 percent of rated capacity.
4. Each load hook shall be mounted on ball thrust bearings to swivel without twisting the wire rope. The lifting tackle shall be of the safety type, and the hooks shall be of hardened steel equipped with a safety catch. Sheaves shall be properly guarded and shall be heavy pattern, deep flanged and properly grooved. Sheaves shall be either bronzed bushed or fitted with ball bearings and supported on fixed pins.

E. Motor:

1. Motors shall be special purpose 1750 rpm, 460 volt, 3 phase specially designed for hoist service and provided with an inching circuit. Brakes shall be solenoid actuated. Hoist motor bearings shall be grease lubricated.
2. Trolley motions shall be through reversible electric motor. Trolley motors shall drive the trolley through enclosed gear reducers with dual output shafts to solid rubber tire driving wheels spring mounted on the underside of the monorail. Gear reducers shall be enclosed heavy-duty helical type, of a self-lubricating design with antifriction bearings.

F. Electrical Equipment and Controls:

1. General:
   a. All electrical and control equipment shall comply with the requirements of Section 40 61 13.01.
      1) The monorail hoist manufacturer shall furnish and mount all electrical equipment on the hoist including motors, control and conduit. Conductors may be removed for shipment. Hoist wire shall be furnished by the hoist manufacturer, cut to length and installed as far as practical for shipment.
2. Power Supply:
   a. Power supply for hoist equipment will be 460V, 3 phase, 60 Hertz. The Contractor shall provide the power feeder with a local disconnect switch to the hoist

controller. Control power transformers shall be provided as necessary by the manufacturer.

3. Controllers:
   a. Control equipment, including relays, pushbuttons, transformers, and interconnecting wiring shall be provided by the monorail hoist supplier and housed in NEMA 4X enclosures.

## 2.04 PRODUCT DATA

A. The following information shall be provided:
   1. Operating and maintenance information in accordance with Section 01 78 23.
   2. Factory tested certification.
   3. Installation Certification Section 43 05 11-Form A.
   4. Instruction Certification Section 43 05 11-Form B.

# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Manufacturer shall test the equipment in accordance with industry standards and federal regulations prior to shipment of the equipment. The monorail, trolley, and hoist shall be completely assembled and no load run tested prior to shipment to the job site. Monorail hoist shall be disassembled to the least amount possible for shipment. The trolley and hoist shall be installed at the location shown and in accordance with the manufacturer's recommendations.

B. The monorail system shall be installed and tested by the Contractor with the assistance of a factory-trained representative. The installation shall be certified on Form 43 05 11-A specified in Section 01 79 90.



## 3.02 TESTING

A. After completion of installation, the monorail hoist, trolley, and hoist shall be completely tested to ensure compliance with the performance requirements as specified. As a minimum, testing shall be by operating the equipment through a complete lift and lowering cycle and through a complete travel of the monorail to determine that the equipment performs smoothly and safely without failure.

B. Such tests shall be carried out with the hoisting equipment loaded as near to the specified capacity as possible. Any defects shall be corrected or replaced immediately by the Contractor and at no expense to the Owner. Final OSHA inspection, load tests, all other testing, and certification shall be at the Contractor's expense.

## 3.03 TRAINING

A. The Contractor shall provide the services of a factory-trained manufacturer’s representative to provide training of the Owner’s personnel in the proper operation and maintenance of the equipment.

B. Prior to final acceptance, the Contractor shall furnish the Construction Manager with two copies of the manufacturer's certifications (Section 01 99 90-Form 43 05 11-B). Training shall be performed in accordance with Section 01 78 23.

## 3.04 MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall include in his bid all costs associated with providing the services of the manufacturer's field representative for checking, aligning testing, placing in operation, and Owner training.

## 3.05 USE BY CONTRACTOR

A. Any hoist used by the Contractor shall be repaired, repainted and otherwise refurbished to like-new condition prior to its acceptance. The Contractor assumes all responsibility for operation and maintenance until the monorail and hoist has been accepted.

**END OF SECTION**

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# DIVISION 43

# PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE

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SECTION 43 05 11

GENERAL REQUIREMENTS FOR EQUIPMENT

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:

1. This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of each individual equipment specification section.

B. Equipment Lists:

1. Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material required to be provided under this contract. The Contractor shall prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.



### 1.02 QUALITY ASSURANCE

A. Arrangement:

1. The arrangement of equipment shown on the drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment actually provided. No additional payment shall be made for such revisions and alterations.

B. References:

1. This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that

date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

| Reference | Title |
|---|---|
| ABMA Std 9 | Load Ratings and Fatigue Life for Ball Bearings |
| ABMA Std 11 | Load Ratings and Fatigue Life for Roller Bearings |
| ANSI B1.1 | Unified Inch Screw Threads (UN and UNR Thread Form) |
| ANSI B1.20.1 | Pipe Threads, General Purpose (Inch) |
| ANSI B16.1 | Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250) |
| ANSI B18.2.1 | Square and Hex Bolts and Screws (Inch Series) |
| ANSI B18.2.2 | Square and Hex Nuts (Inch Series) |
| ISO 1940-1 | Mechanical Vibration – Balance Quality Requirements for Rotors in a Constant (Rigid) State: Part 1: Specification and Verification of Balance Tolerances |

C. Unit Responsibility:

1. The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems as provided in the General Conditions of the Contract Documents.

D. The Contractor shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Contractor to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 43 05 11-C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.

E. Balance:

1. Unless specified otherwise, for all machines 10 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

   a. $U_{per} = 6.015\frac{GW}{N}$

   b. Where:

      1) $U_{per}$ = permissible imbalance, ounce-inches, maximum
      2) $G$ = Balance quality grade, millimeters per second
      3) $W$ = Weight of the balanced assembly, pounds mass
      4) $N$ = Maximum operational speed, rpm

2. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be *G* 2.5 (*G* = 2.5 mm/sec) or better in accordance with ANSI S2.19.



## PART 2 PRODUCTS

### 2.01 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125, unless otherwise noted. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

C. Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

### 2.02 BEARINGS

A. Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L-10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

B. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

C. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size

to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees C and shall be equipped with a filler pipe and an external level indicator gage.

D. All bearings accessible to touch, and located within 7 feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures, shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 degrees C or less for continuous operation at bearing rated load and a 50 degrees C ambient temperature or shall be provided with appropriate shielding shall be provided that will prevent inadvertent human contact.

## 2.03 V-BELT ASSEMBLIES

A. Unless otherwise specified, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or equal.

B. Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull-up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.

C. Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion proof equipment is specified.

## 2.04 PUMP SHAFT SEALS

A. General:

1. Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. For industrial wastewater service, or for fluids other than water or municipal wastewater, the recommendations of the seal manufacturer shall be followed for selection of appropriate seals. Unless specified otherwise, stuffing boxes and mechanical seals shall conform to the requirements set forth in this paragraph.

## 2.05 COUPLINGS

A. Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

B. Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas-Rex, Falk Steel Flex,TB Woods, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

## 2.06 GUARDS

A. Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be stainless steel and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

## 2.07 CAUTION SIGNS

A. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "Caution - Automatic Equipment May Start At Any Time". Signs shall be constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.



## 2.08 GAGE TAPS, TEST PLUGS AND GAGES

A. Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Division 40.

## 2.09 NAMEPLATES

A. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins or shall be riveted to the deck plate.

## 2.10 LUBRICANTS

A. The Contractor shall provide for each item of mechanical equipment a supply of the required lubricant adequate to last through the specified commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment (Section 01 45 20), the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

## 2.11 ANCHOR BOLTS

A. Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the provisions of Section 05 05 20. Unless otherwise stated in the individual equipment specifications, anchor bolt materials shall conform to the provisions of Section 05 05 20.

## 2.12 SPARE PARTS

A. Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified by part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration, such as ferrous metal items and electrical components, shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

# PART 3 EXECUTION

## 3.01 GENERAL

1. Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

**END OF SECTION**

SECTION 43 05 13

RIGID EQUIPMENT MOUNTS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes: This Section specifies requirements for rigid equipment mounts. Rigid equipment mounts consist of equipment pads, equipment anchors, and mounting plates (baseplates, soleplates, or fabricated steel frames) set in grout.

B. Conform to the requirements specified in the Equipment Mounting Schedule (Part 4 of this Section) or equipment mounting configuration requirements specified in individual equipment specifications . Where equipment mounting requirements are not specifically identified, the default mounting configuration for equipment consists of Pad Anchored Equipment Pads per Standard Detail D01007 with adhesive dowels anchoring the equipment pad to the foundation, equipment and driver mounted on a common mounting plate, mounting plate leveled within 0.005 inch/foot, equipment anchored to the equipment pad with cast-in-place equipment anchors per Standard Detail D01002, equipment anchor sleeve length is 10 times the bolt diameter, and the mounting plate is grouted in position using non-shrink grout.

C. If a conflict exists between this Section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.

D. Requirements for non-rigid equipment mounts (vibration isolation systems) are specified in the associated equipment specification. Furnish rigid equipment mounts conforming to the requirements of this Section for the equipment pad and other equipment mounting components supporting the vibration isolation system.



### 1.02 RELATED SECTIONS

A. This Section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 61 45 – Area Exposure Designations
   2. Section 01 73 23 - Structural Design and Anchorage Requirements for Nonstructural Components and Non-Building Structures
   3. Section 01 99 90 - Reference Forms
   4. Section 03 60 00 – Grouting
   5. Section 05 05 20 – Anchor Bolts
   6. Section 09 90 00 – Painting and Coating
   7. Section 43 05 11 – General Requirements for Equipment
   8. Section 43 05 14 – Machine Alignment

### 1.03 REFERENCES

A. This Section contains references to the following documents. They are a part of this Section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this Section as if

referenced directly. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section prevail.

| Reference | Title |
|---|---|
| ACI 318, Appendix D | Building Code and Commentary, Anchorage to Concrete |
| HI 14.3 | Rotodynamic Pumps –for Design and Application |
| HI 14.4 | Rotodynamic Pumps –for Installation, Operation and Maintenance |
| API RECOMMENDED PRACTICE 686 | Recommended Practices for Machinery Installation and Installation Design |
| ASCE 7 | Minimum Design Loads and Associated Criteria for Buildings and Other Structures |
| ASME B1.1 | Unified Inch Screw Threads (UN and UNR Thread Form) |
| ASTM E329 | Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction |
| ASTM F593 | Stainless Steel Bolts, Hex Cap Screws, and Studs |
| ASTM F1554 | Anchor Bolts, Steel, 36, 55 and 105 ksi Yield Strength |
| MIL-PRF-907E | Anti-Seize Thread Compound, High Temperature |
| SSPC | Society for Protective Coatings Specifications, Vol. 2 |
| IBC | International Building Code (including local amendments) |



## 1.04 DEFINITIONS

A. Terminology used in this Section conforms to the following definitions:

1. Baseplate: A mounting plate configured with a top plate and a perimeter edge of the mounting plate that is below the top plate. Baseplates have a cavity between the top plate and a horizontal plane at the bottom edge of the perimeter of the mounting plate.
2. Soleplate: A machined or pre-formed mounting plate with a uniform horizontal surface across the entire underside of the mounting plate, excepting shear lugs/keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.). Soleplates have a top plate but lack the perimeter bottom edge that extends below the underside of the top plate that is a defining feature of baseplates.
3. Fabricated Steel Frame: An equipment mounting plate constructed of rolled steel shapes and plates welded into a frame. Fabricated steel frames do not have top plates.
4. Equipment Pad: Concrete foundation (block or slab) supporting and elevating mounting plates above the supporting structural floor slab or local grade.
5. Mounting Pads: Milled/machined areas of baseplates, soleplates, and fabricated steel frames where the feet or mounting surfaces of mounted equipment and drivers are bolted to the baseplate, soleplate, or fabricated steel frame.
6. Leveling Blocks: Steel blocks temporarily placed under baseplates, soleplates, or fabricated steel frames at leveling positions (at equipment anchors) for the purpose of leveling baseplates, soleplates, or fabricated steel frames prior to grouting.
7. Shims: Thin stainless steel plates of uniform thickness used for fine adjustment of level. Shims are used on top of leveling blocks for mounting plate leveling or used between equipment drivers and baseplates, soleplates, or fabricated steel frames for equipment alignment.

8. Wedges: Pairs of uniformly tapered metal blocks that are stacked with the tapered surfaces reversed (relative to the other wedge) so that the top and bottom surfaces of the wedges are parallel. Wedges are used between equipment pads and baseplates, soleplates, or fabricated steel frames for the purpose of leveling mounting plates.
9. Mounting Stud: Threaded rod or bolts anchored to baseplates, soleplates, or fabricated steel frames for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or fabricated steel frames.
10. Reinforcement Dowels or Reinforcement Hooks: Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.
11. Leveling Position: A location on the top of a concrete equipment pad where leveling tools and equipment will be temporarily installed or used for the purpose of leveling baseplates, soleplates, and fabricated steel frames prior to grouting.
12. Grout Manufacturer: Refers to the manufacturer of the grout product used for installation of rigid equipment mounts.
13. Grout Manufacturer's Technical Representative(s): Refers to the technical representative(s) of the Grout Manufacturer. The Grout Manufacturer's Technical Representative shall not be an employee of the Contractor.

## 1.05 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meetings:
   1. Conduct a pre-installation meeting with the Engineer's representative prior to installation of equipment mounts.
   2. Schedule a pre-installation meeting for the equipment mounts associated with each system or group of identical equipment items.
   3. Where equipment anchors are cast in the floor slab or foundation, schedule the pre-installation meeting prior to pouring the floor slab or foundation.

## 1.06 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. A copy of this Section, including addendum updates, (referenced sections need not be included for this Section) with each paragraph check-marked to indicate compliance or marked to indicate requested deviations from specification requirements. Check marks denote full compliance with a paragraph as a whole. Underline each deviation and denote with a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. Mark copies of this Section with the specification number and equipment number for inclusion (filing) with submittal materials furnished for individual equipment specifications.
   3. Name, employer, and a copy of the employee's Qualified Millwright card or other equivalent certificate of journeyman qualifications for millwrights who will install rigid equipment mounts, as specified in paragraph 3.02, Leveling.
   4. Certificates or other documentation issued by the epoxy grout manufacturer that demonstrates that the grout manufacturer's technical representative has been

factory trained on installation of epoxy grout for equipment mounts, as specified in paragraph 1.07 Quality Control by Contractor.

5. List of Contractor's equipment installation staff that have completed epoxy grout manufacturer's grout installation training specified in paragraph 3.03, Manufacturer's Services.
6. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate or fabricated steel frame depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; grout formwork; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pads. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate, or fabricated steel frames to be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

B. Informational Submittals:

1. Procedures: Section 01 33 00
2. Submit equipment anchor calculations demonstrating compliance with paragraph 2.04, Equipment Anchor Design. Submit equipment anchor calculations with submittal information specified in the associated equipment specification.
3. Results of grout strength tests, as specified in paragraph 3.02, Grouting.
4. Completed Rigid Equipment Mount Installation Inspection Checklist Forms (43 05 13-A), as specified in paragraph 3.03, Manufacturer's Services.



## 1.07 QUALITY ASSURANCE

A. Quality Control By Contractor:

1. Except where union rules require installation by another trade, all machinery to be mounted and leveled by journeyman millwrights.
2. Epoxy grout installation performed by employees that have completed the epoxy grout manufacturer's grout installation training specified in this Section.
3. Provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. Testing laboratory to sample and test materials installed as part of rigid equipment mounts specified in this Section. Testing laboratory services costs borne by the Contractor.
4. Where epoxy grout is specified for bedding mounting plates, furnish the services of a grout manufacturer's technical representative who has been factory trained by the grout manufacturer. The grout manufacturer's technical representative performs training and quality control for epoxy grout installation for rigid equipment mounts as specified in paragraph 3.03, Manufacturer's Services.

B. Special Inspection for Equipment Anchors:

1. Equipment anchors shall comply with special inspection requirements specified in Section 05 05 20.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Configure rigid equipment mounts as specified in the Equipment Mounting Schedule (See Part 4 of this specification) or as specified in individual equipment specifications. Equipment mounting configuration requirements in individual equipment specifications govern over configuration requirements specified in the Equipment Mounting Schedule. In the absence of equipment mounting configuration requirements in either of these locations, mount equipment per the default requirements specified in paragraph 1.01.

B. Pumps installed in accordance with this Section, HI 14.3, and HI 14.4.

### 2.02 MATERIALS FOR EQUIPMENT MOUNTING

A. Equipment pads: Reinforced concrete as specified in Standard Details D01000, D01001, D01002, D01003, D01006, D01007, and D01008.

B. Mounting Plates: Cast iron, cast steel, plate steel, fabricated steel frame, polymer concrete, or FRP as specified in the equipment specification.

C. Grout type for equipment mounting as specified in the Equipment Mounting Schedule or in individual equipment specification.

1. Epoxy Grout for Equipment Mounting: Where epoxy grout is specified in the Equipment Mounting Schedule or in individual equipment specifications, provide Epoxy Grout for Equipment Mounting as specified in Section 03 60 00. Where the term epoxy grout is used in the context of details and specifications for equipment mounting it means Epoxy Grout for Equipment Mounting as specified in Section 03 60 00.
2. Cementitious Nonshrink Grout: Where non-shrink grout is specified in the Equipment Mounting Schedule or in individual equipment specifications, Cementitious Non-shrink Grout, specified in Section 03 60 00, may be used for setting bearing surfaces of baseplates, soleplates, or fabricated steel frames. Where the term non-shrink grout or cementitious grout is used in the context of details and specifications for equipment mounting it means Cementitious Non-shrink Grout as specified in Section 03 60 00.



D. Equipment anchors: Materials per the following table and per the area exposure condition where the equipment is installed. Section 01 61 45 specifies area exposure conditions.

| Area Exposure | Equipment Anchor Materials |
|---|---|
| Indoor, Dry | Carbon Steel, ASTM F1554, Grade 36, weldable per S1 for threaded rod |
| Indoor, Wet | Galvanized Carbon Steel, ASTM F1554, Grade 36, weldable per S1 for threaded rod |
| Outdoor | 304 Stainless, ASTM F593, Cond. CW |
| Submerged, Immersed | 316 Stainless, ASTM F593, Cond. CW |
| Process Corrosive | 316 Stainless, ASTM F593, Cond. CW |
| Chemical Corrosive | 316 Stainless, ASTM F593, Cond. CW |

E. Anchor sleeves: Flexible polyurethane foam, steel cylinder/tubes, or corrugated/ribbed plastic sleeves.

F. Epoxy Primer: High-strength, lead free, chrome free, rust inhibiting two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. Bond strength to sandblasted metal not less than 1500 psi.
   1. ITW Performance Polymer MS-7CZ primer
   2. Approved equal.

G. Anti-seize/Anti-galling compound: Molybdenum disulfide and graphite combination in aluminum complex base grease conforming to MIL-PRF-907E.
   1. Jet Lube 550 by Jet Lube, Inc.
   2. E-Z Break by LA-CO
   3. or approved equal.

## 2.03 EQUIPMENT PADS

A. Minimum dimensions for equipment pads are shown on structural drawings where a minimum equipment pad mass is required for vibration dampening/control.

B. Equipment Pad Drainage:
   1. Furnish equipment pads with 2-inch drains.
   2. Locate equipment pad drains at drainage outlets from equipment or mounting plates
   3. Route equipment drainage outlets or mounting plate drainage outlets to equipment pad drains
   4. Route equipment pad drains to the floor drainage collection system.
   5. Drainage piping for equipment pads shall be routed below the finished floor elevation.
   6. Exposed drain lines mounted on the floor are not acceptable.



## 2.04 EQUIPMENT ANCHORS:

A. Equipment Anchors:
   1. All thread rod with heavy hex welded nuts, heavy hex bolts, post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors), or adjustable canister anchors as specified in the Equipment Mounting Schedule or in individual equipment specifications.
   2. Bolt length as required for the specified embedment and sleeve length. Reduce equipment anchor sleeve length as necessary to fit within finished height of equipment pad if equipment pad height is insufficient to provide specified equipment anchor sleeve length. Unified Coarse Thread Series per ASME B1.1.
   3. Post-installed anchors (wedge, sleeve, undercut, expansion, and adhesive anchors) conforming to the requirements of Section 05 05 20.
   4. Adjustable canister anchors consist of cast-in-place pre-manufactured adjustable anchor inserts. Provide a minimum of 6 inches of vertical bolt height adjustment and lateral adjustment of the anchor bolt while maintaining the anchor bolt in a true vertical orientation.
      a. Jakebolts as manufactured by Unisorb

b. Heavy Duty Adjustable Anchors as manufactured by Deco
c. Rowan Adjustable Canister Anchor Bolt
d. or approved equal.

B. Equipment Anchor Design:
1. Size (diameter) of anchors for clamping/fastening mounting plates to equipment pads determined by the equipment manufacturer.
2. Comply with International Building Code for equipment anchor size, embedment, and edge distance. Provide equipment anchors that are sufficient to resist the maximum lateral and vertical forces specified in Division 01.
3. Resistance to lateral (horizontal) loads based on the static friction between the mounting plate and its supporting grout pad. Include the clamping force applied by equipment anchors and the weight of the equipment for calculating static friction resistance to lateral loads. Do not include lateral (shear) loading on equipment anchors or adhesion between mounting plates and supporting grout in lateral loading resistance calculations.
4. Furnish equipment anchor calculation submittals for all equipment unless one of the following exceptions is applicable:
a. The importance factor, $I_p$, for the equipment is equal to 1.0, flexible connections are provided for all electrical and mechanical connections to the equipment, the center of mass of the equipment is less than 48 inches above the floor when it is mounted or attached to the structure, and the equipment weighs less than 400 pounds.
b. The importance factor, $I_p$, for the equipment is equal to 1.0, flexible connections are provided for all electrical and mechanical connections to the equipment, and the equipment weighs less than 20 pounds.
5. Equipment anchor calculations sealed by a registered structural or civil engineer licensed in the State of Connecticut.

C. Equipment Anchor Tension:
1. Unless alternate bolt torque/tension requirements are specified by the equipment manufacturer, tighten equipment anchors to provide a final clamping force that produces a tensile stress of 15,000 psi in each equipment anchor. Tighten adjustable canister anchors to the manufacturer's maximum safe working load. Tighten post-installed anchors to manufacturer's recommendations.
2. Bolt torque values required to produce the specified bolt tension based on well lubricated plain finish national coarse thread bolts are presented in the following table. Revise bolt torque values per equipment manufacturer's recommendations for alternate thread patterns, thread lubrication, bolt material, or bolt finish.

| Bolt Diam. (in) | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/8 | 1-1/4 | 1-1/2 |
|---|---|---|---|---|---|---|---|---|---|
| Final bolt torque for 15,000 psi bolt stress (ft*lbs) | 8 | 15 | 30 | 50 | 80 | 125 | 180 | 250 | 400 |

3. Prior to leveling and grouting mounting plates, pull test grouted equipment anchors (standard detail D01003) to the values specified in the following table.

| Anchor Diam. (in) | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 | 1-1/8 | 1-1/4 | 1-1/2 |
|---|---|---|---|---|---|---|---|---|---|
| Pull test load (kips) | 2.1 | 3.8 | 6.1 | 9.1 | 13 | 17 | 22 | 28 | 43 |

D. Anchor Sleeves:
   1. Provide sleeves for equipment anchors as specified in the Equipment Mounting Schedule or in individual equipment specifications.
   2. Adjust equipment anchor length/embedment depth shown in Standard Detail D01002 and Standard Detail D01003 if sleeves are not required.
   3. Sleeves may be installed at the Contractor's option if not specified in the Equipment Mounting Schedule or in individual equipment specifications provided they do not interfere with specified embedment lengths.
   4. Fill steel cylinders/tubes and ribbed plastic sleeves with a flexible room temperature vulcanizing (RTV) sealant prior to embedment/installation.

## 2.05 MOUNTING PLATES

A. General:
   1. Round edges of surfaces of baseplates, soleplates, and fabricated steel frames that bear on grout to a radius of not less than 0.25 inch.
   2. Round perimeter corners of baseplates, soleplates, or fabricated steel frames to a radius of not less than 2.0 inches to avoid producing stress risers on the grouted foundation.
   3. Provide grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2.5 inches in diameter for cementitious non-shrink grout) and air release holes in all baseplates and soleplates.
   4. Provide grout relief or vent holes (minimum 1 inch in diameter) in all baseplates and soleplates.
   5. Drill mounting holes for equipment anchors through baseplates, soleplates, and fabricated steel frames. Open slots or burned out holes for equipment anchors are not permitted.
   6. Provide acorn nuts welded to the underside of the baseplate or soleplate or nuts welded to the underside of the baseplate or soleplate and plugged with cork, plastic plugs or grease where terminations to baseplates and soleplates are required.
   7. Where fasteners terminate only into the baseplate, soleplate, or fabricated steel frame, threaded lengths (tapped or embedded in mounting plates) shall be not less than the bolt diameter.
   8. Where baseplates, soleplates, or fabricated steel frames are leveled using jackscrews, tap jackscrew threads in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
   9. Mill mounting pads and/or mounting surfaces of baseplates, soleplates, and fabricated steel frames flat and coplanar within 0.0005 inch per foot in all directions after all welding and stress relieving.
   10. Pre-grout baseplates prior to milling.

11. Baseplates, soleplates, and fabricated steel frames provide common support for the equipment and driver (and flywheel, if one is specified).
12. For equipment with drivers 20 horsepower and greater, provide transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates, soleplates, and fabricated steel frames.
13. Provide alignment/positioning jackscrews in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Additional jackscrews provided for transverse alignment of the flywheel, if flywheels are specified in the equipment specification.)
14. Where specified in individual equipment specifications; baseplates, soleplates, and fabricated steel frames fitted with RK Fixators as manufactured by Unisorb, or approved equal.
    a. Fixators installed at mounting surfaces for drivers.
    b. Fixators consist of a three-piece wedge leveling adjustment device incorporating a spherical washer assembly to provide true level height adjustment at each mounting surface for the equipment driver.

B. Fabricated Steel Frames:
1. Fabricated steel frames consist of structural steel shapes welded to form mounting plates.
2. Fabricated steel frames to be rectangular in shape, excepting fabricated steel frames for centrifugal refrigeration machines and pumps which may be T- or L-shaped to accommodate the equipment driver and accessories.
3. Fabricated steel frames for split case pumps include supports for suction and discharge elbows, if required by the specified configuration.
4. Perimeter members consist of I-beams or C-channel with a minimum depth equal to 1/10 of the longest dimension of the fabricated steel frame. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
5. Fabricated steel frames furnished with thickened steel mounting pads welded to the fabricated steel frame for bolting equipment to the mounting plate.
6. Sandblast surfaces of fabricated steel frames in contact with grout to white metal per SSPC-SP-5.
7. Apply a high-strength epoxy primer as specified in paragraph 2.02 within 8 hours of sandblasting the fabricated steel frame.

C. Baseplates:
1. Baseplates may be welded steel, cast steel, or cast iron with thickened mounting pads for bolting equipment to the baseplate.
2. Provide internal stiffeners on all cast and fabricated baseplates. Stiffeners designed to allow free flow of grout from one section of the baseplate to another.
3. Provide a minimum 2 inches high by 6 inches wide opening in cross bracing and stiffeners for grout flow between sections of the baseplate.
4. All welds continuous and free from skips, blowholes, laps and pockets.
5. Pre-grout baseplates at the factory after all welding has been completed and prior to machining the mounting pads on the baseplate. Pre-grout baseplates in the field if

they have not been pre-grouted at the factory. Remove the equipment from the baseplate, invert the baseplate, and pre-grout as specified in this Section.

6. Prior to pre-grouting, sandblast the underside of baseplates to white metal per SSPC SP-5.
7. Complete pre-grouting within 8 hours of sandblasting.
8. Fill the underside of the baseplate to the bottom edges of the baseplate.
9. Seal cast iron baseplates to prevent surface bleeding prior to shipment to the project site.

D. Plate Steel Soleplates:

1. Not less than 1.0 inch thick for equipment with drivers greater than 30 horsepower.
2. Furnished with grout keys/lugs or stiffeners on the underside of the soleplate.
3. Flat uniform horizontal surface on underside of plate steel soleplates, excepting grout keys, grout pour holes, vent holes, and attachment hardware (nuts, bolts, tapped holes, etc.).
4. Prior to milling the mounting pads for equipment or mounting surfaces, scribe the words “THIS SIDE DOWN”, using welding rod material, on the underside of plate steel soleplates , .
5. Plate steel soleplates without grout pouring holes are acceptable provided that no dimension of the soleplate (width or length) exceeds 18 inches.
6. Sandblast surfaces of plate steel soleplates in contact with grout to white metal per SSPC-SP-5, prior to shipment to the project site.
7. Apply a high-strength epoxy primer as specified in paragraph 2.02 within 8 hours of sandblasting the underside of plate steel soleplates.
8. Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom-suction pumps, the equipment may be supported on individual concrete piers or equipment pads in lieu of mounting on a common equipment pad and soleplate. In such instances, support the equipment at the feet or mounting surfaces on individual plate steel soleplates. Level individual plate steel soleplates and grout into place on the individual piers or equipment pads as specified in this Section. Where multiple soleplates are installed to support one piece of equipment, soleplates shall be coplanar within 0.002 inch/foot.



E. Polymer Concrete Soleplates:

1. Pre-cast soleplates consisting of polymer concrete with stainless steel inserts for equipment mounting.
2. Mounting surfaces shall be coplanar within 0.002 inch/foot.
3. Furnished with a uniform horizontal surface over the entire underside of the mounting plate, excepting grout keys, grout pour holes and vent holes.
    a. PoxyBase as manufactured by Basetek
    b. Chembase as manufactured by Goulds
    c. Approved equal.

F. Corrosion Resistant FRP Baseplates:

1. Pre-formed fiber reinforced plastic fabrications.
2. Product of the manufacturer of the equipment that is mounted on the baseplate.

## PART 3 EXECUTION

### 3.01 PREPARATION

A. Concrete Equipment Pad Preparation:

1. Roughen the top of the equipment pad after the concrete has reached its 28-day compressive strength.
2. Remove all laitance and defective or weak concrete.
3. Roughen surface profile to 0.25 inch amplitude, minimum.
4. Expose broken aggregate without dislodging unbroken aggregate from the cement matrix and without fracturing concrete and aggregate below the concrete surface.
5. Roughen using a light-duty (15 pounds or less), hand-held chipper with a chisel type tool.
6. Abrasive blast, bush-hammer, jack hammers with sharp chisels, heavy chipping tools, or needle gun preparation of concrete surfaces to be grouted are not acceptable.
7. Demonstrate removal of defective or weak concrete to the Engineer prior to leveling.
8. Chip the surface of the concrete such that the final elevation of the equipment pad provides the grout manufacturer's recommended thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate, or underside of the fabricated steel frame.
9. Remove all dust, dirt, chips, oil, water, and any other contaminants and protect the surface with plastic sheeting until grout is installed.
10. Protect concrete equipment pad surfaces that have been finished smooth and level for use as leveling positions. Protect from damage during chipping activities. Alternatively, leveling positions may be restored on chipped surfaces. Restore leveling positions by installing leveling blocks or leveling plates for jackscrews on a high compressive strength epoxy putty (Philadelphia Resins, Phillybond Blue 6A, or equal). Leveling blocks and leveling plates installed level on the epoxy putty.

B. Grout Form Construction:

1. Design forms for a minimum of 6 inches hydrostatic head above the final elevation of the grout and manufacturer's recommendations for form edge clearance for intended pour scheme, but not less than two inches.
2. Install grout expansion joints at 4 to 6 foot intervals, perpendicular to the centerline of baseplates. Design expansion joints in accordance with the grout manufacturer's written instructions.
3. Coat forms with three coats of paste wax on all areas of the forms that will be in contact with the grout.
4. Wax forms before assembly.
5. Prevent accidental application of wax to surfaces where the grout is to bond.
6. Remove any foreign material, such as oil, sand, water, wax, grease, etc., from concrete surfaces that will contact grout before forms are installed.
7. Forms must be liquid tight. Seal any open spaces or cracks in forms, or at the joint between forms and the foundation using sealant, putty, or caulking compound.
8. Chamfer vertical and horizontal edges of the grout with 45-degree chamfers as specified in equipment pad details. Locate 45-degree perimeter chamfer strips at the final elevation of the grout.

9. Match chamfers in concrete portions of the equipment pad.
10. Install block outs at all leveling positions to allow removal of leveling equipment and leveling nuts to be backed off after the grout has cured.
11. Coat jackscrews with a light oil or other acceptable bond-breaking compound prior to grouting.
12. Seal equipment anchor sleeves to protect the sleeved length of the anchor from contact with grout.
13. Wrap exposed portions of equipment anchors with duct tape to protect them from grout splatter and to prevent bonding to grout.

C. Mounting Plate Preparation:
1. Roughen the underside of soleplates and fabricated steel frames and wipe with a residue-free solvent as recommended by the epoxy primer manufacturer before placement of the baseplate, soleplate, or fabricated steel frames on the equipment pad for leveling. Roughen surfaces of mounting plates that will be in contact with grout by power tool cleaning. Cleaning performed by power wire brushing, power sanding, power grinding, power tool chipping or power tool descaling. Impart a minimum profile of 1.0 mil.
2. Prior to placement on the equipment pad for leveling, roughen exposed grout surfaces of pre-grouted baseplates and wipe with a residue-free solvent as recommended by the manufacturer of the epoxy grout used for pre-grouting.
3. Prepare the underside of corrosion-resistant FRP baseplates and polymer concrete baseplates per the baseplate manufacturer's recommendations and prior to placement of the baseplate on the equipment pad for leveling.
4. Grouting for installation of mounting plates on equipment pads completed prior to connecting any field piping or electrical and instrumentation systems.
5. Unless the Engineer accepts an alternate installation procedure in writing, baseplates, soleplates, and fabricated steel frames leveled and grouted with the equipment removed.



## 3.02 INSTALLATION

A. Leveling:
1. Except where union rules require installation by another trade, all equipment and machinery mounted and leveled by a Qualified Millwright.
2. Use precision surveying equipment for leveling.
3. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or fabricated steel frame with a plan dimension greater than 4 feet.
4. Baseplates, soleplates, and fabricated steel frames leveled to the tolerance specified in the Equipment Mounting Schedule, in the individual equipment specification, or as otherwise required by the equipment manufacturer, if more stringent.
5. Apply an anti-seize or anti-galling compound, specified in paragraph 2.02, to all equipment anchor threads prior to beginning baseplate, soleplate, or fabricated steel frame leveling.
6. Level all baseplates, soleplates, and fabricated steel frames against steel surfaces (jackscrew plates, leveling blocks, leveling nuts, support plates, or other steel surfaces). Use of other materials for leveling purposes is strictly and specifically prohibited.

7. Use stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates.
8. Leveling nuts may be used for leveling baseplates, soleplates, and fabricated steel frames weighing less than 200 pounds (inclusive of the weight of the equipment if leveled with the equipment on the mounting plate).
9. Leveling blocks shall be stainless steel, 4 inches square and 1.5 inches thick with an open-ended slot terminating in the center for the equipment anchor.
10. Machine leveling blocks flat on all horizontal surfaces and place under the baseplate or soleplate at each equipment anchor.
11. Provide pre-cut stainless steel shims, slotted for removal after grouting. Coat leveling blocks and shims with a light oil just prior to beginning the leveling and grouting work. Place shims so the tabs on the shims are easily accessible.
12. Clamp baseplates, soleplates, or fabricated steel frames in position (after leveling) by installing the equipment anchor nuts and washers.
13. Apply bolt tension to fix the position of mounting plates during grouting (30 to 60 percent of the final clamping force applied to clamp the mounting plate to the equipment pad).
14. Prior to grouting, verify that the correct level and position of the baseplate, soleplate, or fabricated steel frame has been maintained after clamping it to the equipment pad.

B. Grouting:
1. Adjust ambient temperature to maintain mounting plate, foundation, and grout temperatures to grout manufacturer's recommended temperature.
2. Mix grout for equipment mounting in accordance with the grout manufacturer's written recommendations.
3. Place epoxy grout using a method that avoids air entrapment.
4. Place grout at one end of the baseplate or soleplate and work grout toward the opposite end to force the air out from beneath the baseplate or soleplate.
5. Pour grout through a head box into grout pouring holes.
6. When the head box is moved to the next grout hole, place a 6 inch standpipe over the grout hole and fill with grout.
7. Pour grout to the top of the lower flange of the perimeter I-beams or C-channel of fabricated steel frames.
8. Pour grout at least 0.125 inch but not more than 0.5 inch above the bottom or underside of the perimeter edge of a baseplate or soleplate.
9. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.
10. Never allow the grout in the head box to fall below the top of the baseplate or soleplate once the grout has made contact with the baseplate or soleplate.
11. Grout placement applied in one continuous pour, until all portions of the space beneath the baseplate, soleplate, or fabricated steel frame have been filled.
12. Prepare subsequent batches of grout prior to depleting the preceding batch.
13. Maintain grout height in standpipes after the space under the baseplate, soleplate, or fabricated steel frame has been filled.

14. When the grout has started to take an initial set (typically this is determined by a noticeable increase in temperature and no flow of grout at the vent holes) remove the standpipes and clean excess grout from all surfaces.
15. Check for leaks throughout grout pours. Repair leaks immediately to prevent formation of voids.
16. Check baseplate, soleplate, or fabricated steel frame level and elevation before the grout sets.
17. Cure grout in accordance with the grout manufacturer's written instructions.
18. Collect at least one grout sample from each grout pour. Where specified in the individual equipment specifications, collect a grout sample from the grout pour for each equipment pad.
    a. Place samples in a cylinder of sufficient size to yield three 2-inch cubes as test samples.
    b. Label samples with project name, date, time, the equipment number, and ambient temperature at the time of placement.
    c. Place samples next to the foundation of the equipment being grouted and cure for 48 hours.
    d. Test grout samples in accordance with the grout manufacturer's recommendations.
    e. Grout samples tested by the independent testing laboratory specified in paragraph 1.07 Quality Control by Contractor.
    f. Report test results directly to the Engineer.

C. Completion:
1. Upon acceptance by the Engineer and the equipment manufacturer's representative and after the grout has reached sufficient strength, remove grout forms and block outs at leveling positions. Remove leveling blocks and shims or wedges and support plates. Back off leveling nuts and jack screws to allow the grout to fully support the baseplate, mounting block, or soleplate. Take care not to damage the grout during removal of extended shimming material or leveling equipment and tools.
2. Tighten equipment anchor nuts using calibrated indicating torque wrenches, to develop the full bolt tension specified in paragraph 2.04 Equipment Anchor Tension.
3. Tighten equipment anchor nuts in increments of not more than 25 percent of the final torque value in an alternating pattern to avoid stress concentration on the grout surface. After tightening equipment anchor nuts to final values, apply additional wax, grease, or mastic to all exposed portions of the equipment anchor beneath the baseplate, soleplate, or mounting block.
4. After applying additional wax or mastic to exposed portions of equipment anchors and tightening to final torque values, fill and point block outs (pockets) for access to leveling nuts, leveling blocks, shims, or wedges with the grout material installed under baseplates, soleplates, or fabricated steel frames. Remove jackscrews and fill holes in the baseplate, soleplate, or fabricated steel frame with a flexible sealant (silicone rubber) or a short cap screw.
5. Check for baseplate, soleplate, or fabricated steel frame movement (soft foot) by individually loosening and re-tightening each equipment anchor. Measure and record vertical movement at each equipment anchor during loosening and retightening. Measure vertical movement using a magnetic-based dial indicator on the baseplate, soleplate, or fabricated steel frame referenced to the epoxy grout surface of the

equipment pad, or other approved method. Vertical movement exceeding 25 micrometers (0.001 inch) indicates a soft foot condition. Soft foot conditions are sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or fabricated steel frames.

6. Check for grout voids by tapping along the upper surfaces of the baseplate, soleplate, or mounting block. Mark grout voids. A grout void is sufficient cause for removal and reinstallation of grout and baseplate, soleplate, or fabricated steel frame. At the discretion of the Engineer, grout voids may be repaired as specified in Chapter 5, Section 3.16 of API RP 686.

D. Piping Connections:

1. Anchor piping connecting to flexible connections and/or expansion joints such that the intended function of these connections/joints is maintained in the piping system without imposing strain on the equipment connections.
2. Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, delete any flexible coupling (including equipment connection fittings) shown on the drawings and install the equipment in the following manner, in lieu of installing the flexible coupling:
   a. Install equipment pad as shown in the detail specified in the Equipment Mounting Schedule or in the individual equipment specification.
   b. Install the baseplate, soleplate, or fabricated steel frame supporting the equipment and grouted in place as specified in this Section.
   c. Install and align the equipment in place as specified in Section 43 05 14.
   d. Install and align piping between equipment connections and field piping without welding one of the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints bolted up and pressure-tested.
   e. All piping must be fully supported by supports designed to accept their full weight and thrust forces.
   f. Install the final section of piping. Align the final section of pipe with the equipment and field connections without the use of jacks, chain falls, or other devices to force it into alignment.
   g. Do not weld the final piping joints until after the previous steps have been completed and accepted by the Engineer.



## 3.03 FIELD QUALITY CONTROL

A. Manufacturer's Services

1. Epoxy Grout Training: Prior to commencing rigid equipment mount installation work on equipment pads, furnish the services of a grout manufacturer's technical representative to conduct a training school for the workers who will be using epoxy grout for rigid equipment mount installations. Epoxy grout training school duration to be not less than 4 hours duration and covers all aspects of using the products, including form construction for each equipment installation, surface preparation, mixing, application, void prevention/elimination, and clean up. This requirement does not relieve the Contractor of overall responsibility for this portion of the work. Epoxy grout manufacturer to furnish a list of school attendees who have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

2. Epoxy Grout Quality Control: The epoxy grout manufacturer's technical representative provides quality control services for equipment mounted with epoxy grout. The epoxy grout manufacturer's technical representative must be present (on site) to inspect and verify that the installation personnel have successfully performed surface preparation, epoxy grout application, and Quality Control Inspection in accordance with these specifications for a representative portion of the epoxy grout installation work.
3. Epoxy grout manufacturer's technical representative performs the following services for at least one rigid equipment mount installation for each equipment type and size installed with epoxy grout:
    a. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
    b. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied. Inspect surface for conformance to the specified application criteria, including but not limited to substrate profile, degree of cleanliness, and moisture.
    c. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
    d. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
    e. Inspect preparation and application of epoxy grout form work for conformance to the specifications and manufacturer's recommendations for form edge clearance.
    f. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.
    g. Inspect epoxy grout for cure.
    h. Inspect and record that localized repairs made to grout voids conform to the specification requirements.
    i. Conduct a final review of completed epoxy grout installation for conformance to these specifications.
    j. Attest to conformance of the Contractor's work by signing appropriate entries in the "Rigid Equipment Mount Inspection Checklist," Form 43 05 13-A in Section 01 99 90.

B. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

## 3.04 FINAL INSPECTION

A. The Engineer will conduct a final inspection with the Contractor for conformance to requirements of this Section.

## PART 4 EQUIPMENT MOUNTING SCHEDULE

### 4.01 SCHEDULE

A. Mounts shall conform to the following.

**Equipment Mounting Schedule**

| Equipment Number | Specification Section | Specification Title | Equipment Pad Detail | Mounting Plate Leveling Tolerance (inch/foot) | Equipment Anchor Type | Equipment Anchor Sleeve Length | Grout Type | Application Notes |
|---|---|---|---|---|---|---|---|---|
| Default Config. | *Various* | *Various* | *D01007* | *0.005* | *D01002* | *10D* | *Non-shrink* | *Default equipment mounting configuration for all equipment not otherwise specified in this schedule* |
| Freestanding floor-mounted electrical panels and equipment | *Various* | *Various* | *D01006* | *Not applicable* | *D01004* | *Not required* | *Not required* | |
| SCN-100 | *46 21 73* | *FOG Screening Equipment* | *D01006* | *0.005* | *D01003* | *10D* | *Epoxy* | |
| P-212<br>P-222 | *43 23 80.15* | *Chopper Pump* | *D01006* | *0.005* | *D01003* | *6D* | *Epoxy* | |



**END OF SECTION**

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SECTION 43 05 14

MACHINE ALIGNMENT

## PART 1 GENERAL

### 1.01 SUMMARY

A. This section specifies requirements for alignment of directly coupled mechanical equipment weighing 1000 pounds or more and/or greater than 5 horsepower furnished or modified under this contract.

B. Equipment direct coupled to the motor with drivers 5 horsepower and less and belt or chain driven machinery are specifically exempted from the requirements of this section.

C. Separately mounted equipment connected by offset universal joints are exempted from the offset and angularity requirements, but all units must be installed and leveled as specified in this section and referenced sections.

### 1.02 RELATED SECTIONS

A. Section 43 05 11 – General Requirements for Equipment

B. Section 43 05 13 – Rigid Equpment Mounts

C. Section 43 23 03 – General Requirements for Centrifugal and Axial Flow Pumps

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

| Reference | Title |
|---|---|
| ANSI/ASA S2.75 Part 1 | Shaft Alignment Methodology, Part 1: General Principals, Methods, Practices, and Tolerances |
| ANSI/ASA S2.75 Part 2 | Shaft Alignment Methodology, Part 2: Vocabulary |
| ANSI/ASA S2.75 Part 3 | Shaft Alignment Methodology, Part 3: Alignment of Vertically Oriented Rotating Machinery |
| Shaft Alignment Handbook | Shaft Alignment Handbook, Third edition, John Piotrowski, Marcel Dekker Inc. |

## 1.04 DEFINITIONS

A. Follow definitions as defined in ANSI/ASA S2.75, Parts 1, 2, and 3.

## 1.05 QUALITY ASSURANCE

A. General:
   1. All equipment shall be aligned using laser alignment equipment to the tolerances specified by the subject equipment manufacturer or the criteria specified in this section, whichever is more stringent.

B. Alignment Criteria:
   1. Unless otherwise specified by more stringent manufacturer's requirements or the the detailed equipment specification:
      a. For Horizontal shafts meet the level, flatness, and coplanarity limits in ANSI/HI S2.75, Part 1, Table 1, for equipment bases and soleplates. For vertical shafts meet the plumbness, flatness, and coplanarity limits in ASA-ANSI S2.75, Part 3, Table 1 for equipment bases and soleplates.
      b. Comply with shaft runout tolerances in ANSI/HI S2.75, Part 1 or Part 3, Table 2,
      c. Conduct a test for soft foot prior to aligning machines.
         1) Soft foot (machine frame distortion) shall be not more than 2.0 mils for any speed.
      d. Align all process equipment, including pumps, blowers, turbines, and similar machines to meet the Precision Tolerance Range in Tables 3 and 4 of ANSI/ASA S2.75, Part 1.

C. Qualifications:
   1. All alignment work shall be performed by millwrights trained in the use of the laser alignment equipment by the manufacturer.



## 1.06 SUBMITTALS

A. Provide in accordance with Section 01 33 00:
   1. Action Submittals:
      a. Summary report verifying compliance with the alignment criteria as set forth in paragraph 1.06.B. Include hard copy of all alignment records, signed and dated by the technician performing the work.
      b. Electronic files, including both a summary (pdf) file and files native to the alignment software used for completing the work specified in this section.
   2. Informational Submittals:
      a. Qualifications of the alignment technician.
         1) Millright training
         2) Training certification from the laser alignment equipment manufacturer
      :

## PART 2 PRODUCTS

### 2.01 EQUIPMENT

A. Laser alignment equipment shall be:
   1. Easy-Laser®
   2. PrufTechnik
   3. ACOEM,
   4. or approved equal.

B. Alignment equipment used to perform the work required under this section shall employ laser alignment techniques to achieve the required tolerances. The equipment shall be computer based and its software shall be compatible with current Windows® based spreadsheets and databases. The equipment shall employ a hand-held field computer using a graphic interface to determine actual alignment and necessary corrective action to bring equipment into required tolerance. The link between field measurement components and the computer shall be through cable, infrared, or wireless transmission.

## PART 3 EXECUTION

### 3.01 GENERAL

A. After machine base grouting as specified in Section 43 05 13, align all machines mounted on baseplates or soleplates as specified in this section.

B. Alignment work shall be performed by journeyman millwrights skilled in this type of work under the supervision of a technician trained in the use of the laser alignment by the manufacturer or vendor of the alignment equipment. The use of untrained laborers, carpenters or apprentices for this work will not be acceptable.

C. Submit alignment report for each machine within 2-weeks of completing the alignment.



### 3.02 PROCEDURE

A. Sequence:
   1. Machines supported on integral feet or support pads shall be leveled, grouted and aligned in the following order: driven machine; intermediate bearings or machines; and driver. Under certain circumstances, such as a diesel engine driving a generator, it may be preferable to reverse this order and set the driver first. The Contractor shall submit a written request for a reversal of the alignment order to the Engineer and the Engineer must approve any change in alignment order in writing before it will be allowed.

B. Alignment:
   1. All machines shall be rough aligned without any connections to piping, electrical and instrumentation systems. Upon completion of all field connections, alignment shall be rechecked to demonstrate no change. If change has occurred, the Contractor shall eliminate any external forces affecting machine alignment.
   2. Next, soft foot (machine frame distortion) shall be measured and brought to within the permissible tolerances. Thereafter, the alignment shall be rechecked and the

alignment process repeated if necessary to bring all machinery to final alignment tolerances.

## 3.03 VERIFICATION

A. Factory Personnel:
   1. Where required by other sections in this project manual, factory authorized installation technicians representing the equipment manufacturer shall witness final alignment work. After completion of all alignment work, acceptance of the work shall be documented in writing by factory authorized installation technicians.

**END OF SECTION**

SECTION 43 23 03

GENERAL REQUIREMENTS FOR CENTRIFUGAL AND AXIAL-FLOW PUMPING EQUIPMENT

## PART 1 GENERAL

### 1.01 DESCRIPTION

A. Scope:

1. This section, when referenced in the detailed specification section, provides minimum requirements applicable to centrifugal and axial-flow pumping equipment furnished under this contract. More restrictive requirements and/or specific citation or requirement in conflict with a 43 23 03 provision, where found in individual pump specifications, supersede requirements of this section for each specific instance.
2. "Detailed pump specification," "detailed specification," "individual pump specification," "referencing section," or words of similar import in this section, mean the specification section where the requirements for specific pump performance are presented. "Pumping unit," whenever and wherever used, means the complete pumping assembly, including driver (whether engine, turbine, or motor) and includes accessories such as variable-speed drives required for motor operation, gear reducers, intermediate shafting and bearings, flywheels, and supports for equipment furnished with the pump.

B. Definitions:

1. The following definitions apply for classifying pumps specified in this and referencing sections:
   a. General: Terminology and definitions in this section follow those established in American National Standards Institute (ANSI)/Hydraulic Institute (HI) 9.1 through 9.5, unless otherwise noted.
   b. Solids-bearing liquids: Liquids to be pumped containing, or assumed to contain, solids that require appropriate pump design considerations and/or materials of construction. Solids-bearing liquids are liquids with settleable solids exceeding 50 milligrams per liter (mg/L) and include wastewater, stormwater, primary effluent, return sludge, return activated sludge (RAS), trickling filter circulation, and similar services.
   c. Clear liquids: Liquids to be pumped mostly free of deleterious solids. Potable water, heat reservoir, raw water, secondary effluent pumping, and similar services are clear liquids.
   d. Efficiency: For the purposes of this section and sections referencing this section, efficiency, as related to pumps, is the ratio of the pump output power (water horsepower [hp]) divided by the pump input power (brake horsepower) required to deliver the total head, with meanings as defined in ANSI/HI 14.2.6.6. For column-type pumps, efficiency is computed inclusive of inlet, bowl, column, and discharge head losses.
   e. Net positive suction head, 3 percent reduction (NPSH3): For the purposes of this section and sections referencing this section, NPSH3 means the value of net positive suction head (NPSH) resulting in a reduction of 3 percent in the developed pump discharge head when the pump is tested in accordance with procedures established by ANSI/HI. NPSH3 is the successor designation to net

positive suction head required (NPSHR). Where NPSHR is used in the contract documents it means NPSH3.

f. NPSH margin: For the purposes of this section and sections referencing this section, "NPSH margin," wherever used, means net positive suction head available (NPSHA) divided by the candidate pump's NPSH3 for the specific operating condition in question.

g. POR: preferred operating region as defined in ANSI/HI 9.6.3.

h. AOR: allowable operating region as defined in ANSI/HI 9.6.3.

## 1.02 TYPE

A. Provisions and requirements contained in this section apply specifically to centrifugal and axial-flow pumps, both vertical and horizontal, commonly falling into the generic types covered by ANSI/HI 14.1 through 14.3. This section does not apply, except by specific reference, to positive-displacement pumps of any type.

## 1.03 REFERENCES

A. This section (Section 43 23 03) contains references to the following documents. They are a part of this section and any referencing section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. The following order of precedence prevails in the event of conflict between the requirements of this section or any referencing section and those of the listed documents (in the order of primacy):

1. The referencing section
2. This section
3. The referenced document

B. Unless otherwise specified, references to documents mean the documents in effect at the time of advertisement for bids or invitation to bid (or on the effective date of the agreement if there were no bids). References to documents mean the replacement documents issued or otherwise identified by the organization if referenced documents have been discontinued, or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.



| Reference | Title |
|---|---|
| ABMA 9 | Load Ratings and Fatigue Life for Ball Bearings |
| ABMA 11 | Load Ratings and Fatigue Life for Roller Bearings |
| AISC | American Institute of Steel Construction—Manual of Practice |
| ANSI/API 610 | Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries (also referenced as ISO 13709-2009) |
| ANSI/ASME B46.1 | Surface Texture, Surface Roughness, Waviness and Lay |
| ANSI/HI 9.1–9.5 | Pumps – General Guidelines for Types, Applications, Definitions, Sound Measurements and Documentation |
| ANSI/HI 9.6.1 | Rotodynamic Pumps—Guideline for NPSH Margin |
| ANSI/HI 9.6.2 | Centrifugal and Vertical Pumps for Allowable Nozzle Loads |

| Reference | Title |
|---|---|
| ANSI/HI 9.6.3 | Rotodynamic Pumps (Centrifugal and Vertical) Guideline for Allowable Operating Region |
| ANSI/HI 9.6.4 | Rotodynamic Pumps—Vibration Measurements and Allowable Values |
| ANSI/HI 9.6.6 | Rotodynamic Pumps for Pump Piping |
| ANSI/HI 9.6.8 | Rotodynamic Pumps—Guideline for Dynamics of Pumping Machinery |
| ANSI/HI 9.8 | Pump Intake Design |
| ANSI/HI 11.6 | Submersible Pump Tests |
| ANSI/HI 14.1-14.2 | Rotodynamic Pumps for Nomenclature and Definitions |
| ANSI/HI 14.3 | Rotodynamic Pumps for Design and Application |
| ANSI/HI 14.4 | Rotodynamic Pumps for Installation, Operation, and Maintenance |
| ANSI/HI 14.6 | Rotodynamic Pumps for Hydraulic Performance Acceptance Tests |
| API 686/PIP REIE 686 | Recommended Practices for Machinery Installation and Installation Design |
| ASME B18.8.2 | Taper Pins, Dowel Pins, Straight Pins, Grooved Pins, and Spring Pins (Inch Series) |
| ASME Code | ASME Boiler and Pressure Vessel Code |
| ASTM A27 | Steel Castings, Carbon, for General Application |
| ASTM A36 | Carbon Structural Steel |
| ASTM A148 | Steel Castings, High Strength, for Structural Purposes |
| ASTM A322 | Steel Bars, Alloy, Standard Grades |
| ASTM A564 | Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes |
| ASTM A571 | Austenitic Ductile Iron Castings for Pressure-Containing Parts Suitable for Low-Temperature Service |
| ASTM A995 | Standard Specification for Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts, Grades 2A, 3A, or 6A |
| ASTM B148 | Aluminum-Bronze Sand Castings |
| AWWA C213 | Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines |
| AWWA C550 | Protective Epoxy Coatings for Valves and Hydrants |
| NSF/ANSI 61 | Drinking Water System Components – Health Effects |
| IEC 61298-2 | Process Measurement and Control Devices. General Methods and Procedures for Evaluating Performance Tests Under Reference Conditions |
| ISO 1940-1:2003 | Mechanical Vibration—Balance quality requirements for rotors in a constant (rigid) state—Part 1: Specification and verification of balance tolerances |
| ISO 9001 | Quality Management Systems—Requirements, 3rd Edition (2000) |
| ISO 10816-1 | Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 1: General Guidelines, Annex B, Table B.1. Class I, II or II, as applicable. For the purposes of this specification, Annex B of ISO 10816, Part 1 forms a part of this specification and ISO 10816, Part 1. |
| ISO 10816-3 | Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15000 r/min when measured in situ, Annex A, Table A.1 and A.2. For the purposes of this specification, Annex A of ISO 10816, Part 3 forms a part of this specification and ISO 10816, Part 3. |
| ISO 10816-6 | Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 6: Reciprocating machines with power ratings above 100 kW, Annex A, Table A.1, machine vibration classification number 3. For the purposes of this specification, Annex A of ISO 10816, Part 6 forms a part of this specification and ISO 10816, Part 6. |
| ISO 10816-7 | Mechanical Vibration—Evaluation of Machine Vibration by Measurement on Non-rotating Parts—Part 7: Rotordynamic Pumps for Industrial Applications, Including Measurements on Rotating Shafts, Annex A, Tables A-1 and A-2 Category II as applicable. For the purposes of this specification, Annex A of ISO 10816, Part 7 forms a part of this specification and ISO 10816, Part 7. |

## 1.04 DESIGN REQUIREMENTS, ALL PUMPS:

A. General:

1. Equipment furnished under sections referencing this section shall meet the longevity objective that the pumping equipment, motor, shafting, couplings and appurtenances are designed for at least a 20-year service life and 3 years of "uninterrupted operation." Select all components associated with the rotating elements in the drive train, including equipment supports and supports for rotating elements, that are designed to function without damage or disassembly at reverse rotational speeds up to 130 percent of maximum operational speed during flow reversals through the pump. The complete pumping unit shall operate without overload on any component at any point along the pump's entire full-speed operating curve. Furnish pumps required by virtue of the specified operating conditions to operate against a closed valve or throttled for any period of time exceeding 5 seconds with drivers sized to operate continuously at the power requirement for that condition even though the power requirements at the rated condition may be less.
2. Pump selections proposing maximum diameter impellers for the proposed pump model and casing size will not be accepted.
3. With the exception of submersible pumps and the inlet connection for pumps designed to operate in open forebays or wetwells, pump connection nozzles shall be designed for the loads and moments stipulated in ANSI/HI 9.6.2. Where ANSI/HI 9.6.2 does not cover a specific pump type or category, or where that document is silent on allowable nozzle loads for a particular type of nozzle load (e.g., thermal pipe strain), the contractor shall furnish documentation from the manufacturer attesting to the limitations on loads and moment forces that can be tolerated on each connection and recommended connection details to be used.

B. Pump Selection:

1. Proven designs:
   a. Pumps furnished under sections referencing this section shall be proven designs that have been in similar conditions of service with no objectionable performance characteristics for a period of not less than 5 years. The contractor shall furnish a detailed list of installations with contact information supporting qualification under this requirement with the information required under paragraph 1.08. To satisfy this requirement, the listed pump shall be of the same size volute or bowl, discharge case and nozzle size, and impeller design (including number of vanes) and is operating under similar conditions of pumped fluid, head, capacity, speed, rotation, and NPSHA.
   b. The contractor may propose alternative equipment that cannot meet the requirement for a proven design under this paragraph, subject to additional documentation requirements and under the following conditions:
      1) The proposed design has been in successful operation under similar conditions of volute or bowl, discharge case and nozzle size, impeller design (including number of vanes), pumped fluid, head, capacity, rotation, and NPSHA, but at a higher speed for a period of not less than 3 years.
      2) The proposed design has been in operation in designs where both larger and smaller nozzle size pumps have been in service for a period of not less than 5 years, and impeller design (including number of vanes, plus or minus one

vane in pumps with four or more vanes), pumped fluid, head, capacity, speed, and NPSHA are similar to that for the proposed installation and within one synchronous speed higher or lower than that indicated in the detailed specification.

3) In addition to the installation list required under this paragraph, provide dimensional drawings, bill of materials, and historical (certified) shop test results for candidate pumps documenting performance including, but not limited to head, capacity, speed, and NPSHR, and limit of stable hydraulic operation based on the onset of suction recirculation, if available. Results should match or bracket the specified performance and two or more candidate pump results may be required.

c. If the proposed pump is not a proven design under either of the above paragraphs, the contractor shall demonstrate, by operation of a test pump in a fully equipped hydraulic test facility, that the proposed pump in the size and at the speed proposed with the proposed impeller design will have acceptable operating characteristics under the conditions specified for the proposed installation. Set up the test pump and perform a witnessed demonstration prior to designing, fabrication, and testing of any of the equipment proposed for the specific installation.

2. General performance criteria:

a. Pumps furnished under this section and any referencing section shall operate without loss of head due to cavitation or vibration over the entire specified range of flow and head conditions and are specifically selected for NPSH margin requirements detailed in paragraph 1.04 NPSH margin limitations. Pump selections that do not provide the specified margin will be rejected.

3. General design criteria:

a. Select pumps furnished under sections referencing this section that are designed in accordance with applicable portions of ANSI/HI 9.6.2, 9.6.3, 9.6.4, 9.6.6, 9.6.8 and 14.1-14.3 and the requirements of this section. Select pumps that are specifically designed to pump the fluid described in the detailed specification and to operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified. Clogging or fouling conditions may be of any cause, demonstrated by a 5 percent or greater capacity drift within 2 hours of sustained operation.

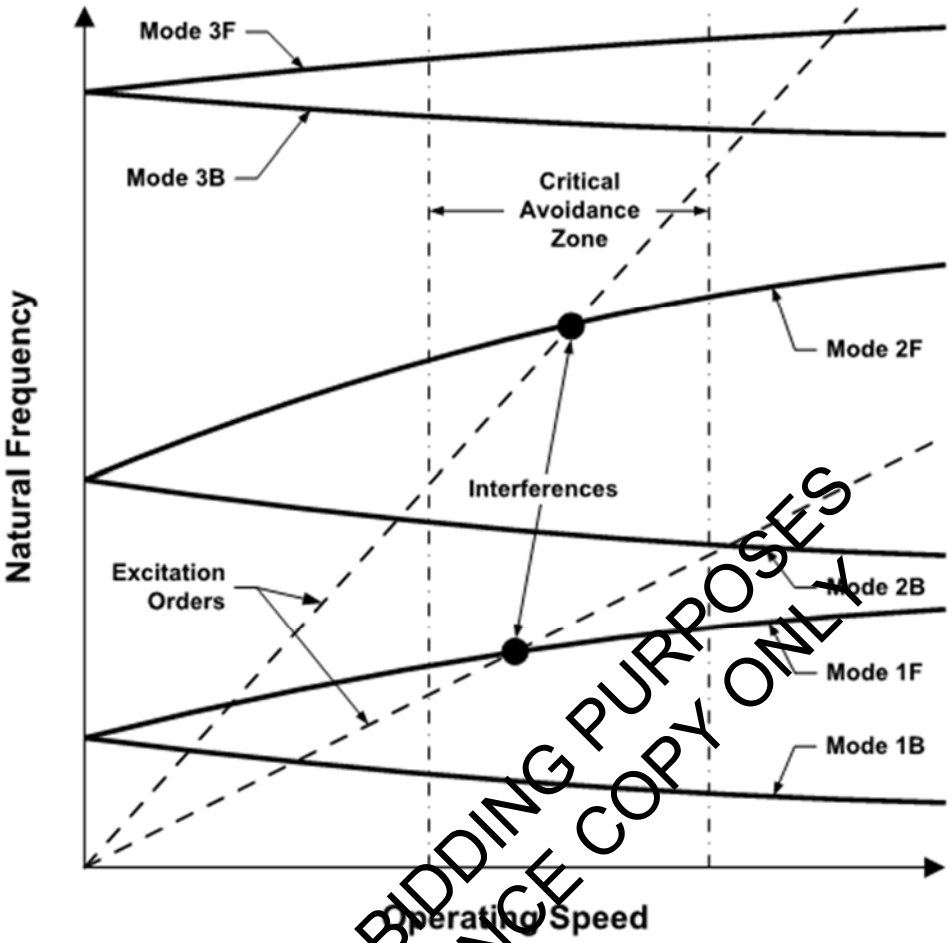
b. Unless otherwise noted or specified, slope pump head capacity curves in one continuous curve within the specified operating conditions. Do not permit points of reverse slope inflection capable of causing unstable operation within the specified zone of continuous-duty operation. Pumps with head/capacity curves with a reverse inflection are specifically prohibited if these characteristics will cause unstable operation within the specified range of operating conditions and where startup/shutdown conditions entail operation against a slow opening/closing valve.

c. Pumps specified to operate at variable-speed shall function without loss of head or capacity due to cavitation or excessive vibration over the entire specified range of flow and head conditions defined by the region bounded by the continuous-duty operating condition specified in the detailed specification referencing this section. Unless otherwise specified in the section referencing this section, acceptance criteria shall include the following:

1) Unless otherwise noted in the detailed specification referencing this section, Operating Condition Points A and B may reside in the AOR outside the POR;

4. POR:
   a. Unless otherwise specified, the POR for a given pump is as defined in ANSI/HI 9.6.3.
   b. The detailed specifications may stipulate a narrower POR than indicated in ANSI/HI 9.6.3.
   c. The suction-specific speed (S) shall not exceed 8,500, unless otherwise indicated in the detailed specifications.
   d. For high- S pumps (greater than 8,500) and other conditions as determined by the engineer, a narrower stable operating region may be defined in the detailed specifications and then identified in ANSI/HI 9.6.3 for the POR. The detailed specifications take precedence over this section.
   e. The detailed specification sections identify the duty points that must be within a pump's POR and those that may be within the AOR and take precedence over this section.

C. Critical Speeds and Natural Frequencies:
   1. General:
      a. The criteria of this paragraph applies to pumps, provided that the foundation and support details provided at the time of pump design are accurate. Repair or replace pumps exhibiting adverse behavior after installation from resonance, vibration, or fatigue at no cost to the owner. The criteria apply to the equipment in "like-new" condition as well as the "as-worn" condition (i.e., when parts, individually and as a composite, reach the manufacturers' maximum tolerances).
   2. NOT USED.
   3. Lateral rotor and structural dynamics:
      a. The complete pumping unit, composed of the entire rotating group and related frames, supports, enclosures, housings, and casings, shall be free from critical speeds from 15 percent below to 25 percent above the operating speeds required to achieve the specified performance characteristics (critical avoidance zone). A critical speed is defined as any damped natural frequency with a logarithmic decrement less than +0.3 that has an interference with a primary excitation order in the critical avoidance zone. Analyze backward rotation for rubber-bearing vertical-column pumps. The critical avoidance zone, interferences, and possible critical speeds can be illustrated on a natural frequency map as presented in the figure below. In the figure, three natural frequencies are shown with forward and backward modes. Only two of those modes, 1F and 2F, have interferences with primary excitation orders. Whether these are critical speeds is determined by the value of log decrement at the intersection. Note that higher order modes, such as 2F, have the same log decrement criterion as the first mode.






b. Process sensitivities are such that operation at infinitely variable speed within the specified operational conditions is an absolute requirement. Any remedy imposing a locked-out speed interval or intervals will not be considered an acceptable remedy for identified critical speeds. Acceptable remedies include combinations of adjustments in rotor geometry or materials, and the substitution of energy-absorbing couplings. Other remedies may be considered so long as they are justified in writing and the proposal is sealed and signed by the design professional retained by the manufacturer to perform the system mass elastic system analyses.

4. Torsional rotordynamics and combined shaft stress:
   a. The complete rotating group shall be free from critical speeds from 10 percent below to 20 percent above the operating speeds required to achieve the specified performance characteristics (critical avoidance zone). A critical speed is defined as any damped natural frequency with a logarithmic decrement less than plus 0.3 that has an interference with a primary excitation order in the critical avoidance zone.
   b. If efforts to remove torsional critical speeds are unsuccessful, perform a combined shaft stress analysis to demonstrate that the response does not adversely affect the entire rotating group fatigue life. The combined shaft stress analysis shall consider any speed in the critical avoidance zone and during

startup, shutdown, or motor control transients if synchronous motors are specified.

c. For constant-torque applications, the pump-rotating group shall be free from torsional response that produces combined (steady plus alternating torque induced) stresses exceeding 50 percent of the material's fatigue limit or 30 percent of the material's elastic limit (but no more than 18 percent of the material's ultimate tensile strength) if relevant fatigue data for the selected material are not available.

d. For variable-torque applications (including variable-speed pumps, vertical pumps, and pumps with large overhung loads) the pump rotating group shall be free from torsional response that produces combined (torsional steady and alternating) peak shear stresses at points of stress concentration (calculated in accordance with the requirements of paragraph 1.04E.3 Torsional Shaft Stresses) that exceed 50 percent of the material's fatigue limit or 4 percent of the material's ultimate tensile strength, based upon ASME or other recognized standard, if relevant fatigue data for the selected material are not available.

e. Document the source of fatigue data used in lieu of elastic or ultimate strength ratios in the analysis report submittal.

D. Impeller clearances, vane-passing frequency, and impeller keyways:

1. The radial clearance between the tip of the impeller vane and diffuser or volute vanes shall be not less than 3 percent and 6 percent, respectively, of impeller diameter. Select a pump that is designed so that internal geometry does not cause uneven flow distribution at impeller vane inlets.

2. Impeller vane combinations shall not be an even multiple of diffuser vanes in column-type pumps.

3. Cut impeller keyways for multistage column-type pumps at differing positions and provide equal angular spacing on the impeller shaft to avoid multiple simultaneous vane-passing pulses.

E. Component design criteria:

1. General:

a. Unless otherwise specified, ensure that combined stresses in steel frames and supports does not exceed those permitted by the American Institute of Steel Construction (AISC) Manual of Practice. Combined stresses in cast, forged, rolled, or fabricated pressure-retaining components, frames, and supports shall not exceed that allowed for the given material in Section VIII, Division 1 of the American Society of Mechanical Engineers (ASME) Code. Design pressures for pressure-retaining parts shall be not less than 50 percent greater than the pump's shutoff head at the manufacturer's listed maximum operating speed. The pump casing strain at any head on the full-speed operating curve (including allowances for increases caused by specified multistage applications) shall not result in distortions at the bearing housings greater than the maximum allowable by the bearing manufacturer to provide the specified bearing life.

b. The term "combined stresses" in this section means the sum of operating stresses, including stresses induced by dynamic and static forces as developed via the analysis procedures stipulated in this section. Static forces (x, y, z, and moments in planes) include the relevant maximum nozzle loads specified in ANSI/HI 9.6.2 or as stipulated by the pump manufacturer. Dynamic forces

include both steady-state and transient stresses induced by operating conditions within the zone of operation established by the specified operating conditions.

2. Anchorage and equipment mounts:
   a. The contractor shall hold the pump manufacturer responsible for the design of the anchor-bolting system and equipment supports for each separately mounted component furnished under the detailed specification. Conform anchorage and equipment support requirements for pumps to the requirements of Section 43 05 13.
   b. Select anchor bolts and connecting bolts for pumps and assemblies supported by other assemblies furnished under this section, or sections referencing this section, that are designed in accordance with Section 01 73 24. All operation and maintenance (O&M) manuals for pumps and assemblies shall contain criteria for anchor and baseplate bolt torque values.
   c. Equipment mounts for vertical (column- and volute-type) pumps weighing more than 1,000 pounds, with discharge nozzles 6 inches in diameter and greater, shall employ soleplates conforming to the requirements of Section 43 05 13. Provide soleplate mounting conforming to Section 43 05 13 for separately supported components in the pump drive system. Fabricated steel supports regardless of design, and the nature of the structural shapes used for such proposed supports, will not be accepted.
   d. Soleplates shall be designed to span openings for equipment connections and provide access to maintenance points. Soleplates shall be of sufficient section to key, not less than 1 inch, into the supporting grout provided for bonding the soleplate to the structure. Provide soleplates of sufficient size to bolt the pump base to the soleplate without encumbering the anchor bolts required for clamping the soleplate to the structure.
   e. Equipment mounts for horizontal pumps shall be designed in accordance with Section 43 05 13 and ANSI/HI 14.3, and shall provide common support for the pump and motor (and flywheel, if one is specified). Conform baseplate bolting to assumptions contained in ANSI/HI 9.6.2.
3. Torsional shaft stresses:
   a. Calculate shaft stresses using the following equation and the stress concentration factors in the tables below:

$$S = S_{cf} \times \frac{G \times D \times \Delta_{\Theta}}{2 \times L}$$

where:

S = stress, pounds per square inch (psi)

$S_{cf}$ = stress concentration factor, dimensionless

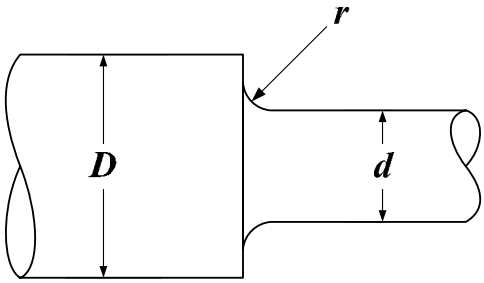
D = minimum shaft diameter at point of concentration, inches

$\Delta_{\Theta}$ = twist in shaft between adjacent masses, radians

L = effective length between masses, inches

G = shear modulus of shaft material, psi

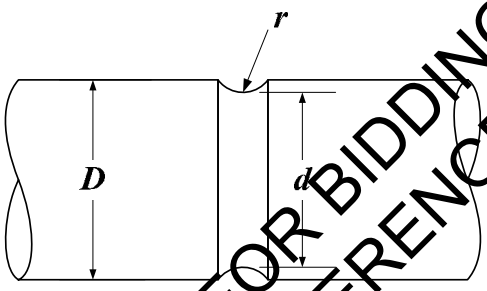
   b. $S_{cf}$ shall be applied at changes in shaft diameter is as follows:




| Shaft diameter ratio D/d = 1.05 | |
|---|---|
| r/d | $S_{cf}$ [a] |
| 0.0025 | 2.67 |
| 0.0100 | 1.84 |
| 0.0200 | 1.58 |
| 0.0300 | 1.47 |
| 0.0400 | 1.39 |
| 0.0500 | 1.34 |
| 0.1000 and greater | 1.22 |

| Shaft diameter ratio D/d = 1.50 | |
|---|---|
| r/d | $S_{cf}$ [a] |
| 0.0025 | 4.05 |
| 0.0100 | 2.54 |
| 0.0200 | 2.07 |
| 0.0300 | 1.85 |
| 0.0400 | 1.72 |
| 0.0500 | 1.62 |
| 0.1000 and greater | 1.40 |

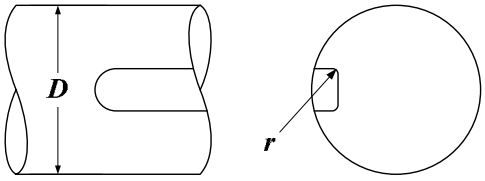
c. Ensure that the $S_{cf}$ to be applied at circumferential shaft grooves is as follows:




| Shaft diameter ratio D/d = 1.05 | |
|---|---|
| r/d | $S_{cf}$ [a] |
| 0.0025 | 3.73 |
| 0.0100 | 2.34 |
| 0.0200 | 1.92 |
| 0.0300 | 1.74 |
| 0.0400 | 1.64 |
| 0.0500 | 1.57 |
| 0.1000 and greater | 1.39 |

| Shaft diameter ratio D/d = 1.30 | |
|---|---|
| r/d | $S_{cf}$ [a] |
| 0.0025 | 5.04 |
| 0.0100 | 2.82 |
| 0.0200 | 2.24 |
| 0.0300 | 1.99 |
| 0.0400 | 1.84 |
| 0.0500 | 1.73 |
| 0.1000 and greater | 1.49 |

d. Ensure that the $S_{cf}$ to be applied at the roots of keyways is as follows:



| r/D | $S_{cf}$ * |
|---|---|
| 0.0025 | 4.35 |
| 0.0100 | 3.20 |
| 0.0200 | 2.64 |
| 0.0300 | 2.43 |
| 0.0400 | 2.32 |
| 0.05 00 | 2.25 |
| 0.1000 and greater | 2.12 |

** Base values of $S_{cf}$ between data points in the tables above upon a straight-line interpolation.*

4. Shaft deflection:
   a. Select pump shafts installed on volute-type pumps to provide sufficient stiffness to operate without distortion or damaging vibration throughout the range of service specified. Limit shaft deflection at the face (impeller side) of the shaft seal to no more than 2 mils at any operating condition within the zone described by the specified continuous-duty operating conditions. Calculate deflection at the shaft seal as required by provisions set forth in ANSI/HI 14.3.
5. Bearings:
   a. Unless otherwise specified, select anti-friction bearings for pumps for a minimum L–10 life of 50,000 hours in accordance with ABMA 9 or 11. Ensure that anti-friction bearings for custom-engineered pumps have bearings selected for an L-10 life of 100,000 hours in accordance with ABMA 9 or 11. Select bearings for other elements in the rotating system such as motors, intermediate shaft bearings, and flywheel bearings using the same criteria as specified for the pump. Base bearing selection upon the worst combination of continuous-duty operating conditions specified and include both steady-state and transient loads. Provide calculations supporting the selection of bearing sizes as and informational submittal.
6. Bearing isolators:
   a. Unless otherwise specified, fit pump and motor bearings with bearing isolators, specifically selected for the size and type of bearing. Provide bearing isolators that are the labyrinth, non-fretting type designed to expel contaminants by centrifugal force and prevent the escape of lubricants. Provide vapor-block capability. Bearing seals shall be Inpro/Seal, or an approved equal.
7. Pump shaft seals:
   a. Unless otherwise specified in the detailed specification, pump shaft seals must be mechanical seals as specified in Section 43 05 11.

F. NPSH margin limitations:
   1. General:
      a. Pumps furnished under this section and sections referencing this section shall be selected for NPSH margin limitations using the criteria set forth in this section. Base NPSH3 characteristics for the candidate pump upon documented test data not more than 5 years old. Perform testing on a pump not more than two nominal pump diameters larger or smaller than the proposed pump with an impeller of the same geometry as that proposed for the pump to be used for the subject application, and operating at either the same speed as the pump for the proposed application or a speed that provides plus or minus 10 percent of the

impeller inlet velocity if reduced-speed testing is used. For very large pumps that cannot be accommodated in the manufacturer's test pit, the use of a model pump, sized in accordance with ANSI/HI 14.6, Appendix K, is acceptable. The contractor shall document the basis for pump selection based upon NPSH margin limitations as set forth in this paragraph.

b. The detailed specification sections provide NPSHA information for anticipated operating conditions for each application. This information is generally referenced to a specific elevation, stated in terms of project datum. The contractor is responsible for requiring the pump manufacturer to adjust the NPSHA information in the specification section to the elevation of the pump impeller eye for the specific pump model and size proposed for the application. NPSH3, as used in the following paragraphs, means the NPSH3 at the impeller eye, determined in accordance with ANSI/HI 11.6 or 14.6, as applicable for the proposed pump. The contractor shall require the pump manufacturer to document the method used to determine NPSH3 for the proposed pump and justifying compliance with the NPSH margin limitations established under this paragraph for each specified operating condition in material submitted under paragraph 1.08. Include in the documentation justification of the NPSH3 tests used to develop NPSH3 characteristics, including the following:

   1) Date, test procedure, and test logs of original NPSH3 information used to project requirements for the pump selected for the application
   2) Test pump size, impeller diameter, impeller model, eye diameter, and speed
   3) Calculations projecting NPSH3 test information to NPSH3 curve information for the pump proposed for the application
   4) Calculations demonstrating compliance with the NPSH margin requirements established in this paragraph

c. The contractor shall submit the manufacturer's margin calculations justifying the proposed pump selection with the material required under paragraph 1.08. The NPSH margin ratios specified in this paragraph are the minimum acceptable margin ratios. If the proposed pump requires greater margin ratios to operate within the specified operating conditions without loss of head due to cavitation, then it is the responsibility of the contractor to bear costs associated with achieving the required margin ratio by lowering the elevation of the pump setting, lowering the elevation of the structure, or through other means. Subject any such adjustments to review and acceptance by the construction manager if necessary.

d. Individual restrictions are applicable to NPSH margin depending upon the type of pumping equipment and the fluid to be pumped as set forth in ANSI/HI 9.6.1, Table 9.6.1.5.5. Under no circumstances may the absolute value of the NPSH3 margin be less than 3.5 feet.

G. Electric Motors:

1. General:

   a. Pumps shall be electric-motor driven unless otherwise specified. Select all motors to be non-overloading at any operating point along the pump's full-speed operating curve, including points located beyond specified operating conditions. Motors shall be capable of carrying the axial/radial load applied to the motor shaft with motor bearing life equivalent to the pump bearing life.

   b. All vertical motors shall be solid-shaft construction. Hollow-shaft motors will not be accepted.

c. Motors furnished with pumps specified for operation at variable-speed shall be inverter-duty types conforming to the requirements of Section 43 05 21 and shall be compatible with the variable-speed equipment furnished with the pump.

d. Protect motor bearings with bearing isolators as specified in paragraph 1.04.

2. NOT USED.

3. Balance:

a. Motors rated 50 hp or greater and motors driving custom-engineered pumps shall be precision-balanced, conforming to a balance grade of G2.5 per International Organization for Standardization (ISO) 1940-1.

b. The contractor shall provide certified balance logs attesting to achieving these requirements and submitted as required by paragraph 1.08. The chief engineer or person in charge of the test facility shall sign the balance logs.

## 1.05 NOT USED.

## 1.06 QUALITY ASSURANCE: ALL PUMPS

A. Quality Certification:

1. All manufacturers and manufacturing sites proposed by the contractor for supply of equipment furnished under this section and sections referencing this section shall hold current certification under ISO 9001. Application for certification under ISO 9001 is not deemed as an acceptable substitute for current certification. Provide documentation of the manufacturer's ISO 9001 certification and the manufacturer's written quality assurance/quality control (QA/QC) program.

B. Unit Responsibility:

1. The contractor shall assign unit responsibility to the pump manufacturer in conformance with the requirements of Section 43 05 11.

C. Performance Confirmation:

1. Hydrostatic tests:

a. Subject all pressure-sustaining parts to factory hydrostatic tests. Unless otherwise specified, conform hydrostatic tests to the requirements of ANSI/HI 11.6 for submersible pumps and ANSI/HI 14.6 for dry pit pumps. Unless otherwise indicated in the detailed specifications, hold castings at the test pressure for the duration indicated in ANSI/HI 11.6 and 14.6. For process pumps designed in accordance with ANSI/API 610, hydrostatic testing must comply with the requirements of paragraph 8.3.2 of ANSI/ ANSI/API 610. Test results shall be certified correct by the chief engineer or individual in responsible charge of the manufacturing facility.

2. Performance guarantee:

a. Unless specified otherwise in the detailed specification, pump performance (flow and head, efficiency, and NPSH3) shall be guaranteed by the pump manufacturer to the criteria specified under this paragraph.

b. Equipment performance documentation, including test data, where tests are specified, shall include sufficient test points (not less than eight) to document hydraulic performance along the complete head/capacity curve from shutoff to maximum capacity, and covers full-speed operating points specified in the detailed specification section referencing this section. Tests conducted at

specified operating conditions shall be with the inlet throttled to produce the NPSHA indicated for that specific condition in the detailed specification. Perform NPSH3 tests for not less than four full-speed operating conditions, but not less than specified operating conditions and at the best efficiency point (BEPQ).

c. Test procedures shall be as set forth in ANSI/HI 14.6, and as specifically detailed in these specifications. However, any increase in flow or head permitted under specified acceptance grade[s] cannot result in overload (nameplate basis, S. F. = 1.0) of the specified motor power rating at any location on the pump's head/capacity curve. Conduct performance tests at the specified maximum speed. Affinity relationship-predicted test results will not be accepted. For column-type pumps, include in the performance documentation curves showing both bowl efficiency and overall efficiency (including inlet, bowl, column, and discharge head losses) at maximum operating speed for the application.

d. The acceptance criteria for head and capacity test results shall be based upon the rated condition specified in the detailed specification and as required in ANSI/HI 11.6 and 14.6 for acceptance Grade 1U, with the above-stated limitation with respect to motor power overload.

e. Where there are none stipulated, the acceptance criteria for head and capacity test results for the other specified duty conditions in the detailed specification shall be as required in ANSI/HI 11.6 and 14.6 for acceptance grade 3B, with the above-stated limitation with respect to motor power overload.

f. The acceptance criteria for NPSH3 at any specified operating condition shall be the values proposed by the contractor in the curves submitted under paragraph 1.08, and duly accepted by the construction manager, with a tolerance of plus 0, minus unlimited, with the exception that S, as calculated for the specific pump, does not exceed the limitation established under paragraph 1.04B. If the NPSH3 data result in an increase in S, the manufacturer shall confirm that the stable operating region for the pump corresponds to the POR as defined in ANSI/HI 9.6.3, and that the operating conditions specified to be within the POR are within the stable operating region for the pump. In addition, the manufacturer shall identify the onset of suction recirculation and confirm that the onset of suction recirculation is outside of the specified operating range.

g. Include in the guarantee a statement to the effect that the pump will operate within the operating regions specified in the detailed specification. The guarantee shall be in writing and signed by the chief engineer or individual in responsible charge of the test facility. Under no circumstances should deviations from specified operating conditions result in overload of the driver furnished with the equipment, nor should such deviations result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

3. Non-witnessed tests:

a. Unless specified otherwise, performance-test pumps in accordance with ANSI/HI 14.6, with the above restrictions on motor power overload. Include in the factory tests test data for each full-speed performance requirement and any other points stipulated for this test procedure in the detailed specification. Conduct these tests with the pump inlet throttled to provide the specified NPSHA. For large-column pumps, model performance testing with reduced NPSHA, pursuant to paragraph **Error! Reference source not found.**, may be used. If specified in the detailed specification, include shaft vibration and case noise in the test data at the full-speed operating conditions.

b. Duplicate the test setup in the manufacturer's test facility as closely as possible to the inlet conditions in the proposed installation, using temporary baffles and other means, within the limitations of the test facility. Where centrifugal pumps are furnished with inlet elbows, inlet adapters or inlet reducers as a part of the manufacturer's scope of supply, test the pumps with the elbow, adapter, or reducer fitted to the pump and apply specified performance criteria to the complete pump assembly, including losses through any elbow, adapter, or reducer. Where submersible pumps are to be furnished with inlet nozzles and/or discharge elbows or adapters, test the pumps with these components fitted to the pumps. Apply the specified performance requirements to the complete pumping assembly including any inlet nozzles, and discharge elbows or adapters. Include in the certified test data separate readings for inlet and discharge head for each data point.

c. Take not less than eight test points, including not less than three within plus or minus 8 percent (in terms of rated flow) of the rated condition (Condition Point A) and not less than two test points within plus or minus 4 percent of the pump's BEP at the test speed. In addition, one test point is sufficient to define head and power requirements at shutoff head.

d. Perform NPSH3 tests in accordance with ANSI/HI 14.6, paragraph 14.6.5.8.2.1, Type 1 Test except that not less than four tests should be performed at the test motor speed to completely cover the range of operating conditions specified in the detailed specification. One of the test points shall be at the BEP flow to confirm the test pump's S. The translation of test results to specified operating conditions shall be in accordance with ANSI/HI 14.6, paragraph 14.6.6.1.1 so long as the exponent used can be supported by certified test data performed on a pump of the same type, size, speed, and specific speed as that of the proposed pump. Include NPSH3 tests at both the proposed and test speeds in test data justifying the exponent, test points at BEP, and at least three other points on the test pump head/capacity curve at least 15 percentage points removed from the BEP. Use the results of the NPSH3 tests to confirm the NPSH margins for each specified operating condition as specified in paragraph 1.04F. Perform NPSH3 tests for column type (axial, mixed-flow, and vertical-turbine) pumps using the open sump/water level or closed tank/tank pressure methods described in ANSI/HI 14.6, Table 14.6.5.8.2.1. Perform NPSH3 tests for submersible wastewater pumps using the method described in Figure 11.6.8 in ANSI/HI 11.6. Extend all NPSH3 tests from 50 percent to 140 percent of best efficiency flow at full speed, or to not less than 10 percent (in terms of flow) past the flow at Operating Condition B, whichever is greater. For a given pump, if the manufacturer can provide documentation that the upper flow limit of the AOR on the right side of the pump curve is less than 140 percent of best efficiency flow, the AOR may be used as the limit for the NPSH3 test. Cause for rejection is failure to achieve specified performance or performance proposed in accepted submittal documents (capacity and head, efficiency, or NPSH3), whichever is more restrictive. Acceptance tolerances are as set forth in paragraph 1.06C.2 Performance Confirmation; Performance guarantee.

e. All test procedures shall be in strict conformance with the referenced standards. However, prediction of performance of a trimmed impeller from test data of the larger impeller will not be permitted. If trimming is required, re-test the pump. Do not allow deviations from specified operating conditions, though allowed by the referenced standards, to result in overload of the driver furnished with the

equipment, nor allow such deviations to result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

f. The contractor shall furnish the construction manager with not less than 2 weeks' advance written notice of the date and place of the non-witnessed tests.

g. All test results, including test logs and generated curves, shall be certified correct by the chief engineer or individual in responsible charge of the manufacturer's test facility, and shall be submitted in accordance with paragraph 1.08.

## 1.07 NOT USED

## 1.08 SUBMITTALS

A. Action Submittals:

1. Procedures: Section 01 33 00.
2. In addition to the material listed in the detailed specification, provide the following submittals:
   a. Documentation of successful pump designs or proposed alternatives as specified under paragraph 1.04B.1 Pump Selection. If included as part of the design, include in the documentation applications where pump cans of a similar size have been provided as part of the design.
   b. A Certificate of Unit Responsibility attesting that the contractor has assigned unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02 Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
   c. A copy of this specification section and the specification sections listed for submittal in the detailed specification sections. Ensure that the specification copies are complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the contractor, underline each deviation and denote by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the contractor with the specifications. Accompany the submittal with a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal is sufficient cause for rejection of the entire submittal with no further consideration.
   d. A copy of the contract document control diagrams and process and instrumentation diagrams (P&IDs) relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings as "no changes required." Failure to include copies of the relevant drawings with the submittal is cause for rejection of the entire submittal with no further review.
   e. Documentation of certification in accordance with ISO 9001 as specified under paragraph 1.06A.

f. Predicted pump performance curves for each condition point specified showing head, power, efficiency, and NPSH3 on the vertical axis plotted against capacity on the horizontal axis, along with the manufacturer's warranty to meet the requirements specified in paragraph 1.07 Scope. Provide curves for variable-speed pumps to demonstrate operation at speeds required to achieve the specified reduced-speed operating conditions. All curves shall clearly display the specified operating conditions and conformance with POR and AOR limits in the individual specification sections. Provide variable-speed plots showing specified operating conditions and POR limits. Plot curves at increments of not more than 5 percent speed or 50 rpm increments, whichever is less, from full speed to the lowest speed required to meet specified operating conditions. Curves for column-type pumps shall show bowl efficiency and allowances for inlet, column, and discharge head losses separately.

g. NPSH margin calculations performed for each specified operating condition in accordance with paragraph 1.04 as applicable and including the information required under paragraph 1.04F.

h. Motor submittal information as specified in Section 43 05 21.

i. Complete description and sketch of proposed test setup for factory test if a factory test has been required under the detailed specification section or as required by the provisions of this section. Include in submittal material sample calculations and proposed test log format. If the contractor proposes a model test for a part or all of the specified performance tests, include in the submittal information the proposed model details and a complete description of the proposed method for comparing the model impeller profiles with the impeller profiles for the prototype pumps.

j. Drawings showing general dimensions and confirming the size of pumps, motors, drives, and specified appurtenances; piping connections; construction details of equipment (including bearings and bearing isolators); wiring diagrams; and weight of equipment.

k. Variable-speed drive information as required under Section 26 29 23 if the equipment specified includes variable-speed capability.

l. Detail drawings of the pump and driver unit foundation demonstrating conformance to this section and Section 43 05 13. Include in the submittal drawings depicting type, size, number, projection, and arrangement of anchor bolts; dimensional drawings of the sole and baseplates; and dimensional drawings for the concrete supports for both the pump and motor, if applicable. Drawings shall also depict other pertinent information, including location of equipment pads and reinforcement; equipment drains; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate, soleplate, or mounting block; size and location of electrical conduits; and any other equipment-mounting features embedded in equipment pads.

m. Limiting nozzle loading criteria, if different from that established by ANSI/HI 9.6.2.

n. The qualifications of the personnel proposed by the contractor to perform field alignment procedures in accordance with the requirements of paragraph 3.04.

3. The following are applicable to all vibration testing of pumps, in accordance with the requirements of paragraph 3.06 Field Vibration Tests and, paragraph 3.07 Torsional Vibration Testing, where required:
    a. The qualifications of the independent testing laboratory and individual personnel proposed by the contractor to perform field vibration testing, analysis, and reporting.
    b. Proposed vibration testing plan. including accelerometers mounting and presentation formats.

B. Informational Submittals
1. Procedures: Section 01 33 00:
    a. Performance guarantee as specified in paragraph 1.06C.
    b. Equipment anchor calculations specified in paragraph 1.04E.
    c. O&M information specified in Section 01 78 23.
    d. Motor information submittals as specified in Section 43 05 21.
    e. Bearing L-10 life calculations.
    f. Critical speed calculations demonstrating compliance with paragraph 1.04C.
    g. Nozzle loading information required under paragraph 3.01.
    h. Motor balance logs, certified and notarized as specified in paragraph 1.04G.
    i. Certified balance logs and worksheets, as specified in paragraph 2.05.
    j. Installation certification Section 43 05 11 Form A as specified in paragraph 3.01.
    k. Training certification Section 43 05 11 Form B as specified in paragraph 3.08.
    l. If factory tests are specified in the detail specification section, certification of satisfactory testing of each unit as specified. Include in the certified material copies of test logs and resulting performance curves.
    m. Documentation of field alignment data in accordance with Section 43 05 14.
    n. Field vibration test reports in accordance with paragraph 3.06.



## PART 2 PRODUCTS

### 2.01 MATERIALS

A. General:
1. Where this section and sections referencing this section are silent with respect to materials of construction on any component, material selection shall follow the requirements of Table H.1, ANSI/API 610, Materials Class I-1, with the exception that shafts for vertical column-type pumps be 12 percent chromium stainless steel. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. Pumps:
1. Finish for surfaces in contact with pumped fluid:
    a. Conform all pump components in contact with the pumped fluid to the following requirements.

b. Indicate surfaces to be machine-finished on the shop drawings by symbols that conform to ANSI B46.1, Surface Texture, Surface Roughness, Waviness, and Lay. Machine surfaces shall be finished to at least the following tolerances:

c. Nominal roughness:

| Surface | Grade, Ref: ANSI B46.1 (SI units microns) (Ra: micro inches) |
|---|---|
| General machine work | 3.2 or better (125 Ra) |
| Flange faces | 3.2 or better (125 Ra) |
| Journal surfaces at sleeve bearings | 0.4 or better (16 Ra) |
| Hydraulic surfaces | |
| Impeller | 4.5 or better (177 Ra) |
| Impeller bowl and diffuser | 6.3 or better (250 Ra) |
| All other wetted surfaces | 6.3 or better (250 Ra) |

d. Flaws such as scratches, ridges, holes, peaks, cracks, or checks that will make the part unsuitable will be cause for rejection. Machine-finished surfaces shall be thoroughly cleaned and coated with a protective layer of rust preventive. Oil and wrap small pieces, unassembled pipe, or finished bolts with moisture-resistant paper.

2. Materials:

a. Unless otherwise specified, wetted cast-iron parts for pumps for solids-bearing liquid services shall have 2 to 3 percent nickel added to the cast iron.

b. Provide stainless-steel impellers for the first stage of custom-engineered pumps, pumps intended for pumping screened or unscreened wastewater, and elsewhere when specified. Stainless-steel impellers shall be ASTM A743, Grade CA6NM. Where cast nickel aluminum bronze impellers are specified, the materials shall conform to ASTM B148, Alloy C95500.

c. Materials for shaft sleeves for packed boxes, fretting seals, and interstage seals shall conform to ANSI/API 610, Annex H 12 percent chromium-hardened or hard-faced 316 austenitic stainless steel. Materials for seal glands for packed boxes and shaft sleeves shall be AISI 316 stainless steel. Fastener parts of all types in wetted areas shall conform to ANSI/API 610, Materials Class S-5 requirements. Regardless of the seal construction, adequately size seal chambers to accommodate specified mechanical seals.



C. NOT USED.

## 2.02 GENERAL QUALITY

A. The details of manufacture and assembly of equipment furnished under this section and referencing sections shall follow the requirements of ANSI/API 610 with respect to the following features (paragraph references, ANSI/API 610):

1. Alignment aids (paragraph 6.1.24)
2. Removal of rotating element (paragraph 6.1.25)
3. Jackscrews for assistance in alignment on baseplates and equipment supports (paragraph 9.3.8.3.2)
4. Castings (paragraph 6.12.2)

B. Provide all components or subassemblies weighing 50 pounds or more with at least one lifting eye or a provision for threading in a lifting eye. Provide components 250 pounds or greater with lifting eyes or provisions for at least two lifting eyes. Provide components 1,000 pounds or greater with at least three lifting eyes or provisions for inserting lifting eyes.

## 2.03 BASEPLATES AND SOLEPLATES

A. Unless otherwise noted in the detailed specification, the pump manufacturer shall furnish pumps with baseplates or soleplates conforming to the requirements of Section 43 05 13. Design baseplates and soleplates to be installed in the housekeeping curb shown and machine flat and co-planar to within 0.002 inch per foot in all directions on the face mating with the pump and motor or driver support. Soleplates shall have the words “THIS SIDE DOWN” permanently affixed to the underside using a welding rod material or stamped prior to milling. Alternative marking methods, using heavy scribing or machining, are acceptable provided that they may be observed following blasting in preparation for coating.

## 2.04 WEARING RINGS

A. Where specified, fit pumps with both stationary and rotating wearing rings. Except for the difference in hardness between stationary and rotating rings, wearing rings shall be stainless steel and conform to the requirements of ANSI/API 610, paragraph 6.7 and material class S-8 (Table H.1, Annex H). The maximum wearing ring clearances shall not exceed 150 percent of the values stated in Table 6, ANSI/API 610. The minimum wearing ring hardness on the rotating ring is 350 Brinell Hardness Number (BHN), with the stationary ring not less than 100 hardness points greater.

B. L-form wearing rings are not acceptable for wastewater, sewage, stormwater, thickener overflow, mixed sludge, digester circulation, digested sludge, waste activated sludge (WAS), RAS, or primary effluent pumping service.



## 2.05 BALANCE

A. The balancing for pumps with suction nozzle sizes 6 inches in diameter and greater and associated components shall conform to the requirements set forth in ANSI/API 610, paragraph 6.9.4.1 (equivalent to ISO 1940 or ANSI 2.19 Grade 2.5), unless other portions of this project manual impose more restrictive requirements. It is the intent that the components be balanced as an assembly (“rotor”) in accordance with ANSI/API 610 definitions. For extended-shaft pumps, balance impeller(s) and shaft up to the first coupling with the line-shaft.

B. For separately balanced components, perform a residual unbalance inspection after rotor assembly per ANSI/API 610 requirements, as described in Annex J of that document. Provide copies of worksheets and demonstrate that tolerances are in compliance (i.e., rotor has passed) in addition to other reporting requirements of this paragraph.

C. Furnish all balance logs, certified correct and signed by the chief engineer or individual in responsible charge of the manufacturing facility, in accordance with paragraph 1.08.

## 2.06 DRIVE UNIT SUPPORTS FOR SEPARATELY SUPPORTED MACHINES AND INTERMEDIATE SHAFT SUPPORTS

A. Supports for separately mounted vertical pump drivers and intermediate shaft bearings shall be composite structures of fabricated steel, ASTM A36. Unless otherwise specified, design the supports to span an opening in the floor sufficient to allow removal for the complete pump. Provide rolled steel beams to stiffen the support and mount a fabricated steel driver unit support pedestal on the support plate. The support pedestal top plate and portions of the support plate assembly intended to join with surfaces in the installation structure shall be milled flat and parallel to 0.002 inch per foot. Provide pedestals with access provisions to adjust or assemble/disassemble couplings. Select a support that is designed to be supported on a soleplate or soleplates embedded in a housekeeping pad at the edges of the floor opening or as indicated. Other details for the driver unit support shall be as indicated.

## 2.07 NOT USED.

## 2.08 NOT USED.

## 2.09 MACHINING

A. Unless otherwise specified, provide machined surfaces with a 125 Ra (micro-inch) finish without any grooves, surface imperfections, or machining marks. Mating surfaces shall be coplanar within a maximum of 0.002 inch. Bearing housings and seals shall have collinear centerlines within less than 0.001-inch total difference. Provide shafts with a 63 Ra (1.6-micron) finish at fit areas (coupling, sleeves, impeller) and 125 Ra (3.2-micron) finish at the clear spans.



# PART 3 EXECUTION

## 3.01 GENERAL

A. With the exception of submersible pumps and the inlet connection for column-type pumps installed in open forebays or wetwells, connect pump inlet and discharge nozzles to field piping using equipment connection fittings conforming to the requirements of Section 40 05 06.16. Select restraining rods on equipment connection fittings that is designed specifically to restrain the unbalanced hydraulic thrust developed by the pump when operating at full speed against a closed valve. Torque all restraining rod nuts to ensure that any moment or shear transmitted to the pump nozzles is within the values permitted under ANSI/HI 9.6.2, or that permitted by the equipment manufacturer, whichever is greatest. Where ANSI/HI 9.6.2 is silent with respect to any particular aspect of allowable nozzle loads, the contractor shall follow the written requirements provided by the equipment manufacturer. Install all pumps furnished under specification sections containing the words “custom-engineered” in the title under the presence of a factory-authorized installation specialist or specialists. Under no circumstances shall any installation procedure take place without the installation specialists present. Equipment installation procedures shall conform to the requirements of Section 43 05 13. Upon completion of installation work, the contractor shall submit a complete, properly signed certification Form 43 05 11-A as specified in Section 01 99 90.

## 3.02 SOLEPLATES

A. Level soleplates, if provided pursuant to this section or any section referencing this section, or where required by the equipment manufacturer's recommendation, in the presence of a factory-authorized installation specialist to a maximum tolerance of 0.002 inch per foot in all directions. Where the equipment manufacturer requires more stringent tolerances, those tolerances prevail.

## 3.03 NOT USED.

## 3.04 ALIGNMENT

A. Journeymen millwrights shall perform alignment of equipment furnished under this section and any referencing section. Carpenters, laborers, or any other trades are specifically excluded from performing this work. In locations where such trades are not available, the contractor shall retain the services of a firm specializing in this type of work to perform the setting and alignment work. The contractor shall submit the qualifications of the proposed firm to the construction manager for acceptance prior to performing the work. The construction manager shall personally witness the final alignment procedures for each item of equipment as a condition precedent to beginning any work required under Section 01 45 23. Alignment techniques shall conform to the requirements of Section 43 05 14.



## 3.05 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01 45 20 and the detailed specification sections.

B. For pumps furnished under specification sections containing the words "custom-engineered" in the title, and where the manufacturer's qualified design professional has conducted the Alternate mass elastic design analyses specified under paragraph 1.04 Critical Speeds and Natural Frequencies, the testing procedure is a plan developed jointly by the contractor and equipment manufacturer to demonstrate performance of each item of equipment at specified operating conditions.

C. Unless otherwise specified in the detailed specifications, field-test centrifugal pumps for lateral vibration in accordance with paragraph 3.06B. In addition, "custom-engineered" pumps, and pumps subjected to Alternate mass elastic design analyses under paragraph 1.04 Critical Speeds and Natural Frequencies, shall undergo field torsional vibration testing (paragraph **Error! Reference source not found.**).

## 3.06 FIELD VIBRATION TESTS

A. Qualifications:

1. The contractor shall retain the services of an independent testing laboratory to conduct the testing work specified under this paragraph. The work shall be directed by a professional mechanical engineer, registered to practice in any one of the 50 states composing the United States.
    a. The engineer (hereinafter termed "professional vibration analysis specialist") shall be a graduate of a college holding Accreditation Board for Engineering and Technology Inc. (ABET) accreditation in mechanical engineering and has

been engaged in the practice of providing the type of monitoring services required under this paragraph for rotating machinery for a period of not less than 10 years.

b. As an alternate qualification, the professional vibration analysis specialist shall have an ISO/ANSI Vibration Analyst Category IV and been engaged in the practice of providing the type of monitoring services required under this paragraph for rotating machinery for a period of not less than 10 years.

2. Submit the professional vibration analyst specialist's qualifications and references, certified and notarized, for review and acceptance by the construction manager not less than 6 weeks prior to the date scheduled for the field vibration test work specified herein. The construction manager shall review the required documentation and references and indicate acceptance or rejection of the proposed analyst's qualifications within 14 days of submission. If the analyst proposed by the contractor is rejected, the contractor shall propose an alternative choice with appropriate documentation.
3. The independent testing laboratory's testing team (comprising the professional vibration analysis specialist and any technicians required to complete the specified tasks) shall be fully equipped to provide continuous pressure, velocity, and displacement values for rotating equipment installed under the requirements of this section. Vibration testing equipment shall include sufficient calibrated pressure and flow monitoring devices to determine pump operating conditions as well as vibration levels.

B. Vibration Tests:

1. Submit vibration testing plan, prepared by the professional vibration analysis specialist, for review and acceptance by the construction manager not less than 3 weeks prior to the date scheduled for the field vibration test work specified herein.
   a. Proposed vibration testing plan, incorporating corresponding pump performance testing, shall be developed to demonstrate absence of natural frequency excitation (resonance) and compliance with specified vibration limits within the pump operating range.
   b. The professional vibration analysis specialist shall consider identified standards and others consistent with practice standards of care in preparing the plan and directing the work.
   c. As part of the plan, professional vibration analysis specialist shall specify and justify selection and mounting of the vibration sensors (fully adhered or magnet-mounted) in accordance with accepted practice and specified requirements. Hand-held probe accelerometers shall not be used.
   d. Plan shall also stipulate the data collection and processing method including frequency response averaging of spectra and waveform points for each discrete measurement.
   e. Include example presentation formats consistent with specifications and accepted practice.
2. Unless otherwise specified in the detailed specification, the RMS vibration velocity shall not exceed the limits established in the appropriate standards indicated in the Table below. The measurement locations shall correspond to the guidelines provided in the specific standards given in the Table below.

| Component | Standard |
|---|---|
| All Pumps | ANSI/HI 9.6.4 or ANSI/HI 11.6 |
| Electric Motors of Any type | ISO 10816-3<br>Table A.1 or A.2, Zone Boundary A/B |
| Reciprocating engines | ISO 10816-6<br>Table A.1, Class 3 |
| Support bearings, flywheels | ISO 20816-1 |

3. Testing:
   a. Perform ramp (sweep) test of pump vibrations (at average or higher head conditions) – minimum 10 minutes (mins) start-up run, slow ramp from minimum to maximum speeds (20 mins). 20 mins at maximum speed, 10 mins at reduced (A operating speed), 10 mins to confirm largest peak; then through coast down.
   b. The professional vibration analysis specialist shall collect vibration readings during the sweep test, make notes about peaks and then proceed to testing with steady state operation at the design and other targeted points. Prepare report of Overall Velocity Trends including pump speed and flow.
   c. Conduct discrete performance and vibration testing of all design points (4), when performance is stable but not less than 10 minutes each. It is not necessary to conduct vibration testing at shut-off.
   d. Conduct similar discrete performance and vibration testing at each discrete peak observed during the sweep test.
4. Reporting:
   a. Provide vibration test reports as an information submittal in accordance with paragraph 1.08, and provide the signature of the responsible professional vibration analysis specialist.
   b. The vibration spectra shall be of sufficient resolution for legibility of magnitude and frequency data to be properly reviewed by the construction manager. Cascade diagrams are not sufficient for variable-speed drive application unless supported by the required data in a format suitable for more detailed analyses. Provide separate spectra at the maximum and minimum operating speeds and any potential resonant frequencies.
   c. Depict RMS velocity by axis on same plot and zoom in on 10 highest peaks for each separate axis. Report should clearly address multiples of operating speed and twice vane pass at operating speed, typically associated with pump phenomena.
   d. Interpret data, identify anomalies and resonant frequencies (if any), provide discussion of probable sources/causes in test report. Provide interpretation as to why there may be peaks beyond typical phenomena.
   e. If deemed necessary by the professional vibration analysis specialist, to determine the potential problem and risk with any identified peaks, further resolve and analyze critical peaks by frequency.

C. Remedial Measures:
   a. If required, professional vibration analysis specialist shall provide written recommendations for remedy of problems identified.
   b. Contractor shall undertake appropriate remedial action, in conjunction with the pump manufacturer, and provide professional vibration analysis specialist services,

and pump manufacturer services throughout the process required to resolve identified problems.

c. Conduct additional testing after modifications or replacements to confirm effectiveness of remedy.

## 3.07 NOT USED.

## 3.08 TRAINING

A. Training shall conform to the requirements of Section 01 79 00 and include separate training sessions for each operator shift maintained by the Owner and a separate session for maintenance personnel.

B. Unless otherwise specified in the referencing section, the training requirement is waived for constant-speed pumping equipment with suction nozzle sizes 6 inches in diameter and smaller and for pumps with connected power requirements 10 hp and less.

C. The training session for maintenance personnel shall include a comprehensive presentation, employing cut-away models or comparable graphics, and documentation on the step-by-step disassembly and subsequent reassembly of a pumping unit.

D. Upon completion of training requirements, the contractor shall submit certified Form 43 05 11-B as specified in Section 01 99 90.

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SECTION 43 23 80.15

SUBMERSIBLE WASTEWATER PUMPS - VARIABLE SPEED

## PART 1 GENERAL

### 1.01 SUMMARY

A. Scope:

1. This section specifies semi-submersible vertical chopper pumps suitable for pumping fluids containing unscreened Municipal FOG consisting of Grease Trap Waste and Waste from Wet Well Cleaning Activities at variable speed.
2. Each pump will be driven by a single variable speed drive provided under Section 26 29 23. The pump vendor shall submit a letter of confirmation on the suitability for use of the Contractor's proposed drive selection.
3. Pumps will be installed in a semi-submersible configuration, with the pumps submerged in the FOG Receiving Tanks and the motor mounted on the top slab of the FOG Receiving Tanks.
4. Manufacturers proposing to furnish equipment specified under this section shall hold current certification under ISO 9001-2001. Application for certification under ISO 9001 shall not be deemed as an acceptable substitute for current certification. Documentation attesting to current certification shall be signed by an officer of the manufacturer's corporation and shall be notarized.
5. Equipment shall additionally conform to the requirements of Section 43 23 03 with the exception that provisions of Section 43 23 03-1.05 and Section 43 23 03-1.07 do not apply unless of specifically called out in this project specification.



B. Type:

1. Pumps shall be of the heavy duty, semi-submersible, vertical shaft, centrifugal chopper type, suitable for pumping fluids containing unscreened Municipal FOG consisting of Grease Trap Waste and Waste from Wet Well Cleaning Activities. The pumps shall be designed for continuous or cyclic operation under submerged or partially without damage to the pump and motor. Special attention shall be devoted to the shaft design to limit deflection under all operating conditions, as specified in this section.

C. Equipment List:

| Item | Equipment Number |
|---|---|
| FOG Recirculation Pump 1 | P-212 |
| FOG Recirculation Pump 2 | P-222 |

D. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.

1. Section 26 29 23 Variable Frequency Motor Controllers
2. Section 43 23 03 General Requirements for Centrifugal and Axial Flow Pumping
3. Section 43 05 11 General Requirements for Equipment
4. Section 43 05 13 Rigid Equipment Mounts
5. Section 43 05 21 Common Motor Requirements for Equipment

## 1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. References shall be as listed in Section 43 23 03.

## 1.03 DEFINITIONS

A. Terminology used in this section conforms to the following definitions:
   1. Equipment Pad: concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade
   2. Mounting Pads: thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers rest on the baseplate or soleplate

## 1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. See Section 01 12 16: Work Sequence.
   2. Coordinate pump and motor operational and starting characteristics with variable-frequency drive settings used for control of this equipment. A system curve is available upon request from the Engineer. Include the following:
      a. Motor minimum operational speed
      b. Motor maximum operational speed
      c. Motor ramp-up and ramp-down speed, voltage, and hertz requirements
      d. Other operating limits that are imposed by the driven equipment for operation and warranty

B. Unit Responsibility:
   1. Assign unit responsibility, as specified in Section 43 05 11, to the manufacturer of the vertical, chopper semi-submersible pumps provided for all equipment and accessories under this section. Have all mechanical equipment components, at least, of this entire equipment assembly furnished by the pump's manufacturer. Provide a completed, signed, and notarized Certificate of Unit Responsibility (Form 43 05 11-C, Section 01 99 90). Additionally, the manufacturer shall review submittal data for the variable speed drive units that are proposed by the Contractor under Section 26 29 23. The manufacturer shall submit a letter indicating whether the proposed units are satisfactory or not for use with the pumps in this section.

## 1.05 SUBMITTALS

A. Action Submittals:
   1. Procedures: Section 01 33 00.
   2. Submittals shall conform to the requirements of Section 43 23 03. A copy of this Section, addendum updates included, along with the sections listed below shall be

submitted with each paragraph check-marked to indicate compliance or marked to indicate requested deviations.

a. This Section (43 23 80.15)
b. Section 43 05 11 – General Requirements for Equipment
c. Section 43 05 13 – Rigid Equipment Mounts
d. Section 43 05 21 – Common Motor Requirements for Equipment
e. Section 43 23 03 – General Requirements for Centrifugal and Axial Flow Pumping Equipment

3. The specification copies shall be complete with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check-marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.
4. A copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
5. Unit Responsibility Certification form (Form 43 05 11-C, Section 01 99 90) attesting that unit responsibility has been assigned in accordance with the requirements of this Section and Section 43 05 11. No other submittal material will be reviewed until the certificate has been found in conformance with this requirement.
6. Predicted pump performance curves for each condition point specified showing head, power, efficiency, and NPSH3 on the ordinate plotted against capacity on the abscissa. Curves shall be provided to demonstrate operation at all speeds required to achieve the specified reduced speed operating conditions. All curves shall clearly display the specified operating conditions, POR and the manufacturer's limits for the AOR.
7. Drawings showing general dimensions and confirming the size of pumps, motors, drives and specified appurtenances; piping connections; construction details of equipment (including bearings and bearing isolators); wiring diagrams; and weight of equipment.
8. Manufacturer's data including materials of construction and equipment weight.
9. Motor Data Form 43 05 21 -A.
10. Proof of service of previously installed units of similar size and configuration in wet wells of the type specified in this Section.
11. Written factory tests report, as specified in paragraph 2.09.
12. Shaft deflection calculations.
13. Anchorage calculations and required documentation.

14. Manufacturer's operation and maintenance information in accordance with Section 01 78 23.
15. Installation Forms in accordance with Section 43 05 11.
16. 5-Year warrantee in accordance with paragraph 1.09.
17. Testing Forms in accordance with Section 01 45 23.
18. Field vibration test protocol as specified in ANSI/HI 11.6.

B. Informational Submittals:
   1. Procedures: Section 01 33 00
   2. Submittals shall conform to the requirements of Section 43 23 03.
   3. Letter of confirmation of suitability of variable frequency drives being provided by the Contractor for this equipment in accordance with Section 26 29 23.
   4. Coordination items required for proper setup of the variable frequency driver as specified in paragraph 1.05.A. Coordination.

C. Closeout Submittals:
   1. Operating and maintenance submittals:
      a. Procedures: Section 01 78 23.
   2. Spare parts:
      a. Procedures: Section 43 05 11. Provide the following spare parts for each model and size of pump furnished for this Section:
      b. One complete set of all gaskets and seals
      c. Two complete sets of all bearings
      d. Two complete sets of mechanical seals



## 1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Independent testing agent hired by the Contractor for field vibration testing: Section 43 23 03.

B. Critical Speeds: Critical Speeds shall be in accordance with Section 43 23 03-1.04 except when the title of the detailed section includes "Custom Engineered" in which case Section 43 23 03-1.05 applies.

C. Vibration Limits: Vibration limits for submersible pumps shall be in accordance with ANSI/HI 11.6. Field testing shall be in accordance with paragraph 3.03 of this section.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Procedures: Section 01 66 00

B. Block shaft and prevent damage to bearings during shipment

## 1.08 SPECIAL WARRANTY

A. Provide a Special 5-Year Warranty. The manufacturer shall warrantee the pumps provided under this section against defects in materials and workmanship for 5 years.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. The manufacturer's standard product may require modification to conform to specified requirements:
   1. Vaughan Vertical Recirculator Chopper Pumps
   2. Hayward Gordon ChopX Vertical Cantilever Pumps
   3. Approved Equal

### 2.02 TYPE

A. Heavy-duty, semi-submersible, vertical shaft, centrifugal chopper type, suitable for pumping fluids containing unscreened wastewater solids, including fats, heavy greases, oils and food waste.

### 2.03 PERFORMANCE/DESIGN CRITERIA

A. Service Conditions:

| Description | |
|---|---|
| Equipment number | P-212<br>P-211 |
| Area exposure | Per Section 01 11 80 |
| Fluid type | FOG, up to 50% grease by volume |
| Fluid temperature | 65 to 140 degrees F |

B. Operating Conditions:
   1. The performance requirements presented in tabular form below are intended to describe the results of hydraulic calculations developed using a mathematical modeling program specifically developed for the purpose. The model was intentionally used to develop the limits of expected extremes in variation of static head, coefficients for pipeline resistance and turbulence losses through fittings and valves.
   2. Equipment furnished under this section shall be fully suitable for continuous operation at any specified condition or any condition lying between the extremes of the operating conditions specified in the following table. The notes presented at the end of the table are intended to be complimentary to the information presented in the table.

C. Table of Operating Conditions:

| Operating Condition | Value |
|---|---|
| Equipment number | |
| Full-speed operation, Condition A [1,3] | |
| Capacity, gpm | 314 |
| Total head, feet | 55.8 |
| NPSHA, feet | 30.5 |
| Full-speed operation, Condition B [2,3] | |
| Capacity, gpm | 513 |
| Total head, feet | 50.0 |
| NPSHA, feet | 41.0 |

1. *Condition A shall be taken as the rated operating condition. Performance at the rated condition shall be guaranteed in accordance with Section 43 23 03. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this section shall be selected to achieve Condition A performance, and also shall operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A may be located in the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and published in the manufacturer's published application data for the specific model proposed for this application.*
2. *Condition B head is presented to indicate operating conditions when the pump is operating at maximum speed against minimum anticipated system head during typical operation, assuming a hypothetical head-capacity curve. Condition B shall be used for pump selection. Condition B shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.*
3. *Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1 – 1.6. Net positive suction head available (NPSHA) in the above tabulation is referred to the pump inlet piping at centerline elevation as shown and is calculated in accordance with ANSI/HI 1.3 for average barometric pressure and maximum temperature conditions. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump installation details. An allowance of five feet has been included for the presence of volatile constituents in the pumped fluid. Required NPSHA margin shall be as specified in Section 43 23 03.*



D. Design Requirements:

| Item | Value |
|---|---|
| Equipment number | P-212<br>P-222 |
| Pump | |
| Minimum efficiency at best efficiency point (BEP) at maximum speed, percent [1] | 70 |
| Piping connection size, inches, minimum | |
| Pump inlet | 6 |
| Pump discharge | 4 |
| Operating speed, rpm, maximum | 1180 |
| Operating speed, rpm, minimum | 880 |
| Approximate pump suction centerline elevation, feet, NAVD 88 | 0 |
| Suction specific speed, dimensionless, maximum[2] | 8500 |

| Item | | Value |
|---|---|---|
| Motor | | |
| | Horsepower | 20 |
| | Type | TEFC Enclosure |
| | Inverter duty | Yes |
| | Space heater | No |
| | Over temperature protection | Yes |
| | Moisture sensors | No |
| | Operating speed, rpm, maximum | 1750 |
| | Voltage/Phase | 460V/3ph |

*Notes:*

1. *The minimum acceptable efficiency at best efficiency point (BEP) at the speed required to achieve the performance specified under Condition Points A and B. The minimum acceptable efficiency is not necessarily required to be associated with any operating condition specified in paragraph 2.03 Operating Conditions.*
2. *The suction specific speed limitation listed applies only to pump selections where both Operating Conditions A and B reside within the proposed pump selection's AOR. Proposed selections with Operating Condition A residing in the AOR shall be limited to designs with suction specific speed less than 8500. Suction specific speed shall be calculated for the maximum pump design speed and impeller diameter, using the capacity in gallons per minute and NPSH3 at Best Efficiency in accordance with the procedures set for in the standards of the Hydraulic Institute.*



## 2.04 SYSTEM OPERATION

A. One pump will be installed in each of the two FOG Receiving Tanks. The chopper pumps will be used to transfer flow to the centrate drain, concentrated FOG tanks, or FOG holding tanks. Chopper pumps may also be used to recirculate the tanks as needed.

## 2.05 MATERIALS

A. Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

B. Provide materials of construction in accordance with the following table:

| Component | Material |
|---|---|
| Motor casing | Ductile Cast Iron |
| Pump casing | Stainless steel, ASTM A276 Type 316 |
| Discharge Flange | ANSI Class 150 |
| Impeller | Stainless steel, ASTM A276 Type 316 |
| Motor and pump shaft | Stainless steel, ASTM A276 Type 316 |
| External bolts and nuts | Stainless steel, ASTM A276 Type 316 |
| Anchor bolts | Stainless steel, ASTM A276 Type 316 |
| Shaft Column | Stainless steel, ASTM A276 Type 316 |
| Discharge Pipe | Stainless steel, ASTM A276 Type 316 |

## 2.06 COMPONENTS

A. General:

1. The motor and rotating parts shall be removable from the motor end of the pump. All motor mating surfaces where watertight sealing is required shall be machined and fitted with nitrile O-rings. The pump shall be fitted with a dynamically balanced chopper impeller designed to pass coarse solids and stringy materials. The pump shall be listed by Factory Mutual or Underwriters Laboratory as conforming in all respects to the requirements in UL 1207.

B. Casing:

1. The pump casing shall be of volute or semi-volute design, spiraling outward to the Class 150 flanged centerline discharge. Casing & backplate shall be stainless steel with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. Backplate shall include a replaceable Rockwell C 60 alloy steel cutter adjustable for 0.005-0.050" clearance to cut against the rotating impeller pumpout vanes for removing fiber and debris.

C. Impeller:

1. Shall be open or semi-open type with pump out vanes to reduce seal area. Chopping/ maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a maximum set clearance between the impeller and cutter bar of 0.015” and 0.025". Impeller shall be cast alloy steel heat treated to a minimum Rockwell C 60 and dynamically balanced. The impeller shall be keyed to the shaft and shall have no axial adjustments or set screws required.

D. Cutter Bar:

1. The cutter bars shall be recessed into the pump bowl and shall include a minimum of two (2) shear bars with cupped edges extending diametrically across the intake opening to within 0.010 - 0.030 inches of the cutter nut to prevent intake blockage and minimize material wrapping around the pump shaft. Individually mounted shear bars shall not be acceptable. Cutter bar shall be cast alloy steel heat treated to a minimum Rockwell C60.
2. The cutter bar shall have a relief notch on the back side to prevent solids from binding between the impeller and cutter bar.

E. Cutter Nut

1. The impeller shall be secured to the shaft using a special cutter nut, designed to cut stringy materials and prevent binding. The cutter nut shall be cast alloy steel heat treated to a minimum Rockwell C60.

F. Upper Cutter

1. Shall be threaded into the casing behind the impeller, designed to cut against the pump-out vanes and impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast alloy steel heat treated to a minimum Rockwell C60. The upper cutter teeth shall be positioned closely as possible to the center of shaft rotation to minimize cutting torque and nuisance motor tripping.

2. The ratio of the upper cutter cutting diameter to the shaft diameter shall be 3.0 or less.

G. Recirculation Nozzle Assembly
   1. The pump shall be fitted with a recirculation nozzle assembly to permit recirculation/conditioning of the FOG Receiving Tank contents prior to discharge if needed. The recirculation nozzle shall be adjustable minimum 180 degrees horizontally and 45 degrees vertically.
   2. A valve assembly shall be connected to the pump discharge to adjust pump flow either to the nozzle or pump discharge flange.
   3. Valve shall be ductile cast iron with 316 SS valve disk. The operating levels shall be located above at a mounting plate for access.

H. Shaft
   1. Shaft shall be heat treated steel alloy. Upper shaft extension shall be turned, ground, and polished.
   2. The shaft column shall be minimum 4" O.D. precision steel tubing welded to steel flanges and machined with piloted bearing fits for concentricity of all components. All support column tubes shall be leak tested. Distance between shaft bearing shall not exceed critical speed dimensions.

I. Pump Shaft Bearings
   1. Shall be oil bath lubricated by ISO Grade 46 oil, with the exception of the top bearing which shall be grease packed.
   2. Bearings shall have a minimum L-10 life rated 100,000 hours.
   3. Shaft thrust shall be taken up by either a double row angular contact ball bearing or two back-to-back mounted single row angular contact ball bearings, which bear against a machined shoulder on one side and the seal sleeve on the other side. Overhang from the centerline of the lower thrust bearing to the seal faces shall be a maximum of 4.7", with a mechanical seal to isolate the bearings from the pumped media.

J. Mechanical seal
   1. The mechanical seal shall be located immediately behind the impeller hub to maximize the flushing available from the impeller pump-out vanes. The seal shall be cartridge-type mechanical seal with Viton O-rings and silicon carbide or tungsten carbide faces . This cartridge seal shall be pre-assembled and pre-tested so that no seal settings or adjustments are required from the installer. Any springs used to push seal faces together must be shielded from the fluid to be pumped. The cartridge shall also include a 17-4PH, heat treated seal sleeve and a ductile cast iron seal gland.

K. Motor
   1. Motor shall be variable speed type motor conforming to the requirements of Section 26 05 00.01.

L. Variable Frequency Drives:
   1. The variable frequency drive will be provided by the Contractor under Section 26 05 00.01 and will conform to the requirements of Section 26 05 00.01, the Contract electrical one-line diagrams, and the Contract wiring diagrams.

## 2.07 EQUIPMENT MOUNTS

A. Mounting Plates
   1. Each pump along with its associated motor, drive, and appurtenances shall be rigidly mounted on a common Type I baseplate as defined in Section 43 05 13.

B. Grout Type
   1. Use epoxy grout per Section 03 60 00.

C. Equipment Anchors
   1. Install per Standard Detail D01001.

D. Equipment Anchor Sleeves
   1. Install per Section 43 05 13.
   2. Length shall not be less than 6D (D = nominal bolt diameter; bolt diameter determined by mounting plate manufacturer).

E. Equipment Pad
   1. Install per Standard Detail D01006.

## 2.08 EQUIPMENT AND SYSTEM CONTROLS

A. Section 40 61 13.01 specifies control system requirements.

## 2.09 FINISHES

A. Procedures: Section 09 90 00

## 2.10 SOURCE QUALITY CONTROL

A. Provide non-witnessed factory testing at a location in the Continental United States and in accordance with Section 43 23 03-1.06

B. Submit factory testing results report in accordance with Section 43 23 03.

C. Hydrostatic tests:
   1. Factory-test all pressure-sustaining parts in accordance with Section 43 23 03.

D. Performance and NPSH tests:
   1. Subject each pump to performance and NPSH testing in accordance with Section 43 23 03 to verify the full range of operating condition

E. Motor tests:
   1. First check impeller, motor rating, and electrical connections for compliance with the specifications
   2. Subject all motor circuits to electrical resistance tests to confirm functionality

## PART 3 EXECUTION

### 3.01 EQUIPMENT MOUNTING

A. Procedure: Section 43 05 13

B. Position equipment pad and equipment anchors for final placement of equipment

C. Use a bolting template to position equipment anchors

D. Level mounting plates

E. Pour grout bed supporting each mounting plate

F. Eliminate grout voids below mounting plate

G. Tension equipment anchors

H. Provide a completed Installation Form, Section 01 99 90, for each equipment installation

### 3.02 COATINGS

A. Finish Coating: see paragraph 2.09.

### 3.03 FIELD QUALITY CONTROL

A. Field Testing
   1. Procedures: Section 01 45 20.
   2. Vibration Test:
      a. Vibration levels shall be determined by affixing suitable sensors to the top of the motor housing in both the x-x (parallel to the nozzle) and y-y (perpendicular to the nozzle) directions. The Contractor or his designated testing agent shall provide all sensors and monitoring equipment.
      b. As a condition precedent to final acceptance of the equipment, the pumps shall be individually operated at all specified operating conditions. The Contractor shall provide the means to recirculate pumped fluid or alternatively throttle the pumps to achieve the specified head at specified flow.
      c. Vibration levels shall not exceed that specified in paragraph 1.07 when the pump is operating within the manufacturer's listed POR as determined in accordance with Section 43 23 03. When operating at conditions outside the POR, vibration levels shall be no more than 125 percent of that specified in paragraph 1.07.

B. Manufacturer Services
   1. On-Site Inspections and Training
      a. Provide a factory-trained manufacturer's representative at the Site for the following activities. Specified durations do not include travel time to or from Site.
         1) Installation inspections
            a) Assist, supervise, and inspect the Contractor's activities during installation.
            b) Provide four inspection hours.

c) Provide a completed Form 43 05 11-A, Section 01 99 90.

2) Component test phase inspections
   a) Assist, supervise, and inspect the Contractor's activities during the component test phase specified in Section 01 45 20 and this section.
   b) Provide four inspection hours.
3) System test phase inspections
   a) Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 20.
   b) Provide eight inspection hours.
4) Operational test phase inspections
   a) Assist, supervise, and inspect the Contractor's activities during the operational test phase specified in Section 01 45 20.
   b) Provide eight inspection hours.
5) Training Sessions
   a) Comply with procedures described in Section 01 79 00.
   b) Provide a minimum of eight hours classroom training for each training session.
   c) Conduct two training sessions, one training session per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff.
   d) Certify completion of training on Form 43 05 11-B, Section 01 99 90.

## 3.04 SYSTEMS START UP

A. Procedures: Section 01 45 20.

B. Preoperational (factory) testing: See paragraph 2.09.

C. Component testing: Perform the following tests.
   1. Complete field testing in accordance with paragraph 3.03.



**END OF SECTION**

# DIVISION 44
# POLLUTION AND WASTE CONTROL EQUIPMENT

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SECTION 44 31 14

GREASE FILTER/MIST ELIMINATOR

## PART 1 GENERAL

### 1.01 SUMMARY

A. SCOPE:

1. This section specifies duct-mounted filters for removing grease and moisture from corrosive air streams.
2. The installation of the grease filter/mist eliminator and filter must fit in the space available as shown.

B. EQUIPMENT LIST:

| Item | Equipment No. |
|---|---|
| Grease Filter | N/A |



### 1.02 QUALITYASSURANCE

A. This section contains references to the following documents, included as specified and modified. A document referencing other standards is included under this Section as if referenced directly. If this Section's requirements and those of the listed documents conflict, use this Section's requirements.

B. Document references are in effect at the time of Advertisement for Bids or Invitation to Bid (or on effective date of the Agreement if no bids), unless otherwise specified.

| Reference | Title |
|---|---|
| SMACNA | Thermoset FRP Duct Construction Manual |
| National Bureau of Standards Voluntary Product Standard PS 15-69 | Custom Contact-Molded Reinforced-Polyester Chemical Resistant Process Equipment |
| ASTM C582 | Standard Specification for Contact Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment |

### 1.03 PERFORMANCE REQUIREMENTS

A. GENERAL:

1. Design and select specified units for continuous outdoor operation with air-containing corrosive and flammable vapors and gases generated from treatment and conveyance of municipal wastewater.
2. Expect vapors and gases to include methane, hydrogen sulfide, chlorine gas, sulfur dioxide, gasoline vapors, ammonia, grease, and water-saturated air. Expect the air stream to contain droplets of dilute sulfuric acid, with temperatures varying between 20 and 95 degrees Fahrenheit.

B. OPERATING REQUIREMENTS:

1. The grease filter/mist eliminator must remove 99.8 percent of all particles greater than 10 microns in diameter at 400 feet per minute face velocity. Face velocity through pads must not exceed 500 feet per minute to avoid carry-over. Units must comply with the following:

| Item | Capacity, scfm | Max. Pressure Drop at Ultimate Capacity with Filters Clean, in., W.C. | Connection Diameter, inches |
|---|---|---|---|
| Grease Filter | 630 | 0.5 | 10 |

## 1.04 SUBMITTALS

A. Provide the following information in accordance with the Contract Documents:

1. A copy of this specification section (with addendum updates included) and all referenced and applicable sections (with addendum updates included) with each paragraph check-marked (✓) to indicate specification compliance or deviations requested from specification requirements. Denote full compliance with a paragraph as a whole with a check mark.
2. Underline and denote each specification deviation requested by the Contractor with a number in the margin to the right of the identified paragraph, and reference to a detailed written explanation of the reasons for the request. The Engineer is the final authority for determining acceptability of requested deviations. Paragraph portions not underlined signify the Contractor's compliance with the specifications. Failure to include with the submittal a copy of the marked-up specification sections with justification(s) for any requested deviations to specification requirements is sufficient cause for rejection of the entire submittal with no further consideration.
3. Detailed installation drawings showing equipment layout, size and location of all piping, and instrumentation and structural connections.
4. Certification from the resin manufacturer demonstrating that selected resin and catalyst systems are appropriate for service conditions.
5. List of equipment components and materials.
6. Pressure drop data through filter pads.
7. Fabricator qualifications.



## PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. The Owner and Engineer believe the following candidate manufacturers to be capable of producing equipment and/or products satisfying Section requirements.

B. Do not construe this statement as an endorsement of a particular manufacturer's products, or that a named manufacturer's standard equipment or products will comply with Section requirements.

C. Candidate manufacturers include AMACS, Diamond Fiberglass, and ECS, without exception.

## 2.02 MATERIALS

| Component | Material |
|---|---|
| Housing | FRP as per Section 06 70 13 |
| First-stage pad | Type 316 stainless steel |
| Second-stage pad | Polypropylene or 316 stainless steel |
| Gaskets | EPDM |
| Hardware | Type 316 stainless steel |

## 2.03 EQUIPMENT FEATURES

A. HOUSING:

1. The grease filter/mist eliminator filter must consist of filter pads housed inside a fiberglass-reinforced plastic (FRP) enclosure suitable for outdoor installation. Provide a resin system with corrosion-resistant vinyl ester meeting Class 1 flame spread rating. Provide a resin system not requiring any additives such as Nyacol or antimony to achieve the Class 1 flame spread rating. Use resin manufactured by AOC, Ashland, or Reichold. Finished laminate including liner and structure must be translucent.
2. Provide housing with doors and chambers to access to filter pads from both sides of the filter housing.
3. The housing must allow removal and replacement of filter pads through a hinged door fastened with stainless-steel quick-release toggle clamps, and manual removal of the cartridges by one operator. The housing must have a flanged inlet and outlet for installation in the air piping.
4. Provide access doors hinged with stainless-steel locking latches. The housing must withstand 20 inches of water column pressure and 12 inches of water column vacuum.
5. Provide housing with support legs and angle clips to attach to equipment pad. Use Type 316 stainless-steel supports and accessories. Provide a drain connection with a ball valve.
6. Provide housing capable of achieving required pad face velocity for initial airflow by inserts or other means. Use removable inserts.
7. Provide an inlet transition with included angle of 60 degrees maximum. FRP construction housings must comply with the following:
   a. Use an opaque pigment coat for the exterior.
   b. Use a vinyl ester resin Nexus veil corrosion liner for the interior.
   c. Wall thickness must be no less than 3/8 inch.
   d. Use a polyvinyl chloride (PVC)-lined filter pad to protect the FRP corrosion liner from scratching.

B. FILTER PADS:

1. The pad is for grease removal and must be at minimum 2 inches thick. Use a water-washable pad.
2. Use pads removable by one operator for cleaning, not exceeding 20 pounds each. Provide a differential pressure to measure pressure drop across entire unit.

3. Provide the grease filter/mist eliminator filter with a 2-inch drain connection. Field-route drain piping as shown on the Drawings. Install an external water trap to allow drain valve to remain open.
4. Candidate pad manufacturers include ACS and York, without exception.

## 2.04 INSTRUMENTS

A. Select and provide a differential pressure gauge to measure pressure drop across the grease filter/mist eliminator filter on the units provided by the equipment supplier. Provide an industrial enclosure rated for the location.

## 2.05 STANDBY COMPONENTS

A. Provide one extra set of filter pads.

## 2.06 PRODUCT DATA

A. Provide the following information:
   1. Applicable maintenance information as specified in Section 01 78 23.
   2. Instructions for installation of equipment. At a minimum, include the following information:
      a. Major parts list, including weights of component parts.
      b. Unpacking and unloading procedures, including directions indicating proper methods for moving equipment.
      c. Instructions for field assembly of match-marked components, as they will be shipped.
      d. Instructions for anchoring and securing equipment.
      e. Site storage and protection requirements for equipment prior to installation.



# PART 3 EXECUTION

## 3.01 INSTALLATION

A. Install each grease filter/mist eliminator as shown on the Drawings and recommended by the manufacturer. Support the unit so there is no strain on connected piping. Install to ensure access for filter removal. Route drain pipe to a disposal point.

B. Permanently mark the two pressure gauges as recommended by the manufacturer for filter maintenance.

**END OF SECTION**

# DIVISION 46

# WATER AND WASTEWATER EQUIPMENT

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SECTION 46 21 73

FOG SCREENING EQUIPMENT

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Self-contained, fully automatic, self-cleaning, dual drive fats, oils and grease receiving screen.
   2. Equipment control system and interface with Plant distributed control systems (DCS).

B. Equipment List:

| Item | Equipment Number |
|---|---|
| FOG Receiving Screen | SCN-100 |
| FOG Control Panel | VCP-100 |



### 1.02 RELATED SECTIONS

A. This section contains specific references to the following related sections. Additional related sections may apply that are not specifically listed below.
   1. Section 01 73 24 Structural Design and Anchorage Requirements for Nonstructural Components and Nonbuilding Structures
   2. Section 05 10 00: Structural Metal Framing
   3. Section 26 05 00.01 Common Work Results for Electrical for Small Projects
   4. Section 43 05 11 General Requirements for Equipment
   5. Section 43 05 13 Rigid Equipment Mounts
   6. Section 43 05 14 Machine Alignment

### 1.03 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   1. AISI (American Iron and Steel Institute)
   2. ABMA (American Bearing Manufacturers Association)
   3. AGMA (American Gear Manufacturers Association)
   4. NEMA (National Electrical Manufacturers Association)
   5. NFPA (National Fire Protection Association)
   6. ASTM (American Society for Testing and Materials)
   7. AWS (American Welding Society Code)
   8. ASME (American Society of Mechanical Engineers)
   9. NEC (National Electrical Code)

10. UL (Underwriters Laboratory Standards)

## 1.04 UNIT RESPONSIBILITY

A. Manufacturer's Qualifications: Manufacturer shall have experience in manufacturing equipment of similar size and configuration to the equipment specified herein. For a manufacturer to be determined acceptable for providing the screening equipment on this project, they must show evidence of a minimum of five installations and five years' experience in the design and manufacturing of screening equipment of a similar size and type as specified herein.

B. Assign unit responsibility, as specified in Section 43 05 11, to the screen manufacturer for the equipment specified in this section and electric motors specified in Section 43 05 21

C. Provide a completed and signed Unit Responsibility Certification Form (Form 43 05 11-C, Section 01 99 90).

## 1.05 SUBMITTALS

A. Action Submittals
   1. Comply with procedures described in Section 01 33 00.
   2. Submit a completed Certificate of Unit Responsibility attesting that the Contractor has assigned and the screen manufacturer accepts unit responsibility in accordance with the requirements of this section and Section 43 05 11-1.02: Unit Responsibility. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.
   3. Submit a copy of this specification section and those listed below, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
      a. This section (43 24 51)
      b. Section 43 05 11: General Requirements for Equipment
      c. Section 43 05 13: Rigid Equipment Mounts
      d. Section 43 05 21: Common Motor Requirements for Equipment
   4. Use check-marks ( ✓ ) to denote full compliance with a paragraph as a whole. Underline and denote deviations with a number in the margin to the right of the identified paragraph. Remaining portions of the paragraph not underlined signify the Contractor's compliance with the specifications. Submit a detailed, written justification for each requested deviation. Failure to submit a copy of the marked-up specification sections, along with justification(s) for all requested deviations from the specification requirements, with the submittal, shall be sufficient cause for rejection of the entire submittal with no further consideration.
   5. Provide a copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment. Include addendum updates applying to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, mark the drawing or drawings with "no changes required". Failure to include copies of relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

6. Provide drawings showing general dimensions and confirming the size of all equipment, piping connections, construction details of equipment (including bearings), wiring diagrams, and weight of equipment.
7. Provide motor submittal information specified in Section 43 05 21 and conforming to paragraph 2.08: Motor and Drive Unit.
8. Submit detail drawings of the equipment foundation demonstrating conformance to this section and Section 43 05 13. Include drawings depicting type, size, number, projection, and arrangement of anchor bolts, dimensional drawings of the baseplates, and dimensional drawings for the concrete support pad for the equipment. Drawings shall also depict all other pertinent information, including: location of equipment pads and reinforcement; equipment drains; elevation of top of grout and grout thickness; elevation of top of baseplate or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pad.
9. Provide drawings for the control and starter panels to include enclosure front view and interior layout of equipment.
10. Provide diagrams for network cables, PLC wiring, and panel ladder logic.
11. Provide list of recommended spare parts not supplied.

B. Informational
1. Comply with procedures described in Section 01 33 00.
2. Provide performance guarantee as specified herein.
3. Provide UL 508A label and compliance with short circuit rating.
4. Provide operation and maintenance information as specified in Section 01 78 23.
5. Provide motor product data as specified in Section 26 05 00.01.
6. Provide documentation of field alignment data in accordance with Section 43 05 14.
7. Submit Installation Certification Form 43 05 11-A as specified in paragraph 3.04.
8. Submit Training Certification Form 43 05 11-B as specified in paragraph 3.04.

C. Closeout Submittals
1. Comply with procedures described in Section 01 33 00.
2. Provide warranties as specified in paragraph 1.08.
3. Spare parts
   a. One (1) complete set of replacement brushes and necessary hardware.
   b. One (1) motor operator for the spray water ball valves.

## 1.06 QUALITY ASSURANCE

A. Factory Testing
1. Shall be performed according to the manufacturer's standard test procedures.
2. Provide certified test results as an Informational Submittal.

B. Performance Guarantee
1. Manufacturer must guarantee the equipment performance specified in paragraph 2.03 Performance/Design Criteria. The guarantee shall be in writing, signed by an officer of the manufacturing corporation, and notarized. Under no circumstances shall deviations from the specified operating conditions result in overload of the

driver furnished with the equipment, nor shall such deviations result in power requirements greater than the driver's nameplate (1.0 service factor) rating.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with procedures described in Section 01 66 00.

## 1.08 WARRANTIES

A. Equipment shall be covered against manufacturing defects in materials and workmanship during normal use and service for a period of one (1) year from date of startup.

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products satisfying the requirements of this section. The Screening Equipment shown on the drawings is based on the named supplier as the Basis of Design, all changes required in an alternate supplier will be the responsibility of the Contractor.

B. Candidate Manufacturers
   1. SAVI, THEBEAST FOG Station, Model VFA-1200DM.
   2. Approved Equal.



## 2.02 PERFORMANCE/DESIGN CRITERIA

A. Equipment Performance Requirements:

| Requirement | Value |
|---|---|
| Equipment Number | SCN-100 |
| Number of Units | 1 |
| Influent Type | Municipal FOG consisting of Grease Trap Waste and Waste from Wet Well Cleaning Activities |
| Average Solids Concentration (%TS) | 3%TS |
| Minimum Flow (gpm) | 300 |
| Maximum Flow (gpm) | 600 |
| Perforation size (mm) | 6 |
| Inlet Connection | 6-inch flanged |
| Outlet Connection | 10-inch flanged |
| Drum Motor HP | 2 |
| Screw Motor HP | 2 |

B. Equipment Utility Requirements

| Requirement | Value |
|---|---|
| Equipment Number | SCN-100 |
| Maximum Available Spray Wash - Hot Water (gpm/psi) | 33/40 |
| Maximum Available Spray Wash – 2W Water (gpm/psi) | 48/40-60 |
| Spray Wash Water Temperature (degree-F) | 120 |
| Power Supply | 460 V/3ph |
| Screen Installation Location | Indoor |
| Screen NFPA Classification Requirement | Unclassified |
| Control Panel Locations | Indoor |
| Control Panel NFPA Classification Requirement | Unclassified |

C. Dimensional requirements are as shown on Contract Drawings.

## 2.03 SYSTEM OPERATION

A. FOG Screening Equipment will start up when unloading of FOG begins and will be shut off when unloading is complete.

## 2.04 COMPONENTS

A. General
   1. Equipment provided shall be a fully automatic, self-cleaning, FOG receiving system incorporating a perforated plate screen and an integral screen and screenings washing, screenings conveying and dewatering/compacting system contained within a stainless steel tank.
   2. Each rotating drum screen unit shall be provided with a rotating screen basket, exterior basket cleaning spray bar(s), exterior basket cleaning brush, concentric transport screw with integral screenings washing, dewatering and screenings compaction zone.
   3. All parts and assemblies shall be 316 Stainless Steel unless otherwise noted.
   4. The system shall contain basic start and stop status indicators at the hauler control panel, along with all control logic required for the core operation and maintenance of the system.

B. Inlet Control Valve
   1. An inlet control valve for the FOG screening system shall be provided.
   2. The inlet valve shall be a Red Valve Series 5800 Electrical Actuated Control Pinch Valve or approved Equal.
      a. Ductile Iron body with Flanged ANSI B16.1 Class 125 end connections
      b. Buna-N sleeve and seals
      c. 316 Stainless steel stem, bolts, and hardware
   3. Actuator shall conform with the requirements of Section 40 05 57.23.

C. FOG Screen

1. Screening Basket:
    a. The drum screen basket shall be designed and built to withstand the maximum possible static hydraulic forces exerted on the screen by the liquid flow. Structural and functional parts shall be sized to prevent deflections or vibrations that may impair the screening, conveying, washing and compacting operations.
    b. The drum screen basket shall be of a cylindrical shape with perforations around the entire basket.
    c. The drum screen basket shall be mounted at the drive end using a large diameter, single row, heavy duty industrial bearing assembly with integral ring gear comprising part of the drive system. The bearing assembly shall have a built in grease fitting.
    d. The drum screen basket shall be perforated plate with maximum openings of 6mm. Bar screens, wire mesh or wedge wire, or stationary screens of any type will not be acceptable screen media.
    e. The drum shall have no support arms on the influent side of the screen basket to snag and accumulate long stringy solids. Screens with influent side support arms will not be accepted.
    f. The drum screen basket shall have angled lifting vanes to retain loose solids during rotation and lift them up and into the screw auger trough. Helical shaped vanes which can tumble screenings rather than lift screenings shall not be accepted.
    g. The screenings collection trough shall extend beyond the screen opening at the influent end to maximize solids capture and reduce screenings recycle.
    h. The drum screen basket shall be provided with a seal system incorporating an HDPE seal.
2. Drum Screen Basket Cleaning Brush and Spray Bar(s):
    a. The exterior of the rotating drum screen basket assembly shall be cleaned by hot and cold water high pressure stainless steel spray bars and a stainless steel backed polypropylene brush. The drum screen basket shall continuously rotate in one direction during the cleaning cycle and pass through the topmost portion where it is cleaned by the spray bar and brush.
    b. Exterior cleaning brush shall be mounted on a holding device which keeps the brush in constant contact with the screen basket and can be adjusted to compensate for brush wear.
3. Screenings Transport Screw and Dewatering Zone
    a. Screenings generated during the screening process (material larger than 6 mm diameter) shall be collected and transported out of the screening zone for washing and dewatering prior to discharge.
    b. The screenings transport screw shall be constructed of an epoxy coated high strength alloy steel for maximum torsion resistance in the screw. The screw shall be near-white blasted, primed with an inorganic zinc primer and coated with a 2-part epoxy with thickness of 12 – 16 mils.
    c. The transport tube shall be provided with four anti-rotation bars bolted from the outside along the longitudinal axis. The screenings transport screw shall not be dependent on the anti-rotation bars for support during normal operation.

d. The screenings collection trough shall be attached to the screenings transport tube by a drum support flange. The screw drive assembly shall be attached via a drive support flange welded to the upper end of the screenings transport tube.

e. The concentric transport/dewatering screw shall be designed to transport and dewater the screened material. The unit shall be provided with screw flights of constant pitch approaching the compaction zone to prevent clogging in the compaction zone. Designs incorporating a decreasing pitch screw will not be accepted.

f. The screenings transport screw shall be supported by a sealed, self-lubricating lower bronze bushing. The lower bushing shall be designed such that it does not take any thrust load from the transport screw. Designs requiring bearings of any type or externally lubricated bushing(s) or water injection into the housing shall not be accepted.

g. The compaction zone shall be integral to the transport screw and compaction tube. The compaction zone shall be designed to form a screenings plug and return water released from the screened material back to the tank through a wedge wire compaction zone.

h. A back-pressure iris place from SINT engineered polymer shall control the screenings dewatering and formed plug at the discharge end.

i. The compaction zone housing shall be fabricated entirely of stainless steel. The lower body shall be a welded construction with a minimum of 10 mm end plates for maximum torsion resistance. The bottom of the compaction zone shall be curved to promote maximum cleaning and minimum depositing of materials. Units utilizing a fiberglass reinforced compaction zone housing will not be accepted.

j. The compaction zone shall be furnished with a latched, hinged access cover with a gasket. The access cover shall incorporate a motor cut-out switch to prevent operation of the unit with the access cover open. Units which require the use of any tools to gain access to the compaction zone will not be accepted.

k. A heating pad shall be provided for the compaction zone. Electrical wiring routed to a factory mounted conduit box for field connection.

4. Spray Wash Systems

a. The compaction zone spray shall be furnished with a slow closing, solenoid valve, stainless steel piping and fittings, flexible reinforced hoses and spray nozzles.

b. Drum and tank flush spray systems shall each be furnished with an automatically controlled electrically actuated full port stainless steel ball valve, stainless steel piping and fittings, flexible reinforced hoses and spray nozzles.

c. Automatic spray wash systems for the screen shall be constructed of stainless steel piping and flexible reinforced hose rated for 50 psi. Spray wash system shall operate only when the screen basket is rotating.

d. The hot water drum spray system shall be furnished with a solenoid valve, stainless steel piping and fittings, flexible reinforced hoses and spray nozzles.

e. A drum wash system shall be located over the rotating perforated drum which utilizes a spray bar with adequate spray nozzles to ensure a consistent spray pattern over the entire length of the drum.

f. A screenings spray wash system shall be located in the lower section of the transport tube to break up and return organic materials to the flow stream and to ensure maximum screenings washing.

g. A compaction zone wash system shall be provided which periodically cleans the compaction and dewatering zone via a stainless steel wash system located in the uppermost end of the compaction and dewatering chamber. The header shall be designed to completely wash the full surface of the transport tube drainage area.

h. The hot water drum wash system shall be located over the rotating perforated drum which utilizes a spray bar(s) with adequate spray nozzles to ensure a consistent spray pattern over the entire length of the drum.

i. Hotwash water consumption shall not exceed 33 gpm at 40 psi. Protected water (2W) wash water consumption shall not exceed 48 gpm at 40-60 psi.

5. Tank
   a. The tank housing screening system shall be constructed from Type 316 stainless steel, incorporating covers, connections for odor control and spray wash assemblies and associated mechanical screening equipment.
   b. Vendor shall supply inlet and outlet flanges on the tank in locations such that general operation and performance is not hindered and alignment is consistent with the general arrangement outlined in the contract documents.
   c. The bottom of the influent section of the tank shall be sloped toward the screen to eliminate sedimentation.
   d. The inlet section of the tank shall be sized to match the inlet shape of the drum to prevent a wall for solids to dam and collect.
   e. The inlet stage of the tank shall be provided with a flush water system.
   f. the cover shall be provided with a keyed turn-lock. Tank and cover shall be spray water tight.
6. Drive Units
   a. The FOG receiving unit shall be a dual drive system which allows the drum and screw to be driven independently to optimize solids removal.
   b. Gear reducers shall be a helical gear type as manufactured by NORD or approved equal. Provide a cast iron frame; design in accordance with AGMA recommendations for wastewater service.
   c. Transport screw shall be directly driven by a flange mounted gear reducer.
   d. The transport screw gear reducer shall be bolted to a machined flange welded to the upper end of the transport tube.
   e. The rotating screen drum basket shall be driven by a flange mounted gear reducer using a spur gear and bull gear assembly.
   f. Gear reducers shall be driven by 240/480V, 3 ph, 60 hz motors rated for the installation environment location. Motor horsepower shall be as noted in Paragraph 2.02.
   g. Chain drives, belt drives, friction drives, or hydraulic drives will not be accepted.
   h. Designs incorporating a separate upper bearing for the transport screw will not be accepted.
7. Drum Retraction
   a. The complete screen assembly must be able to be retracted away from the front seal plate to allow for replacement of the seal without pivoting the screen or requiring lifting devices such as cranes or come along hoists.
   b. Units that require pivoting of the screen for seal replacement shall be required to provide a complete workable lifting system.

## 2.05 ELECTRICAL CONTROLS AND DEVICES

A. Control Panel: 480 volt primary control panel shall be provided with a type 316, stainless steel, NEMA 4X enclosure. Panel shall be suitable for wall mounting with the following electrical components to provide proper operation of the equipment:
   1. Main disconnect with through door interlock handle
   2. Step down control transformer
   3. Branch circuit protection
   4. Motor starter, soft start w/ overload (drum motor)
   5. Motor starter, reversing w/ overload (screw motor)
   6. Emergency stop pushbutton
   7. Hand-Off-Auto selector switches for drum and screw drive
   8. Hand-Off -Auto switches for screen drum and tank flush wash water electrically actuated ball valves
   9. Open-Close-Auto switch for compaction zone wash water solenoid valve
   10. Load monitors shall provide overload protection for drum and screw by sensing motor power factor
   11. Hour meter for each motor
   12. Control power on, run and fault indicating lights
   13. Alarm reset pushbutton
   14. Allen-Bradley Micro850 with Ethernet and required IO
   15. Operator Interface Unit, Allen Bradley PanelView 800 with 4 inch screen
   16. Run and alarm auxiliary contacts for use by the customer
   17. Intrinsically safe relay for level sensor
   18. Panel Heater, with Thermostat
   19. GFCI circuit breaker for compaction zone heating pad.
   20. UL508A label.

B. Motor Cut-out Switch: One (1) interlock switch suitable for the area classification shall be factory mounted to the compaction/discharge zone access door. Interlock switch shall prevent operation of the screen while the door is open.

C. Electrically Actuated Ball Valves: Provide two (2) electrically actuated full port 316 stainless steel ball valve to control flow to the drum spray wash and tank flush assemblies. The full port ball valve shall be 2-piece body, threaded ends, cast body from CF8M, 316 stainless steel, ball and stem from 316 stainless steel, and RTFE seats. Each valve shall be controlled by a NEMA 4X electric actuator with a housing from cast aluminum with thermally bonded polyester power coating, stainless steel output shaft, stainless steel fasteners, 120 volt, single phase, 60 Hz, two SPDT limit switches, and visual indication on valve position.

D. Solenoid Valves: Provide two (2) NEMA 4X slow closing solenoid valves to control flow to the compaction zone spray wash assembly and drum hot water spray. Valves shall have a brass body. Valves shall be 120 volt, single phase, 60 Hz.

E. Level Control: Provide one (1) non-contacting radar transmitter for operation of the unit by screen start level and high level. Unit shall not be affected by FOG, debris or foam.

The radar unit shall provide a 4-20mA level signal and be rated for installation in a Class 1, Div. 1/Div. 2 area when using an intrinsically safe circuit. The sensor shall be supplied with 33 feet of integral cable.

F. One (1) ambient temperature thermostat shall be provided to control power to the compaction zone heat pad. The thermostat shall be 120 Volt, single phase, 60 Hz with a NEMA 4X housing. The temperature set point shall be selectable by an adjustable dial.

G. One (1) NEMA 4X 304 stainless steel Remote Indication Station complete with –
   1. System ready pilot light (green).
   2. Valve closed pilot light (red).
   3. High level pilot light (yellow) - flashes at high level and changes solid/on when inlet valve starts closing.
   4. One (1) high level alarm horn.
   5. Screen On/Off Pushbutton.
   6. Screen running indication light.

## 2.06 EQUIPMENT MOUNTS

A. Mounting plates
   1. Screening equipment shall be rigidly mounted on a Type I baseplate as defined in Section 43 05 13.
   2. Equipment shall be supported on a common concrete equipment pad, as specified.
   3. Mounting plate shall be leveled to 0.1 inch/foot or less.

B. Grout Type
   1. Use epoxy grout per Section 03 60 00.

C. Equipment Anchors
   1. Install per Standard Detail D01001.

D. Equipment Anchor Sleeves
   1. Install per Section 43 05 13.
   2. Length shall not be less than 6D (D = nominal bolt diameter; bolt diameter determined by mounting plate manufacturer).

E. Equipment Pad
   1. Install per Standard Detail D01006.

## 2.07 MOTOR AND DRIVE UNIT

A. Electric motors shall conform to the requirements of paragraph 2.03.C, Design Requirements and Section 43 05 21.

## 2.08 CONTROLS

A. See Section 40 61 96 for pumping equipment and system control strategies.

## 2.09 FINISHES

A. Comply with procedures described in Section 09 90 00.

B. Stainless steel components shall not be coated.

## PART 3 EXECUTION

## 3.01 ALIGNMENT

A. Comply with procedures described in Section 43 05 14.

## 3.02 FIELD QUALITY CONTROL

A. Field Testing
   1. Test equipment and systems as specified in Section 01 45 20, including:
      a. Performance Tests: Note that the functional tests specified in Section 01 45 20 shall include measurement of equipment performance.
      b. Operational Tests
         1) Testing period shall not be less than 48 hours.
         2) Coordinate operational testing with the demonstration and training requirements specified in Section 01 79 00.
   2. Include in the bid all costs for services of Testing Firms and Design Professionals performing these services.

B. Manufacturer Services
   1. On-Site Inspections and Training
      a. Provide a factory-trained manufacturer's representative at the Site for the following activities. Specified durations do not include travel time to or from Site.
         1) Installation inspections
            a) Assist, supervise, and inspect the Contractor's activities during installation.
            b) Provide 4 inspection hours.
            c) Provide a completed Form 43 05 11-A, Section 01 99 90.
         2) Component test phase inspections
            a) Assist, supervise, and inspect the Contractor's activities during the component test phase specified in Section 01 45 20 and this section.
            b) Provide 4 inspection hours.
         3) System test phase inspections
            a) Assist, supervise, and inspect the Contractor's activities during the system test phase specified in Section 01 45 20.
            b) Provide 8 inspection hours.
         4) Operational test phase inspections
            a) Assist, supervise, and inspect the Contractor's activities during the operational test phase specified in Section 01 45 20.
            b) Provide 8 inspection hours.

5) Training Sessions
   a) Comply with procedures described in Section 01 79 00.
   b) Provide a minimum of 8 hours classroom training for each training session.
   c) Conduct two training sessions, one training session per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff.
   d) Certify completion of training on Form 43 05 11-B, Section 01 99 90.

## 3.03 SYSTEMS START UP

A. Comply with procedures described in Section 01 45 20.

B. Commissioning
   1. See section 01 91 00.
   2. Minimum period of successful operation, as part of a system, shall be 1 week on specified process fluid.

**END OF SECTION**